Journal of Global Business and Trade

Vol. 19 No. 5 October 2023

1 Personality, Behavior, and Performance of Platform Workers: Evidence from Vietnam
Nguyet Nguyen, Thi Hoang Ha Tran

17 External Cost-Benefit of Emission Control Routes between Korea and China Liner Shipping Networks
Jeho Hwang, Sihyun Kim

37 A Study on the Effect of Technical Barriers to Trade (TBT) Measures on Imports from China and Employment in Korea
Chan-Hyo Park, Dong-Joo Lee

55 Linking Supply Chain Alliance Orientation to Market Performance: Evidence from South Korean Firms
Charles Arthur Robb, Minhyo Kang, Aaron Rae Stephens, Seogsoo Kim

77 The Influence of Seller Reputation and Trust in Streamers on Live Stream Shopping Purchase Intention: The Moderation Effect of Country Image
Fan Zhou, De-Kui Li, Ki-Hyung Bae

95 Analyzing Differences in Cruise Tourist Decision: Making Processes Based on Value Perception
Miseong Kim, Yeonghye Yoon

111 An Analysis of the Impact of COVID-19 on Logistics Performance: A Case of the Port of Koper
Young-Kyou Ha

125 A Study on the Digital Trade Transaction Paradigm of Middle-Aged and Senior Citizens in Korea: The Mediating Effect of E-commerce Usage Level
Hyuk Kwon

141 Determinants of Switching Behavior of New Energy Vehicles in China: Evidence from Subjective Norms
Jingwen Wu, Menghua Li, Sok-Tae Kim

171 Current Status and Policy Direction of the Age-Friendly Industry in Korea
So-Jin Kim

185 Impact of Economic Policy Uncertainty on the Outward Foreign Direct Investment of Chinese Firms
Yuhan Meng, Gahee Bak, Hongshik Lee

203 Does CEO Power Affect the Relations between CEO Compensation and Risk-Taking?
Yong Jae Shin, Unyong Pyo, Fan Ye

229 The Russia-Ukraine War and Its Impact on the Food Security of Korea, China, and Japan: A CGE Approach
Esambe Sone, Jong-Hwan Ko

International Academy of Global Business and Trade

Journal of Global Business and Trade Vol. 19 No. 5 October 2023 IAGBT

ISSN 1946-5130 (Print)
ISSN 2470-4733 (Online)

Journal of Global Business and Trade

Vol. 19 No. 5 October 2023

Published by
International Academy of Global Business and Trade

The Journal of Global Business and Trade

IAGBT

www.pfw.edu/jgbt

Journal of Global Business and Trade

indexed and abstracted in **SCOPUS**

ISSN 1946-5130 (Print)
ISSN 2470-4733 (Online)

About Journal

Journal of Global Business and Trade (JGBT) is the official publication of the International Academy of Global Business and Trade (IAGBT) and is published by IAGBT on a semiannual basis. JGBT is the leading peer-reviewed, scholarly journal that publishes research across the entire range of topics encompassing the domain of global business and trade.

JGBT aims to be a resource for the advancement of the theoretical foundations and the practical applications in the context of Asia-Pacific global business, trade and economy. The journal takes a broad perspective of the global economy by covering many vibrant sectors such as manufacturing, retailing, international trade, agricultural economy, tourism, and information technology, just to name a few. The journal will publish research papers, reports, and commentaries of significant interest to the community engaged in global business and trade. By being a conduit for sharing intellectual ideas and opinions among the academia and individual global industry sectors, the journal aims to bridge the gap between research and sound decision-making.

JGBT is the only business journal that highlights a diversity of perspectives through research papers, reports, and commentaries of significant interest to the international business and trade community.

JGBT enhances sound research through quick and constructive review of the manuscripts submitted.

JGBT aims to appeal to academics, government representatives, business major students, business and industry professionals, and trade organizations.

ISO abbreviation of journal title

The official title of the journal is 'Journal of Global Business and Trade' and the abbreviated title is 'J. Glob. Bus. Trade'

Year of launching (history)

Journal of Global Business and Trade was launched in 2005.

Availability of the full-text in the web

Full text is freely available from: https://www.pfw.edu/jgbt

Fund support

This journal was supported by the International Academy of Global Business and Trade.

Index in database

The articles published in this journal are indexed and/or abstracted in SCOPUS, EBSCO, ProQuest, Exribris, and GoogleScholar.

Subscription information

All correspondences regarding membership, subscriptions and changes of address should be sent to the society addressed as below:
International Academy of Global Business and Trade, 2101 E. Coliseum Boulevard, Fort Wayne, IN 46805, U.S.A. (Tel: 1.260.481.6794, Fax: 1.260.481.6879, E-mail: myeonghwan.kim@pfw.edu, Homepage: https://www.pfw.edu/jgbt). The annual subscription fees are free of charge.

Submission

The IAGBT operates an on-line submission system. Details of how to submit online and full author instructions can be found at: https://www.pfw.edu/jgbt. Manuscripts should be submitted to the on-line submission system at http://www.jgbt.us following all prompts on the screen. Other correspondences can be sent by e-mail to the editor Myeong Hwan Kim at myeonghwan.kim@pfw.edu.

Peer review under responsibility of International Academy of Global Business and Trade.

Journal of Global Business and Trade Volume 19, Number 5

Published 30 October 2023

Publisher (Editorial office)

International Academy of Global Business and Trade founded in 2005,
2101 E. Coliseum Boulevard, Fort Wayne, IN 46805, U.S.A. (Tel: 1.260.481.6794, Fax: 1.260.481.6879,
E-mail: myeonghwan.kim@pfw.edu, Homepage: https://www.pfw.edu/jgbt).

Copyright

ⓒ 2023 International Academy of Global Business and Trade. All rights reserved.

Editorial Staff

The Journal of Global Business and Trade (JGBT) editorial team is committed to providing subscribers with the best quality articles in a timely manner, ensuring a journal that subscribers will find stimulating and useful in their teaching and professional activities.

Editor-in- Chief

Soonhwan Jeon — Joongbu University, Korea

Editor

Myeong Hwan Kim — Purdue University Fort Wayne, U.S.A.

Associate Editor

Adriana Grigorescu — National School of Political Studies and Public Administration, Romania

Erendira Yareth Vargas Lopez — University of Colima, Mexico

Editorial Advisory Board (Past Editor)

Radesh Palakurthi — The University of Memphis, U.S.A.

Shin-Kyuo Lee — Paichai University, Korea

Editorial Review Board

Alice Y. Ouyang — Central University of Finance and Economics, China
Amelia L. Bello — University of the Philippines Los Banos, Philippines
Bhuyan Iqbal — Daffodil International University, Bangladesh
Chang E. Koh — University of North Texas, U.S.A.
Chiehwei Hung — Feng-Chia University, Taiwan
Constantin Holzer — University College Cork, Ireland
Dalsang Chung — Governors State University, U.S.A.
Eddy Junarsin — Universitas Gadjah Mada, Indonesia
Eric M. P. Chiu — National Chung-Hsing University, Taiwan
Greg M. Richey — University of California Riverside, U.S.A.
Hong Mu Lee — Waseda University, Japan
Hui-Tzu Lin — Ling Tung University, Taiwan
Inhyuck "Steve" Ha — Western Carolina University, U.S.A.
Jaekyung Ko — Jeju National University, Korea
Jeanette Angeline B. Madamba — University of the Philippines Los Banos, Philippines
Jie Li — Central University of Finance and Economics, China
Junhee Seok — Chungnam National University, Korea
Kankesu Jayanthakumaran — University of Wollongong, Australia
Kazuyo Sekiguchi — Tokyo Keizai University, Japan
Ker-Tah Hsu — National Taichung University of Education, Taiwan
Peter Ractham — Thammasat University, Thailand
Samuel M. Schreyer — Fort Hays State University, U.S.A.
Sang-Soo Chang — Asia University, Japan
Seo-Young Lee — Mokwon University, Republic of Korea
Seung-Lae Kim — Drexel University, U.S.A.
Shanyue Jin — Gachon University, Korea
Shuai Su — Shandong University of Political Science and Law, China
Sok-Tae Kim — Dongguk University, Korea
Sun Gi Chun — Alabama State University, U.S.A.
Taewoo Roh — Hanyang University, Korea
Tongshui Xia — Shandong Normal University, China
Tungalag. J. — National University of Mongolia, Mongolia
Victor Raul Lopez Ruiz — University of Castilla-La Mancha, Spain
Xingle Long — Jiangsu University, China
Yongseung Han — University of North Georgia, U.S.A.
Yoon-Min Kim — Keimyung University, Korea
Yoshio Ito — Asia University, Japan
Young Cheol Jung — Mount Royal University, Canada
Young-Joon Seo — Kyungpook National University, Korea
Yu Luo — Remmin University of China, China
Zuankuo Liu — Shandong Normal University, China

Manuscript Editor

Hyun-Sup Choi — Kyobo Centre Co., Ltd., Korea

Journal of Global Business and Trade

Vol. 19 No. 5 October 2023

1 Personality, Behavior, and Performance of Platform Workers: Evidence from Vietnam
Nguyet Nguyen, Thi Hoang Ha Tran

17 External Cost-Benefit of Emission Control Routes between Korea and China Liner Shipping Networks
Jeho Hwang, Sihyun Kim

37 A Study on the Effect of Technical Barriers to Trade (TBT) Measures on Imports from China and Employment in Korea
Chan-Hyo Park, Dong-Joo Lee

55 Linking Supply Chain Alliance Orientation to Market Performance: Evidence from South Korean Firms
Charles Arthur Robb, Minhyo Kang, Aaron Rae Stephens, Seogsoo Kim

77 The Influence of Seller Reputation and Trust in Streamers on Live Stream Shopping Purchase Intention: The Moderation Effect of Country Image
Fan Zhou, De-Kui Li, Ki-Hyung Bae

95 Analyzing Differences in Cruise Tourist Decision: Making Processes Based on Value Perception
Miseong Kim, Yeonghye Yoon

111 An Analysis of the Impact of COVID-19 on Logistics Performance: A Case of the Port of Koper
Young-Kyou Ha

125 A Study on the Digital Trade Transaction Paradigm of Middle-Aged and Senior Citizens in Korea: The Mediating Effect of E-commerce Usage Level
Hyuk Kwon

141 Determinants of Switching Behavior of New Energy Vehicles in China: Evidence from Subjective Norms
Jingwen Wu, Menghua Li, Sok-Tae Kim

171 Current Status and Policy Direction of the Age-Friendly Industry in Korea
So-Jin Kim

185 Impact of Economic Policy Uncertainty on the Outward Foreign Direct Investment of Chinese Firms
Yuhan Meng, Gahee Bak, Hongshik Lee

203 Does CEO Power Affect the Relations between CEO Compensation and Risk-Taking?
Yong Jae Shin, Unyong Pyo, Fan Ye

229 The Russia-Ukraine War and Its Impact on the Food Security of Korea, China, and Japan: A CGE Approach
Esambe Sone, Jong-Hwan Ko

The Journal of Global Business and Trade
IAGBT
www.pfw.edu/jgbt

ISSN 1946-5130 (Print), ISSN 2470-4733 (Online)
http://dx.doi.org/10.20294/jgbt.2023.19.5.1

The Journal of Global Business and Trade

Journal of Global Business and Trade

https://www.pfw.edu/jgbt

Personality, Behavior, and Performance of Platform Workers: Evidence from Vietnam*

Nguyet Nguyen[a], Thi Hoang Ha Tran[b]**

[ab]*Business Administration Faculty, Thuongmai University, Vietnam*

Received 1 July 2023, Revised 11 August 2023, Accepted 5 October 2023

ABSTRACT

Purpose – Based on personality - job fit theory (Kristof-Brown, 2006) and social exchange theory (Blau, 2017) we explaine evidence of the relationship between proactive personality, proactive feedback seeking behavior, and the job performance of platform workers. We also examine the moderating role of perceived organizational support in relationship between proactive personality and feedback seeking behavior and job autonomy as a moderating role between the proactive feedback seeking behavior and job performance of platform workers.

Design/Methodology/Approach – This study follows structural equation modeling following a partial least square method on a sample group of 171 platform workers selected by convenient random sampling techniques and analyzed by SmarlPLS 4.0 to test research hypotheses.

Findings – Research findings show that proactive personality plays an important role in promoting proactive behavior seeking feedback and job performance, and affirms the positive moderating role of perceived platform support between feedback seeking behavior and proactive personality. The study also confirmed that proactive feedback seeking behavior has a direct and indirect impact on the performance of platform workers, and this relationship is further strengthened in conditions of highly autonomous work.

Research Implications – Some implications of human resource management on digital labor platforms are also proposed to improve the efficiency of human resource management.

Keywords: feedback seeking behavior, job autonomy, job performance, perceived platform supports, platform workers, proactive personality

JEL Classifications: J50, M12, M51, M52, M54

* *The research was funded by Thuongmai University, Hanoi, Vietnam.*
** *Corresponding Author, E-mail: mynguyet@tmu.edu.vn*
© 2023 International Academy of Global Business and Trade. All rights reserved.

I. Introduction

The free economy creates beneficial conditions for the development of digital technology as an intermediary between individuals (platform labor or businesses) and customers, simultaneously attracting labor (platform workers) to provide services through applications (ILO, 2021). The salient feature of platform employment is the relationship between workers and separated and dispersed enterprises; workers can be flexible and proactive at work, but the lack of certainty and formal supervision in the traditional employment environment (Hien et al., 2021). Instead, operating platforms rely heavily on the participation of labor and the establishment of policies to motivate employees to actively improve work efficiency to contribute to the achievement of the organization's goals (Wiesenfeld et al., 2001). Therefore, in this form of work, proactive worker personality is recognized as a decisive factor for the job performance and the level of contribution to the platform. When a worker has a proactive personality, it tends to control the situation and take initiative to adapt to the working environment. Therefore, the development of governance activities for platform workers, such as attracting new workers, promoting, and maintaining the participation of proactive workers, plays an important role for the existence and development of digital labor platforms (Shin & Jeung, 2019). Therefore, a study of proactive personality, factors influencing the proactive behavior of platform workers, and decisions that encourage these behaviors in order to enhance work outcomes is necessary in the context of the development and sustainability of digital labor platforms. This largely depends on the engagement and, more importantly, continuous participation of workers (Sun et al., 2015). The theory of job-appropriate personality by Holland (1997) suggested that personality characteristics of individuals reveal their ability to adapt to work, specifically in that personality characteristics that match job characteristics increase work productivity and job satisfaction. The unique personality of the individual creates a tendency to be consistent when situations arise that trigger the personality of the individual to actively perform positive behaviors to solve the situation (Tett & Burnett, 2003). This proactive personality aims to align the external environment with personal factors through a number of activities such as seeking feedback, negotiating, and forming career initiatives (Parker & Collins, 2010). However, according to social exchange theory, workers will be more proactive and effortful at work when they feel repayment from the organization (Blau, 2017; Cropanzano & Mitchell, 2005). Positive emotions as a result of receiving support from the organization contribute to improving worker efficiency (Ford et al., 2018). In addition, job autonomy play an important role in promoting the proactive personality and behaviors of workers. A job that provides freedom and self-determination for workers is a suitable environment for employees to express initiative and creativity (Hackman & Oldham, 1976). In a platform job that offers proactive and flexible working times, workers can determine when to work depending on their own working conditions, suitability with their capabilities, and circumstances. Workers must be proactive if they want to achieve the desired level of reward and income. Proactive platform workers often place the focus on tasks performed, actively learning and growing knowledge and skills to meet the requirements of the task. On the other hand, in a that lacks the supervision of the platform, the work performance of platform workers is measured and evaluated based on customer feedback. Platform workers must proactively perform evaluation seeking to help properly perceive their own capacity, constantly improving to achieve higher work results. Proactive behavior depends on policy support from the platform, such as information support, providing additional resources for workers to successfully complete tasks, and the level of autonomy in each task. The issue of basic human resource management is still a young topic compared to the traditional context, so it is necessary to provide more evidence of this issue

in the context of the strong increase of digital labor platforms.

The paper focuses on the relationship between proactive personality, proactive behavior seeking feedback, and job performance, as well as the mediating role of feedback-seeking behavior with the relationship between proactive personality and job performance, and considers the modertating role of organizational support and work autonomy in these relationships in the context of digital labor platforms in Vietnam. The study makes use of personality - job fit theory and social exchange theory in explaining these relationships (Blau, 2017; Kristof-Brown, 2006). This research contributes significantly to the management of digital labor platforms in promoting the proactive behaviors of workers.

II. Literature Review and Hypotheses

1. Proactive Personality, Proactive Feedback Seeking Behavior, and Platform Workers Performance

Job performance is an important concern for both individuals and organizations. Job performance is described as the extent to which workers perform tasks and responsibilities, including the quantity and quality that individuals achieve (Mak et al., 2011). In organizational terms, policies, procedures, and work outcomes demonstrate a level of job responsiveness appropriate to individual resources (Pineda-Herrero, 2010). Pradhan and Jena (2016) pointed out three components of job performance: task, adaptive, and contextual performance. In this study, the job performance of platform workers was based on contextual performance for several reasons. On (1) digital labor platforms, customer satisfaction determines the performance of workers. This is based on feedback to rate platform worker performance (Meijerink & Keegan, 2019). Most (2) digital platform workers spend their time interacting with customers. This results in digital platforms workers that are more likely to engage in customer-directed Organizational Citizenship Behavior (OCB). Unlike traditional OCB that is much more focused on employees and organizations, customer-directed OCB focuses on customers (Brown et al., 2002). Customer-directed (3) OCB includes understanding customer needs, helping customers, and improving customer service. Moreover, platform workers perceive future work-requests depending on customer ratings on the platform (Brown et al., 2002).

Job autonomy refers to the degree of freedom, independence, and right to self-determination in the process of scheduling or work processes (Oldham & Hackman, 2010). Jobs that have high level of autonomy will require high responsibility in reality. Job autonomy is a key characteristic that is particularly relevant to job engagement in the level of autonomy afforded to workers (Zheng et al., 2011). Morgeson and Humphrey (2006) suggested that the job autonomy has three components of self-determination: decision making, self-determination work methodology, and self-development. An intrinsic motivating factor of platform workers is the openness of work, which gives workers the power to choose tasks, and how they are to be performed (Ye & Kankanhalli, 2017).

Perceived organizational support concerns employee beliefs about the extent to which the organization recognizes their contributions and concern for happiness (Eisenberger & Stinglhamber, 2011). They perceive the support of the organization, including the awareness of the organization's attitude toward them (Shore & & Tetrick, 1991). Perceiving the support of the organization is a method of supporting activities including: resources, information support to understand and solve problems, support by the organization leader, and policies for compensation and benefits (Eisenberger & Stinglhamber, 2011; Kurtessis et al., 2015).

A proactive personality is a way in which individuals respond to environmental factors

through actions (Bateman & Crant, 1993). It is characteristic of an individual to consistently identify opportunities and try to act appropriately to produce desired results (Crant, 2000). A proactive personality demonstrates self-determination and confidence in finding opportunities and solutions in actions to improve work performance. A proactive personality plays a decisive role that allows platform workers to identify opportunities and solve problems at work (Crant, 2000).

Proactive behaviors are behaviors that employees actively perform to improve working conditions, or new behaviors in response to inappropriate working conditions (Grant & Ashford, 2008). Proactive behavior at work focuses on the future with the goal of making changes, or adjusting yourself to the context (Ashford et al., 2018). The performance of a variety of tasks promotes proactive behavior at work in anticipation of external changes and uncertainties that may affect work. With the characteristics of labor, this study chooses active behavior at work as the behavior of actively seeking feedback from customers. First, feedback at work is evaluation information about the quality of the work of the employee. Positive feedback helps improve external motivation (Gagné & Deci, 2005). In technology delivery services, a requestor provides feedback on the quality of services provided by employees, and these are grounds for establishing a reward and penalty mechanism as to understand employees feedback (Bederson & Quinn, 2011).

Proactive personality can be viewed as a: this perspective suggests that houses can be damaged, and be damaged by people in the house (Bateman & Crant, 1993). Greguras and Diefedorff (2010) showed that proactive personality predicted performance and organizational citizenship behaviors. According to Crant (2000), proactivity has a positive impact on employee attitudes and behaviors because proactive individuals identify or create opportunities that create favorable conditions for individual or team effectiveness. Proactive individuals are not limited by resources and situations. They also find opportunities and act, propose, perform, and process until a change is made (Crant, 2000). In addition, Kim et al. (2010) showed that the proactive people have many possibilities, determined new processes. Erdogan and Bauer (2005) and Kim and Wang (2008) found a gap between mastery and search, speeding up the process. Anseel et al. (2005) argued that proactive workers often seek feedback from stakeholders in order to reduce environmental uncertainty in order to achieve improved efficiency through work. Meanwhile, employees can have both positive emotions and high levels of self-improvement and efficiency (Bergeron et al., 2014). On the basis of this overview, we formulated the following hypothesis.

H1: Proactive personality has a positive impact on the proactive feedback seeking behavior of platform workers.

Feedback is of great value in helping employees achieve goals and adjust work behavior (Ashford et al., 2003). It is a valuable resource for achieving goals through the adjustment process. At the beginning of the work, behaviors to seek feedback from the stakeholders are considered a basis for improving the work process and creating a high level of effectiveness that will create self-confidence in workers; that will they have the ability to redesign the work process and master the situation (Nae et al., 2015). Feedback-seeking behavior is the effort of employees to ask superiors, colleagues, or customers to provide an assessment of their work results, the results of which allow employees to actively use their resources to improve work results (Bakker et al., 2012).

H2: Job feedback seeking behavior has a positive impact on the job performance of platform workers.

Proactive workers are considered crucial to the organization because they are more productive

(Kammeyer-Mueller et al., 2013). This initiative helps them adapt to new tasks faster by grasping the work environment and understanding the work faster (Zhang et al., 2012). Proactivity in planning, understanding work, and actively improving work methods positively impacts work results (Bakker et al., 2012). According to personality - job fit (Kristof-Brown, 2006), employee personality has the ability to predict individual job performance, including career success, job performance (Kim et al., 2010), innovation and creativity (Parker & Collins, 2010). We form the third hypothesis below.

H3: Proactive personality has a positive impact on the job performance of platform workers.

2. Moderating Role of Perceived Platform Support and Job Autonomy

According to Bamberger and Belogolovsky (2017), it is very difficult to achieve a high job performance without supporing from organization. Fuller et al., (2012) and Li et al. (2010) indicated that proactive behavior depends on the opportuinity tobe proactive. According to organizational support theory (Eisenberger & Stinglhamber, 2011), when an organization appreciates employee dedication and considers their benefits, the staff will take pride in being a member of the organization and continuously make efforts to improve work performance, and to perform behaviors that exceed the organization's requirements, such as engaging in proactive behavior. In order to find out if workers are interested in the organization, they need to feel adequate in the support of the organization and will help to actively participate in behaviors tow the understand the results, and specifically seek feedback from stakeholders to actively improve. Organizational support theory suggests that when workers feel support from an organization, they will feel affection for the organization. This makes them feel obligated to commit to the organization (Eisenberger & Stinglhamber, 2011). Perceived organizational support leads to positive job attitudes and behaviors. When people are in need of knowledge support, resources, and identify with the meaning of the organization, the effort to adapt to the organization will be shown by improving work capacity through the input of customers, supervisors, colleagues (Qian et al., 2018). This results in both benefits to the organization and employee; employees improve positive attitudes and organizations reap the benefits of perceived organizational support. In such a situation, workers actively managed by digital labor platforms tend to view themselves as employees (Maleki & Kuhn, 2017). Given this past research, this study proposes the following hypothesis.

H4: Platform support perception plays a moderating role between proactive personality and the proactive feedback seeking behavior of platform workers.

The relationship between proactive behavior and work outcome can change depending on the "health" of each worker. The behavior of the individuals will be strong in random or forecasted situations. Accidental situations are considered to be a repository of explicit expectations about appropriate behavior providing incentives to perform desired behaviors (Nguyen et al., 2020). In organizations, self-control is used to measure the health of the infrastructure at work (Sørlie et al., 2022). Hackman and Oldham (1976) defined autonomy as the level of freedom that people have to schedule and determine the way they complete their work. Job autonomy allows the worker change work in order to improve behaviors and proactivity (Frese et al., 2007). Some studies have shown the relationship between job automy and proactive behaviors, including receiving comments from stakeholders and owner actions in developing new work processes (Tornau & Frese, 2013). Wang et al. (2017) pointed out that job autonomy moderates the relationship between proactivity and participation, from which work isaffected to some extent. Even when an employee works in an environment with high autonomy, personality

is activated. Job autonomy leads to high self-confidence (Saragih, 2011). In some cases with a low level of autonomy, the operation of factories can be affected because monitoring for errors and rules prevent freedom. Therefore, in a low job autonomy, worker behaviors are less likely to contribute to job performance because they have no ability or benefit from being able to shape these behaviors. Thus, we formulated the following hypothesis.

H5: Job autonomy plays a moderating role between proactive feedback seeking behavior and the job performance of platform workers.

3. The Mediating Role of Proactive Behavior Seeking Feedback

A critical function of feedback is to regulate behavior by helping employees work toward defined goals. Therefore, seeking feedback can help workers determine whether work meets standards (Tuckey et al., 2010) Based on conservation of resources theory, proactivity is a critical individual resource, especially for marketing employees required to take initiative and plan work. To improve function at work, proactive people use personal resources to seek feedback from supervisors (Putra Utama & Eflina Purba, 2019). Feedback is an important factor that enables proactive people to improve performance and influence results. Seeking feedback is a three-stage process, consisting of motivation, cognition, and behavior (McCormick et al., 2019), in which initiative in personality leads to the information seeking behavior of of employees (Dahling et al., 2015; Harrison et al., 2015). At the same time, it promotes the improvement of work results. The respective hypothesis is formed below.

H6: Proactive behavior seeking feedback plays a mediating role between proactive feedback seeking behavior and the job performance of platform workers.

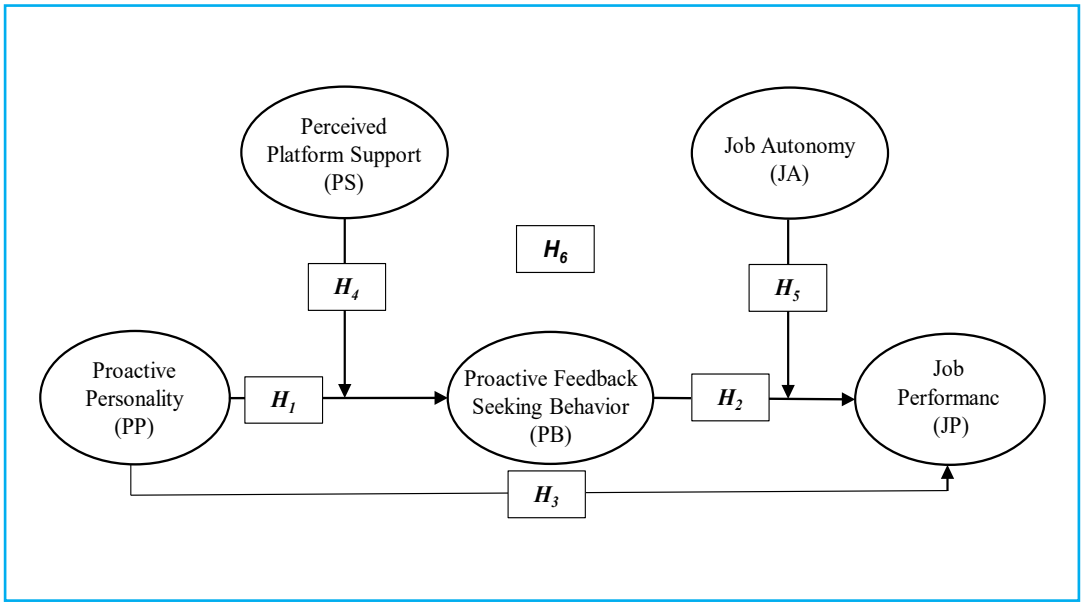
III. Methodology

This study explores the relationship between proactive personality, proactive behaviors that seek feedback, work outcomes, and the moderation of platform support and job autonomy of platform workers. Therefore, this approach focuses on workers participating in online labor platforms, including driving and delivery. A questionnaire was designed with scales adjusted from previous studies and evaluated for relevance by experts in the field of human resource management to ensure suitability. The questionnaire consists of 32 questions in two main parts; the (1) general information of respondents, and (2) questions to comment on the variables of the study. Respondent platform workers could respond on a seven-point scale ranging from “1 - strongly disagree” to “7 - strongly agree”. The questionnaire sets out the research purposes, and the voluntary nature of the survey ensures confidentiality and consent of survey participants. A total of 500 questionnaires were distributed through online forums and communities, delivery groups, and technology drivers, including Baemin, ShopeeFood, GrabFood, Bee, and Grab. At the end of collection, there were 172 useable questionnaires to be included in the study. In particular, in terms of gender, there were 83.72% male and 16.28% female. in terms of age, 35.4% of workers were 25-44, accounting for 48.84% and over 45 accounted for 15.76%. In terms of employment, 31.40% were part-time workers, and 68.60% were full-time workers, in terms of work experience, 5.23% of employees worked for more than 3 years, 46.52% of employees have worked for 1-3 years, and 48.26% of employees worked for less than 1 year.

The research model proposes five concepts including: Proactive Personality, Proactive Behavior Seeking Feedback, Work Outcome, Organizational Support, and Work Autonomy (Fig. 1). The scale of the research model was taken from previous research. In particular, the proactivity scale was assessed with four items developed by Bateman and Crant (1993), work

outcome was measured using four items adopting Sobaih et al. (2019), behavioral proactivity scale was adjusted from Parker and Collins (2010), the job autonomy scale consisted of four variables based on items from Oldham and Hackman (2010), and platform support was assessed with four items used in the research of (Eisenberger & Stinglhamber, 2011).

Fig. 1. Research Model



Source: compiled by the authors.

Collected data were were processed and analyzed through the PLS-SEM method. The research model has independent variables, dependent variables, and moderating and mediating variables. Therefore, the model was tested in two steps with structural equation modeling (Hair et al., 2019). First, we evaluate the measurement model to test the validity and reliability of the instruments, and next we evaluate the structural model through boostrapping results to test the hypothesis.

IV. Research Results

1. Measurement Model Assessment

The measurement model was evaluated through the determination of factors. Outer loading should be greater than 0.5, Composite Reliability (CR) should be greater than 0.7, and average variance extracted (AVE) should be greater than 0.5 for first-order variables. The results (Table 1) show that the outer loading in the model ranges from 0.706 - 0.915. The composite reliability (CR) in the research model reaches a value greater than 0.7 (fluctuations in the range of 0.825 to 0.915), which indicates that the internal consistency of the measure is sufficiently reliable. All structures in this study reached a minimum of 0.653 AVE. Therefore, the conclusion is that the study demonstrates sufficient convergence effectiveness (Hair et al., 2019).

Table 1. Evaluation of the Measurement Model

Code	Number of Items	Outer Loading	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
JA	4	0.868-0,915	0.908	0.913	0.783
JP	4	0.743-0,859	0.822	0.831	0.653
PB	4	0.729-0,843	0.824	0.825	0.656
PP	4	0.706-0,862	0.828	0.850	0.661
PS	4	0.852-0.910	0.902	0.915	0.772

Note: PP - Proactive Personality; PB - Proactive Feedback Seeking Behavior; PS - Perceived Platform Supports; JA - Job Autonomy JP - Job Performance.
Source: Data processed.

In addition, the results of the HTMT coefficient (Table 2) reached its highest value at 0.734, lower than the stricter criterion of 0.85 (Henseler et al., 2015), so the measurement items were both valid and reliable.

Table 2. Results of the HTMT Coefficient Test

	JA	JP	PB	PP	PS	PS x PP	JA x PB
JA							
JP	0.470						
PB	0.310	0.633					
PP	0.381	0.734	0.687				
PS	0.110	0.334	0.397	0.232			
PS x PP	0.201	0.175	0.187	0.133	0.119		
JA x PB	0.038	0.301	0.107	0.168	0.195	0.001	

Note: PP - Proactive Personality; PB - Proactive Feedback Seeking Behavior; PS - Perceived Platform Supports; JA - Job Autonomy JP - Job Performance.
Source: Data processed.

2. Structural Model Assessment

The model estimation results used the bootstraping method on 5,000 samples in which the VIF values of the scales in the model were between 1.416 - 3.662, smaller than the proposed level 5 (Hair et al., 2014), so the model did not suffer from multicollinearity.

Table 3. Forecasting Level

Factor	R2 Correction	Forecasting Level	Q2	Forecasting Level
PB	0.392	High	0.367	Meaningful
JP	0.484	Average	0.455	Meaningful

Note: PP - Proactive Personality; PB - Proactive Feedback Seeking Behavior; PS - Perceived Platform Supports; JA - Job Autonomy JP - Job Performance.
Source: Data processed.

The results of the forecast level of the research model (Table 3) show that the adjusted R2 value of the Proactive Feedback Seeking Behavior and Job Performance variables reached 0.392 and 0.484, respectively, with a high influence between independent variables on the dependent variable (the average proposed by Wetzels and Odekerken (2009) is 0.26). The Q2 values of the dependent variables reach values of 0.356 and 0.455, respectively, demonstrating a high degree of inter-variable impact (Hair et al., 2014). The results of the coefficients of f2 of the relationships all reach values greater than 0.03 $f^2_{PP-JP} = 0.183$ và $f^2_{PB-JP} = 0.067$ $f^2_{PP-PB} = 0.396$, $f^2_{PPxPS-PB} = 0.030$, and $f^2_{PBxJA-JP} = 0.069$, and represent the degree of correlation between the variables (Cohen, 1989).

3. Hypothesis Test Results

Some noteworthy findings from the results (Table 4) of the study on the influence of proactive personality and work results with the mediation of the support of the foundation and the work autonomy are shown below.

Table 4. Hypothesis Test Results

Direct Hypothesis	Beta	T values	P values	Findings
H1: PP -> PB	0.504	8.609	0.000	Accepted
H2: PP -> JP	0.225	2.670	0.008	Accepted
H3: PP -> JB	0.385	5.706	0.000	Accepted
Moderation Hypothesis	Beta	T values	P values	Findings
H4: PS x PP -> PB	0.122	2.148	0.032	Accepted
H5: JA x PB -> JP	0.150	2.924	0.003	Accepted
Median Hypotheses	Beta	T values	P values	Findings
PP -> PB -> JP	0.113	2.436	0.015	
PP -> JP	0.385	5.706	0.000	
H6: PP -> PB -> JP	0.498	9.772	0.000	Accepted

Note: PP - Proactive Personality; PB - Proactive Feedback Seeking Behavior; PS - Perceived Platform Supports; JA - Job Autonomy JP - Job Performance.
Source: Data processed.

Hypothesis 1 suggested that there was a positive influence of proactive personality on feedback seeking behavior of platform workers (β = 0.504; P-value = 0.000). This result agrees with (Anseel et al., 2005) that suggested that platform workers have a proactive personality that promotes proactive behaviors at work, such as actively seeking feedback from customers. Platform workers that want to achieve income and rewards need to take initiative. Proactivity in searching for tasks suitable to the location, time, and personal conditions is vital. Proactive workers know it is valuable to identity and understand the needs to do something to achieve higher outcomes. In particular, they find ways to improve the value of the organization, the ability to support customers, and exert themselves to be able to show support behaviors for success in tasks.

The results of the research support Hypothesis 2 in that the proactive behavior of seeking feedback has a positive effect on the work outcomes of platform workers (β = 0.225; P-value = 0.008). This finding is congruent with the research of Bateman and Crant (1993). This emphasizes the proactive behaviors of seeking feedback on the job, especially from the customer, to promote remediation and improvement to achieve better job performance. Platform workers often actively ask customers to evaluate service experiences, thereby assessing the level of task completion. Customer feedback can be positive or negative, but proactive workers will learn to adjust behavior, and not repeat mistakes. Proactivty in collecting feedback from customers helps platform workers grasp opportunities, enhance the ability to adapt to changes and turbulence in work, and actively take action to achieve desired results.

This study found evidence to accept Hypothesis 3 on the relationship between proactive personality and the work outcomes of foundational workers (β = 0.498; P-value = 0.000). This result is reinforced by the studies of Thomas et al. (2010) and Tornau and Frese (2013) in demonstrating positive performance, contributing to work outcomes. The more proactive the platform worker, the more work performance improves. Competition among labor platforms is becoming increasingly fierce, and proactive workers often strive to find efficient ways to improve work outcomes. Proactivity helps platform workers recognize work opportunities in advance such as task selection, and how to perform a task to achieve optimal time and cost. Platform laborers often work in conditions that are not with many objective factors, such as weather conditions and traffic, so the proactive characteristic can help them change and adapt positively to ensure good performance.

The results of research also accepted Hypothesis 4 in that when platform support was strengthened and increased, platform workers were more proactive and performed proactive behaviors at work (β = 0.122; P-value = 0.032). This explanation agrees with Wang et al. (2017) and Lartey et al. (2019) also suggested that when individuals feel comfortable in an organization that supports them, they find that understand, feel comfortable, and share their values, thereby creating an extremely positive relationship with the organization. In the digital working environment, the support conditions of the platforms are assessed at a low level (Hien et al., 2021). In fact, there are many platform workers determined by the design of the platform, such that workers have less right to choose, and work comes with stricter forms of control from the platform (Hien et al., 2021). Platforms that provide services often control the time and progress of an employee's employment. In this case, when workers interrupt the working period for a extended time, they will be locked out of right to continue. The time to receive tasks on the platforms is relatively short, and if not involved in the work continuously, a worker will not receive the next task. The platforms manage and control the times and schedule of employees, while the basic conditions of labor, such as basic salary and insurance, are largely absent.

Job autonomy was found to play a moderating role in the relationship between proactive behavior at work and job performance (β = 0.150; P-value = 0.003), so Hypothesis 5 was supported. This study was supported by Dhar (2016) and Wang and

Cheng (2009) who showed that those with high proactivity will have many possibilities to shape the creative process to create an optimal flow. Self-determination shows that when high self-mastery leads to ideal behaviors, about it leads to high results (Deci et al., 2017). This development implies that when there is self-control, the worker will be able to perform certain behaviors to help and prevent errors. The findings reinforce the view that a proactive personality has a positive impact on motivation, proactive behavior, and job performance (Parker et al., 2010). These results are consistent with theories and research indicating that organizational states drive the proactive behaviors of employees in manifesting conforming behavior.

Finally, Hypothesis 6 on the mediating effect of proactive seeking feedback behavior in proactive personality and work outcomes relationship was accepted ($\beta = 0.150$; P-value = 0.003). This finding is supported by research by Ashford et al. (2003). Both proactive personality and behaviors trend toward positive employee behaviors, which allows improved work outcomes. Proactive behaviors to collect customer feedback is a predictor of subsequent behavior, as customers that give positive feedback to employees continue a behavior, while negative feedback also adjust behavior. In particular, this is uncertain work, and there is ambiguity about the role, so proactively seeking feedback often promotes adaptation. The higher the adaptability to situations, the better the work performance.

V. Conclusion

The above research findings offer human resource management that wishes to improve the proactivity and work outcomes of platform workers options. First, digital labor platforms should provide a higher level of job autonomy, not only through the time flexibility of tasks but also by creating opportunities for employees to be proactive at work. It is necessary to adjust the level of control of technology platforms to allow workers to increase initiative while improving job performance. Second, it is necessary to strengthen the support from the platforms for workers, strengthen the encouragement of workers to be creative, and create a variety of channels to allow customers to give feedback on the quality of services provided by the platform workers. Third, evaluating gig worker performance likely depends on the characteristics of the platform, the characteristics of the worker, and the characteristics of the requesters. Finally, digital labor platforms should to assess the fit between individual and organizational personalities in order to establish appropriate standards in engaging their respective workers. This allows recruitment platforms to be proactively joined, and it is necessary to create proactive training programs for workers after they first join the platform.

Overall, this study adds new theoretical contributions when considering proactive personality and work outcome, including the role of platform support and work autonomy in an informal working environment and the participation of platform workers, which is something that not many previous studies have noted. Findings in the study partly help digital labor platforms to adjust or develop appropriate policies and programs to motivate employees to meet job requirements and improve job performance.

There are certain limitations in the research. First, the job outcomes of platform workers may exist due to relative differences between workers participating in the platform, such as qualifications, full-time and part-time work, age, gender, and so on, but these have not been mentioned in this study. Next, in the context that the number of workers participating in digital labor platforms has not yet been accurately counted, the sample size is mainly situated in large cities, with convenient sampling methods limiting the representative sample. Therefore, this issue should be further considered in subsequent studies.

References

Anseel, F., Beatty, A., Shen, W., Lievens, F., & Sackett, P. (2015). How are we doing after 30 years? A meta-analytic review of the antecedents and outcomes of feedback-seeking behavior. *Journal of Management*, *41*, 318-348. https://doi.org/10.1177/0149206313484521

Ashford, S. J., Blatt, R., & VandeWalle, D. (2003). Reflections on the looking glass: A review of research on feedback-seeking behavior in organizations. *Journal of Management*, *29*(6), 773-799. https://doi.org/https://doi.org/10.1016/S0149-2063(03)00079-5

Ashford, S. J., Caza, B. B., & Reid, E. M. (2018). From surviving to thriving in the gig economy: A research agenda for individuals in the new world of work. *Research in Organizational Behavior*, *38*, 23-41. https://doi.org/10.1016/j.riob.2018.11.001

Bakker, A. B., Tims, M., & Derks, D. (2012). Proactive personality and job performance: The role of job crafting and work engagement. *Human Relations*, *65*(10), 1359-1378. https://doi.org/10.1177/0018726712453471

Bamberger, P., & Belogolovsky, E. (2017). The dark side of transparency: How and when pay administration practices affect employee helping. *Journal of Applied Psychology*, *102*(4), 658. https://www.proquest.com/scholarly-journals/dark-side-transparency-how-when-pay/docview/1890084510/se-2?accountid=201058

Bateman, T. S., & Crant, J. M. (1993). The proactive component of organizational behavior: A measure and correlates. *Journal of Organizational Behavior*, *14*, 103-118.

Bederson, B. B., & Quinn. A. J. (2011). Web workers unite! addressing challenges of online laborers. Proceedings of the 2011 Annual Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '11), 97-106.

Bergeron, D. M., Schroeder, T. D., & Martinez, H. A. (2014). Proactive personality at work: Seeing more to do and doing more? *Journal of Business and Psychology*, *29*(1), 71-86. https://doi.org/10.1007/s10869-013-9298-5

Blau, P. (2017). *Exchange and power in social life*. Routledge. https://doi.org/10.4324/9780203792643

Brown, T., Mowen, J., Donavan, T., & Licata, J. (2002). The customer orientation of service workers: Personality trait effects on self and supervisor performance ratings. *Journal of Marketing Research*, *39*, 110-119. https://doi.org/10.1509/jmkr.39.1.110.18928

Cohen, J. (1989). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Crant, J. (2000). Proactive behavior in organizations. *Journal of Management*, *26*, 435-462. https://doi.org/10.1016/S0149-2063(00)00044-1

Cropanzano, R., & Mitchell, M. S. (2005). Social exchange theory: An interdisciplinary review. *Journal of Management*, *31*(6), 874-900. https://doi.org/10.1177/0149206305279602

Dahling, J., O'Malley, A. L., & Chau, S. L. (2015). Effects of feedback motives on inquiry and performance. *Journal of Managerial Psychology*, *30*(2), 199-215. https://doi.org/10.1108/JMP-12-2012-0409

Deci, E., Olafsen, A., & Ryan, R. (2017). Self-determination theory in work organizations: The state of a science. *Annual Review of Organizational Psychology and Organizational Behavior*, *4*. https://doi.org/10.1146/annurev-orgpsych-032516-113108

Dhar, R. L. (2016). Ethical leadership and its impact on service innovative behavior: The role of LMX and job autonomy. *Tourism Management*, *57*, 139-148. https://doi.org/https://doi.org/10.1016/j.tourman.2016.05.011

Eisenberger, R., & Stinglhamber, F. (2011). *Fostering enthusiastic and productive employees*. American Psychological Association. http://www.jstor.org/stable/j.ctv1chs4s3

Erdogan, B., & Bauer, T. (2005). Enhancing career benefits of employee proactive personality: The role of

fit with jobs and organizations. *Personnel Psychology*, *58*, 859-891. https://doi.org/10.1111/j.1744-6570.2005.00772.x

Ford, A. C., Harris, L. A., Lacy, B. E., Quigley, E. M. M., & Moayyedi, P. (2018). Systematic review with meta-analysis: The efficacy of prebiotics, probiotics, synbiotics and antibiotics in irritable bowel syndrome. *Alimentary Pharmacology & Therapeutics*, *48*(10), 1044-1060. https://doi.org/https://doi.org/10.1111/apt.15001

Frese, M., Garst, H., & Fay, D. (2007). Making things happen: Reciprocal relationships between work characteristics and personal initiative in a four-wave longitudinal structural equation model. *The Journal of Applied Psychology*, *92*, 1084-1102. https://doi.org/10.1037/0021-9010.92.4.1084

Fuller, J. B., Jr., Marler, L. E., & Hester, K. (2012). Bridge building within the province of proactivity. *Journal of Organizational Behavior*, *33*(8), 1053-1070. https://doi.org/https://doi.org/10.1002/job.1780

Gagné, M., & Deci, E. L. (2005). Self-determination theory and work motivation. *Journal of Organizational Behavior*, *26*(4), 331-362. https://doi.org/10.1002/job.322

Grant, A. M., & Ashford, S. J. (2008). The dynamics of proactivity at work. *Research in Organizational Behavior*, *28*, 3-34. https://doi.org/https://doi.org/10.1016/j.riob.2008.04.002

Greguras, G., & Diefedorff, J. (2010). Why does proactive personality predict employee life satisfaction and work behaviors? A field investigation of mediating role of the self-concordance model. *Personnel Psychology*, *63*, 539-560. https://doi.org/10.1111/j.1744-6570.2010.01180.x

Hackman, J. R., & Oldham, G. R. (1976). Motivation through the design of work: Test of a theory. *Organizational Behavior and Human Performance*, *16*(2), 250-279. https://doi.org/https://doi.org/10.1016/0030-5073(76)90016-7

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2-24. https://doi.org/10.1108/EBR-11-2018-0203

Hair, J., Sarstedt, M., Hopkins, L., & G. Kuppelwieser, V. (2014). Partial least squares structural equation modeling (PLS-SEM). *European Business Review*, *26*(2), 106-121. https://doi.org/10.1108/EBR-10-2013-0128

Harrison, C. J., Könings, K. D., Schuwirth, L., Wass, V., & van der Vleuten, C. (2015). Barriers to the uptake and use of feedback in the context of summative assessment. *Advances in Health Sciences Education*, *20*(1), 229-245. https://doi.org/10.1007/s10459-014-9524-6

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43*(1), 115-135. https://doi.org/10.1007/s11747-014-0403-8

Hien, T., Nga, T., Ninh, H., Anh, T., Huyen, T., & Hanh, N. et al. (2021, October 5). *Some employment issues in the freelance economy (GIG economy) in Vietnam: Case study of technology delivery/driving and domestic workers*. http://ilssa.org.vn/vi/news/mot-so-van-de-ve-viec-lam-trong-nen-kinh-te-viec-lam-tu-do-nen-kinh-te-gig-tai-viet-nam-nghien-cuu-truong-hop-lai-xegiao-hang-cong-nghe-va-giup-viec-g-364

Holland, J. L. (1997). *Making vocational choices: A theory of vocational personalities and work environments* (3rd ed.). Psychological Assessment Resources.

ILO (2021). *World employmentnd social outlook: The role of digital labour platfroms in transforming the world of work*. https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_771749.pdf

Kammeyer-Mueller, J., Wanberg, C., Rubenstein, A., & Song, Z. (2013). Support, undermining, and newcomer socialization: Fitting in during the first 90 days. *Academy of Management Journal*, *56*(4), 1104-1124. https://doi.org/10.5465/amj.2010.0791

Kim, T. Y., Hon, A. H. Y., & Crant, J. M. (2009). Proactive personality, employee creativity, and newcomer outcomes: A longitudinal study. *Journal of Business and Psychology*, *24*(1), 93-103. https://doi.

org/10.1007/s10869-009-9094-4

Kim, T. Y., Hon, A. H. Y., & Lee, D. R. (2010). Proactive personality and employee creativity: The effects of job creativity requirement and supervisor support for creativity. *Creativity Research Journal*, *22*(1), 37-45. https://doi.org/10.1080/10400410903579536

Kim, T. Y., & Wang, J. (2008). Proactive personality and newcomer feedback seeking: The moderating roles of supervisor feedback and organizational justice. *Current Topics in Management*, *13*, 91-108.

Kristof-Brown, A. (2006). Perceived applicant fit: Distinguishing between recruiters' perceptions of person-job and person-organization fit. *Personnel Psychology*, *53*, 643-671. https://doi.org/10.1111/j.1744-6570.2000.tb00217.x

Kurtessis, J. N., Eisenberger, R., Ford, M. T., Buffardi, L. C., Stewart, K. A., & Adis, C. S. (2015). Perceived organizational support: A meta-analytic evaluation of organizational support theory. *Journal of Management*, *43*(6), 1854-1884. https://doi.org/10.1177/0149206315575554

Lartey, J. K. S., Amponsah-Tawiah, K., & Osafo, J. (2019). The moderating effect of perceived organizational support in the relationship between emotional labour and job attitudes: A study among health professionals. *Nursing Open*, *6*(3), 990-997. https://doi.org/10.1002/nop2.295

Li, N., Liang, J., & Crant, J. M. (2010). The role of proactive personality in job satisfaction and organizational citizenship behavior: A relational perspective. *The Journal of Applied Psychology*, *95*(2), 395-404.

Mak, A., Wong, K., & Chang, R. (2011). Critical issues affecting the service quality and professionalism of the tour guides in Hong Kong and Macau. *Tourism Management*, *32*, 1442-1452. https://doi.org/10.1016/j.tourman.2011.01.003

Maleki, A., & Kuhn, K. (2017). Micro-entrepreneurs, dependent contractors, and instaserfs: Understanding online labor platform workforces. *The Academy of Management Perspectives*, *31*(3). https://doi.org/10.5465/amp.2015.0111

McCormick, B. W., Guay, R. P., Colbert, A. E., & Stewart, G. L. (2019). Proactive personality and proactive behaviour: Perspectives on person–situation interactions. *Journal of Occupational and Organizational Psychology*, *92*(1), 30-51. https://doi.org/10.1111/joop.12234

Meijerink, J., & Keegan, A. (2019). Conceptualizing human resource management in the gig economy: Toward a platform ecosystem perspective. *Journal of Managerial Psychology*, *34*(4), 214-232. https://doi.org/10.1108/JMP-07-2018-0277

Morgeson, F. P., & Humphrey, S. E. (2006). The work design questionnaire (WDQ): Developing and validating a comprehensive measure for assessing job design and the nature of work. *Journal of Applied Psychology*, *91*(6), 1321-1339. https://doi.org/10.1037/0021-9010.91.6.1321

Nae, E., Moon, H., & Choi, B. (2015). Seeking feedback but unable to improve work performance? Qualified feedback from trusted supervisors matters. *Career Development International*, *20*, 81-100. https://doi.org/10.1108/CDI-08-2014-0107

Nguyen, K. T., Nguyen, P. N. D., Do, T. T. T., Trinh, A. T., & Truong, V. A. N. (2020). Proactive personality, value congruence, perceived organizational support, and problem prevention behavior: A reciprocal moderated mediation model. *Management Science Letters*, *10*(16), 4045-4054. https://doi.org/10.5267/j.msl.2020.7.004

Oldham, G., & Hackman, J. (2010). Not what it was and not what it will be: The future of job design research. *Journal of Organizational Behavior*, *31*, 463-479. https://doi.org/10.1002/job.678

Parker, S. K., Bindl, U. K., & Strauss, K. (2010). Making things happen: A model of proactive motivation. *Journal of Management*, *36*(4), 827-856. https://doi.org/10.1177/0149206310363732

Parker, S. K., & Collins, C. G. (2010). Taking stock: Integrating and differentiating multiple proactive behaviors. *Journal of Management*, *36*(3), 633-662. https://doi.org/10.1177/0149206308321554

Pineda-Herrero, P. (2010). Evaluation of training in organisations: A proposal for an integrated model. *Journal of European Industrial Training*, *34*, 673-693. https://doi.org/10.1108/03090591011070789

Pradhan, R. K., & Jena, L. K. (2016). Employee performance at workplace: Conceptual model and empirical validation. *Business Perspectives and Research*, *5*(1), 69-85. https://doi.org/10.1177/2278533716671630

Putra Utama, F., & Eflina Purba, D. (2019). *Proactivity and employee creativity: Mediator roles of feedback-seeking behavior and moderating effect of task feedback*. Atlantis Press.

Qian, J., Song, B., Jin, Z., Wang, B., & Chen, H. (2018). Linking Empowering Leadership to Task Performance, Taking charge, and voice: The mediating role of feedback-seeking. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.02025

Saragih, S. (2011). The effects of job autonomy on work outcomes: Self efficacy as an intervening variable. *International Research Journal of Business Studies*, *4*, 203-215. https://doi.org/10.21632/irjbs.4.3.203-215

Shin, I., & Jeung, C. W. (2019). Uncovering the turnover intention of proactive employees: The mediating role of work engagement and the moderated mediating role of job autonomy. *International Journal of Environmental Research and Public Health*, *16*(5). https://doi.org/10.3390/ijerph16050843

Shore, L. M. F., & Tetrick, L. E. (1991). A construct validity study of the survey of perceived organizational support. *Journal of Applied Psychology*, *76*(5), 637-643. https://doi.org/10.1037/0021-9010.76.5.637

Sobaih, A. E. E., Ibrahim, Y., & Gabry, G. (2019). Unlocking the black box: Psychological contract fulfillment as a mediator between HRM practices and job performance. *Tourism Management Perspectives*, *30*, 171-181. https://doi.org/https://doi.org/10.1016/j.tmp.2019.03.001

Sørlie, H. O., Hetland, J., Bakker, A. B., Espevik, R., & Olsen, O. K. (2022). Daily autonomy and job performance: Does person-organization fit act as a key resource? *Journal of Vocational Behavior*, *133*. https://doi.org/10.1016/j.jvb.2022.103691

Sun, Y., Wang, N., Yin, C., & Zhang, J. X. (2015). Understanding the relationships between motivators and effort in crowdsourcing marketplaces: A nonlinear analysis. *International Journal of Information Management*, *35*(3), 267-276. https://doi.org/https://doi.org/10.1016/j.ijinfomgt.2015.01.009

Tett, R. P., & Burnett, D. D. (2003). A personality trait-based interactionist model of job performance. *Journal of Applied Psychology*, *88*(3), 500-517. https://doi.org/10.1037/0021-9010.88.3.500

Thomas. J. P., Whitman, D. S., & Viswesvaran, C. (2010). Employee proactivity in organizations: A comparative meta-analysis of emergent proactive constructs. *Journal of Occupational and Organizational Psychology, 83*, 275-300.

Tornau, K., & Frese, M. (2013). Construct clean-up in proactivity research: A meta-analysis on the nomological net of work-related proactivity concepts and their incremental validities. *Applied Psychology an International Review*, *62*. https://doi.org/10.1111/j.1464-0597.2012.00514.x

Tuckey, M., Brewer, N., & Williamson, P. (2010). The influence of motives and goal orientation on feedback seeking. *Journal of Occupational and Organizational Psychology*, *75*, 195-216. https://doi.org/10.1348/09631790260098677

Wang, A. C., & Cheng, B. S. (2009). When does benevolent leadership lead to creativity? The moderating role of creative role identity and job autonomy. *Journal of Organizational Behavior*, *31*, 106-121. https://doi.org/10.1002/job.634

Wang, Z., Zhang, J., Thomas, C. L., Yu, J., & Spitzmueller, C. (2017). Explaining benefits of employee proactive personality: The role of engagement, team proactivity composition and perceived organizational support. *Journal of Vocational Behavior*, *101*, 90-103.

Wetzels, M., & Odekerken, G. (2009). Using PLS path modeling for assessing hierarchical construct models: Guidelines and empirical illustration. *Management Information Systems Quarterly - MISQ*, *33*. https://doi.org/10.2307/20650284

Wiesenfeld, B. M., Raghuram, S., & Garud, R. (2001). Organizational identification among virtual workers: The role of need for affiliation and perceived work-based social support. *Journal of Management*, *27*(2), 213-229. https://doi.org/10.1177/014920630102700205

Ye, H. (Jonathan), & Kankanhalli, A. (2017). Solvers' participation in crowdsourcing platforms: Examining the impacts of trust, and benefit and cost factors. *Journal of Strategic Information Systems*, *26*(2), 101-117. https://doi.org/10.1016/j.jsis.2017.02.001

Zhang, Z., Wang, M., & Shi, J. (2012). Leader-follower congruence in proactive personality and work outcomes: The mediating role of leader-member exchange. *Academy of Management Journal*, *55*(1), 111-130. https://doi.org/10.5465/amj.2009.0865

Zheng, H., Li, D., & Hou, W. (2011). Task design, motivation, and participation in crowdsourcing contests. *International Journal of Electronic Commerce*, *15*(4), 57-88. http://www.jstor.org/stable/41300716

The Journal of Global Business and Trade

ISSN 1946-5130 (Print), ISSN 2470-4733 (Online)
http://dx.doi.org/10.20294/jgbt.2023.19.5.17

Journal of Global Business and Trade

https://www.pfw.edu/jgbt

External Cost-Benefit of Emission Control Routes between Korea and China Liner Shipping Networks*

Jeho Hwang[a], Sihyun Kim[b]**

[ab]*Department of Logistics, Korea Maritime and Ocean University, South Korea*

Received 9 August 2023, Revised 13 September 2023, Accepted 5 October 2023

ABSTRACT

Purpose – International Maritime Organization (IMO) regulations on air pollution for the shipping industry have been strict, and various related policies and projects are being implemented internationally to demonstrate eco-shipping. This study aims to design a new scheme for eco-shipping, namely Emission Control Routes (ECR) regarding ship operations, and to estimate social, environmental, and economic benefits through its implementation.

Design/Methodology/Approach – This study employed Kernel Density Estimation (KDE) analysis based on voyage segments to design the ECR domain. In addition, this analysis was conducted using data from the Automatic Identification System (AIS) for 1,728 port calls in liner shipping between Korea and China. Finally, the amount of external cost was estimated by scenario analysis, which set the speed limit within ECR waters at 10, 11, and 12 knots.

Findings – The results found that if the ECR system is implemented in the liner service between Korea and China, social and environmental costs can be reduced by 26.17% – 40.61%, and ship operators can achieve cost savings of 45.07% – 66.99% in fuel costs.

Research Implications – This study is crucial as it explores a new direction of air environment policy for the shipping industry, and analyzes the cost-effectiveness following the scenario condition for implementing the ECR strategy. In addition, political performance can be created synergistically when existing environmental policies have the potential for collaboration with the Emission Trading System (ETS).

Keywords: cost performance, emission control routes (ECR), liner shipping industry, policy effectiveness
JEL Classifications: C22, E43, E44, G01

* *This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2021S1A5A8064764).*
** *Corresponding Author, E-mail: sihyunkim@kmou.ac.kr*
© 2023 International Academy of Global Business and Trade. All rights reserved.

I. Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) has addressed global community-wide environmental issues, such as extreme weather events owing to the ozone layer depletion caused by air pollution from industrial activities, and global warming from 1992 (Horowitz, 2016; UN, 1998; Sands, 1992). Followed by the UNFCCC, the Kyoto Protocol entered into force in 1997 as the first international cooperation to prevent global warming. Although it included legal binding such as the allocation of Greenhouse Gas (GHG) emissions quotas for participating countries, compensation for meeting the quota, and economic penalties for non-compliance, it provides an initial framework for cooperative efforts for preventing global climate change. It served as an opportunity to recognize the need to strengthen the capacity of environmental sustainability at the national and business levels (Wang & Jin, 2023). Like other industries, it became a trigger to not only format emission trade markets but also promote technology development to improve ship operation energy efficiency or Carbon Capture and Storage (CCS) in the maritime industry. However, developed countries participating in the Kyoto Protocol have strengthened environmental trade regulations, which has also served as a cause of heightened non-tariff trade barriers. Moreover, ship operators are being economically burdened by the protocol in extensive environmental regulations.

According to trends to create an eco-friendly industrial environment, the Intergovernmental Panel on Climate Change (IPCC) adopted the Paris Agreement, which allows individual countries to progressively set national contribution plans for GHG emissions by sustainably responding without specifying a target achievement point at COP17 in 2015 as a supplement to the Kyoto Protocol, which expired internationally in 2020 (Kitetu & Ko, 2023). The International Maritime Organization (IMO) leads the sustainability of the global shipping industry based on organic interests according to laws, systems, and conventions at the international level related to the shipping industry and environment. Furthermore, it established the Marine Environment Protection Committee (MEPC) in 1997 to reduce air pollutant emissions caused by maritime transport. This committee continues to make efforts by adopting international standards to prevent environmental pollution and recommending or mandating implementation.

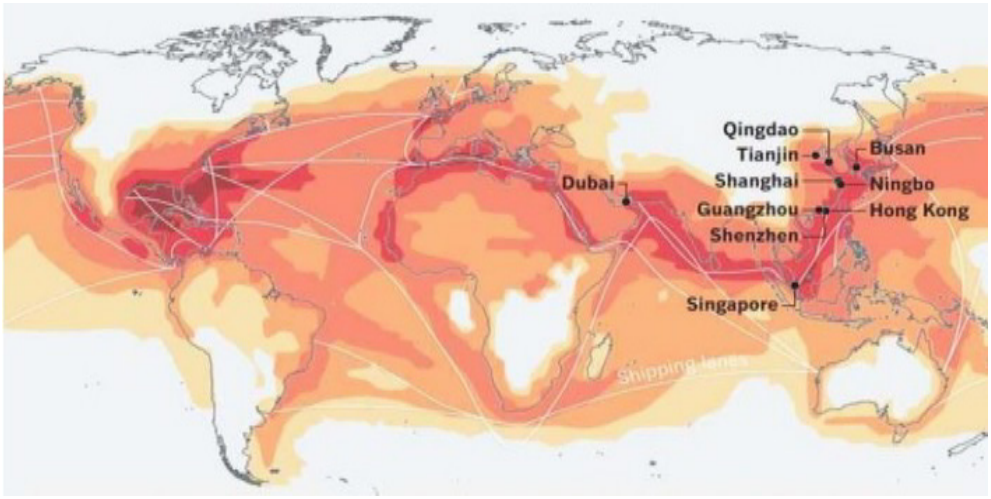
Regarding air pollution in particular, as of July 2010, Annex VI of MARPOL 73/78 (Annex to the Convention for the Prevention of Air Pollution from Ships) was amended. Consequently, this paves the way for the strict implementation of regulating air pollutant emissions from ship operations. Initially, the focus was on regulating Carbon Dioxide (CO_2) emissions, which have a direct impact on global warming. However, the scope of regulating air pollutants has been expanded to include Sulfur Oxides (SO_X), Nitrogen Oxides (NO_X), and Particulate Matter (PM) in the Emission Control Area (ECA) based on regulations 13-14 in Annex VI. However, the ECA, which the IMO designates or recommends for member states, is geographically limited to improving air quality in coastal areas near ports and adjacent port cities. Along with the ECA system, IMO has prepared and implemented various types of mandatory or recommended measures for energy efficiency and emission reduction for existing and newly built ships.

Specifically, South Korea and China, which were selected as the top 10 ports with the highest port area air pollution levels in 2016, as shown in Fig. 1, fall within the spatial scope of the ECR design proposed in this study. Additionally, South Korea and China are transportation hubs for liner shipping, with numerous large mother and feeder ports accompanied by a high frequency of trips (Qian et al., 2016; Zhao et al., 2013). Moreover, among the various types of maritime transport carrying different cargoes, the maritime sector with the highest air pollution contributor is liner shipping, where about 80% of trade is conducted by container ships (Czermański et al., 2021; Fan et

al., 2016).

The level of air pollution at sea due to frequent container vessel traffic is severe. Therefore, liner shipping is focused on improving the effectiveness of preventing air pollution from ships. In the case of classifying navigation modes as mooring, maneuvering, anchoring, and sailing modes from the perspective of vessel operations, about 80% of fuel is consumed in sailing mode, and this occupies the greatest voyage time (Authority, 2018; Li et al., 2018; Ng et al., 2013).

Fig. 1. Distribution of Air Pollutants in Coastal Water and the Open Sea



Source: Wan et al. (2016).

Globally, laws and institutional foundations for the introduction of eco-friendly fuel in the maritime sector are being established worldwide, and eco-friendly ships are being built and operated on a particular port call. However, as part of the strategy to create a green shipping industry, the Green Shipping Corridor (GSC) Project is in its initial phase for the purpose of building an environment-friendly infrastructure for the smooth operation of commercial vessels combusting green fuel. Moreover, it takes a long time for international GSC infrastructure construction. Accordingly, it is essential to continuously explore new strategies to reduce air pollutant emissions that can be implemented in the mid-term.

As a result, this study proposes introducing the ECR system for open sea areas. In short, the ECR is a sea domain that can be designated in consideration of shipping trajectories and vessel operational characteristics in terms of geospatial aspects. As mentioned above, the spatial scope of this study for the ECR scheme is international water bodies within the port call lane of container ships engaged in liner trade between ports in South Korea and China.

The purpose of this study is to estimate the cost savings in social and environmental externalities that could be achieved by implementing an ECR strategy in the open seas covering South Korea and China through scenario analysis to set the recommended speed for the Vessel Speed Reduction Program (VSRP). In other words, this study aims to estimate not only the effect of air

pollution reduction achieved by the ECR system but also the effectiveness of the economic, social, and environmental cost-benefit ratio.

II. Literature Review

1. Air Quality Regulations by IMO

Various environmental regulations and recommendations are being enacted that target air pollution in worldwide industrial sectors. Particularly, in the global shipping industry, the IMO has developed various environmental policy instruments and implemented or recommended regulatory measures to IMO member states as part of the common goal of improving the environment. Additionally, IMO environmental regulations are mandatorily upheld by regulators as they urge compliance, exert social pressure, and cause financial penalties for noncompliance. Consequently, ship operators are being economically burdened by rapid changes in extensive environmental regulations, and the gradual tightening of regulations.

First, IMO-designated ECAs are classified as ECAs regulating SO_X and NO_X for the North and Baltic Seas in Europe, and SO_X, NO_X, and PM for the East and West coasts and the Hawaiian Islands in the U.S. The Mediterranean Sea will become an IMO-designated ECA in 2025. Moreover, countries that have designated national ECAs for territorial seas and exclusive economic zones (EEZ) to regulate air pollutant emissions are summarized in Table 1 (EGCSA).

Table 1. National ECA Designation Status

Large Category	Subcategories
Europe	European Union Member States (Gibraltar, Portugal, Sweden, Italy, Turkey, Estonia, Germany, Norway, Belgium, Ireland)
America	European Union Member States (Gibraltar, Portugal, Sweden, Italy, Turkey, Estonia, Germany, Norway, Belgium, Ireland)
Asia	India, Republic of Korea, Pakistan, Japan, Malaysia, Singapore, China, Taiwan, Hong Kong
Africa and Middle East	Oman, Kenya, Qatar, Saudi Arabia, Bahrain, South Africa, Egypt–Suez Canal Authority, United Arab Emirates
Oceania	New Zealand, Australia

Source: Authors' tabulation based on EGCSA (2021).

Regarding the strength of regulations, the current state of regulation levels, which are progressively tightened depending on the air pollutant, is as follows. Ships operating within the SO_X-ECA must comply with the regulatory levels for sulfur oxide content in the bunker fuel. Table 2 shows the evolution of regulatory levels for SO_X (Stillwater Associates). The regulation level in the ECA has been strengthened by 15 times compared to that of the initial setting, and the regulation level outside of the ECA has been strengthened by nine times compared to that of

the initial setting. In the case of the NO_X-ECA, the regulation is tightened in stages depending on the revolutions per minute of the engine based on the construction date of the vessel. Table 3 shows the changes in regulations (SAFETY4SEA). The current regulation level for NO_X is the Tier 3 regulatory level, which was introduced in 2016. It has been strengthened five times compared to the Tier 1 regulation level, which is the initial regulatory period.

Table 2. Changes in SO_X Content Regulation for Bunker Fuel

Application Period	ECA	Application Period	Non-ECA
2005.05-2010.06	1.5%	2005.05~2011.12	4.5%
2010.07-2014.12	1.0%	2012.01~2019.12	3.5%
2015.01-	0.1%	2020.01~	0.5%

Source: Authors' tabulation based on Stillwater Associates (2017).

Table 3. Changes in NO_X Emission Regulation According to RPM

Tier	Ship Construction Date on or after	Total Weighted Cycle Emission Limit (g/kWh) n=engine's rated speed (rpm)		
		$n < 1.30$	$1.30 \leq n < 1,999$	$2,000 \leq n$
1	-2000.01.01	17.0	$45n^{-0.2}$	9.8
2	-2011.01.01	14.4	$44n^{-0.23}$	7.7
3	2016.01.01-	3.4	$9n^{-0.2}$	2.0

Source: Authors' tabulation based on Safety4Sea (2018).

Additionally, the Energy Efficiency Design Index (EEDI), which is applied in the construction phase of a ship, is applied to CO_2 which has the highest proportion of emissions in a vessel's operational processes. The status of the strengthening of the regulatory level is summarized in Table 4 (Joung et al., 2020).

Table 4. Long-Term Strategy for Strengthening EEDI Standards

Phase	Application Period	Target Reduction Rate for Emissions
1	2015.01.01-2019.12.31	10%
2	2020.01.01-2024.12.31	20%
3	(Early enforcement) 2022.01.01-	30%

Source: Authors' tabulation based on Joung et al. (2020).

The Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Index (CII) are applied to ships currently in the shipping market by the IMO. In addition, it has been recommended that ship operators manage ship Energy Efficiency Operational Indicators (EEOI) on an ongoing basis through the Ship Energy Efficiency Management Plan (SEEMP). Ships of 5,000 gross tons or more need to transmit information regarding fuel consumption in accordance with the data collection system (Julio et al., 2022). Furthermore, under MARPOL 73/78, IMO member states are required to be evaluated regularly for compliance with the relevant provisions of the convention through the IMO member state audit scheme. Although IMO allows alternative compliance measures for each regulated air pollutant, such as the exhaust gas cleaning system (EGCS), selective catalytic reduction (SCR), carbon capture and storage (CCS), and exhaust gas recirculation (EGR), ship operators are facing shipping market trends of ever-tightening IMO regulations on air pollutant emissions, the economic operation of their fleets, and the schedule to convert future ships to green energy. This has further led to strategies that balance environmental regulations with economic performance.

In other words, recommendations for the shipping industry urged by IMO could be mandatory for the transition to an eco-friendly shipping industry in the future. In terms of ship operation, there is a policy direction that can contribute by reducing air pollutant emissions in order to support IMO's recommendations, which are introduced in this study.

2. International Cooperation for Net-Zero Emissions

To combat climate change by preventing air pollution caused by the international shipping industry, the IMO has set a long-term goal of zero CO_2 emissions from ship operations by 2050 (IMO, 2018). In response to the IMO declaration, measures are being taken to fundamentally decarbonize the maritime industry in terms of policy and technology to accelerate the creation of a green shipping environment. Unlike the direct regulation of air pollutant emissions by the IMO, various supportive policies and projects are being implemented at the international, national, and regional levels to encourage the transition to an environment-friendly shipping industry. In addition, at a time when eco-technology advancement is crucial, technological capabilities and competitiveness could be enhanced depending on government intervention (Lee, 2022; Yang, 2022).

Moreover, long-term plans to accelerate the decarbonization of the shipping industry in line with IMO 2050 goals are gradually being implemented. For example, the green shipping corridor (GSC) is being established under the Clydebank Declaration. The GSC is a long-term project designed to create a green shipping industry interface by creating an infrastructural environment wherein global trading vessels designed or retrofitted with zero-emission fuels and zero-emission propulsion technology can be used for specific port calls between ports (Global Maritime Forum & McKinsey Company, 2021).

As of 2022, the GSCs for container ships are the Rotterdam–West Coast Norway Corridor, which provides infrastructure for methanol fuel; the Rotterdam–Singapore Corridor, which provides infrastructure for methanol and ammonia; the Halifax–Hamburg Corridor, which provides infrastructure for hydrogen, ammonia, and methanol; and the Gothenburg–North Sea Port Corridor, which provides infrastructure for biofuel, methanol, ammonia, and electric fuel (Global Maritime Forum, 2022). The GSC currently in place can be expanded by connecting with other ports building green fuel infrastructure, and it can create a gradually expanding zero-emissions network.

Therefore, shipping companies are striving to maintain competitiveness by forming a fleet when ordering new vessels or retrofitting existing vessels with alternative fuels that are suitable from an economic perspective depending on various considerations, such as vessel type, vessel

size, cargo type, distance for port calls, energy density level of alternative fuels, and operating cost (Mao et al., 2020).

There is also the emission trading system (ETS) as a market-based measure on the policy side, unlike direct regulation. The purpose of ETS is to induce change in eco-friendly industries related to highly carbon-intensive international trade and prevent climate change (Kim & Jung, 2022). As part of the emissions business, the ETS can limit the carbon emissions of individual shipping companies or reduce emissions so that some emission allowances can be traded secondarily under the cap-and-trade system (Boemare and Quirion, 2002). The size of the global ETS market has shown a steady upward trend, reaching €186 billion in 2018, €240 billion in 2019, €288 billion in 2020, €762 billion in 2021, and €865 billion in 2022 (Statista, 2023). Furthermore, it is expected that the establishment of international standards for pricing in international carbon markets will vitalize cap-and-trade. Countries in which national ETS is being operated include the European Union (EU), United States, South Korea, Japan, China, Kenya, New Zealand, Switzerland, and others, and as of 2021, China has also implemented an ETS (IEA, 2020).

Notably, the EU has signed the ETS revision agreement to support an effective transition from conventional to alternative fuels in addition to the existing ETS to drastically decarbonize the shipping industry. It supports shipping companies adopting green fuels in the form of subsidies for fixed insurance premiums, differential carbon contracts, and so on included in ship operating costs. In addition, it has turned the relatively expensive fuel cost gap of using green fuel into OPEX support. It operates a financial support system for future emission reduction and promotes direct intervention in the development of new green technologies by guaranteeing projects by public institutions to attract private investment in clean energy technologies (European Commission, 2021). In addition, the Carbon Border Adjustment Mechanism (CBAM) has emerged as a measure to adjust trade competitiveness in terms of cost between nations that have introduced a carbon tax or ETS. The EU will come into effect in CBAM in 2026, which could add environmental provisions as a proactive response to Free Trade Agreement (FTA), and it is being considered for introduction in the United States (Yoon, 2022; Lee and Yoo, 2022; Chang, 2022).

Additional policy frameworks for the prevention of air pollution from the shipping and port industry are implemented at national and regional levels, including a monitoring, reporting, and verification scheme; clean-shipping index; environmental ship index; NO_X-tax and fund; a climate and clean air coalition in EU to prevent pollution from ships in United States; the maritime Singapore green initiative in Singapore; clean maritime plan (CMP2050) in United Kingdom; and environmental differentiated fairway dues in Sweden (Gössling et al., 2021).

The characteristics of environment-friendly policies for the shipping industry can be categorized into major policies and minor policies, which complement them in different ways. Based on policy characteristics, there are different directions, such as goals, periods for achieving goals, stakeholders involved in the policy, and policy implementation measures. However, in contrast with previous developments which made for IMO 2050, this study focuses on the characteristics of regular port calls in liner shipping to reduce the scheme for air pollutant emissions caused by container vessel operation from a new perspective. Moreover, variable speed change occurs relatively frequently on container ships during a voyage to reduce the time to enter a port of call. This decreases fuel consumption efficiency during the voyage and contributes to air pollution.

3. Cost-Effectiveness Estimation Associated with Emissions

As the shipping and port industry transforms into an environment-friendly industry, various

studies have been conducted to estimate the environmental and economic performance of the industry. Berechman and Tseng (2012) used a bottom-up method to estimate air pollutant emissions from ships and trucks operating at Kaohsiung Port in Taiwan and the associated costs. For analysis, ships were classified into eight types and five classes, and cargo vehicles were divided into cargo vehicles used for onshore activities inside the port and outside the port. For the ships, berthing time, ship type, class, maximum continuous rating (MCR), the emission factor for each air pollutant, activity intensity, emission factor, distance traveled, and load of the container were used to calculate air pollutants emitted. Moreover, the concept of environmental cost per emission was introduced to calculate the environmental cost per emission for each air pollutant. Hence, the final environmental cost of operating ships and trucks was estimated to be $123 million/year.

Nunes et al. (2019) conducted an eco-efficiency analysis of port calls heading to Leixões Port, Sétubal Port, Sines Port, and Viana do Castelo Port located in Portugal. Eco-efficiency estimation was performed by selecting NO_X, SO_2, CO_2, VOC_S, and $PM_{2.5}$ emissions. Cost factors applied were mainly cited from the CAFÉ, BeTa, and NEEDS Projects, which were studies on the cost effect of air pollution. As a result of the analysis, the eco-efficiency of Sines Port was the highest, followed by Leixões Port, Viana do Castelo Port, and Setúbal Port. However, it was pointed out as a limitation that relative errors in eco-efficiency estimation values may exist by applying the top-down method rather than the bottom-up method.

Tichavska and Tovar (2015) measured the incremental cost and environmental efficiency of vessel-related air pollutant emissions from a regional perspective for the Port of Las Palmas. For emission estimation, a bottom-up methodology was adopted, and for the externality cost estimation, the top-down methodology was adopted. The types of ships analyzed were container ships, tankers, and ferries. The economic cost of air pollutants NO_X, SO_2, CO_2, VOC_S, and $PM_{2.5}$ were estimated at €174,288,076, while the cost with sensitivity scenarios was €180,930,427.

Ammar (2019) analyzed the environmental and economic performance of a ship with twin diesel engines running on methanol. Consequently, it was derived that emissions by air pollutants were reduced by −89.00% (SO_X), −82.56% (PM), −76.78% (NO_X), −55.00% (CO), and −18.13% (CO_2). Additionally, cost efficiencies of 6,548$/*ton*(CO), 385.2$/*ton*(NO_X), and 39.9$/*ton*($CO_2$) were derived when the ship was traveling at low speed and using SCR.

However, this study has discrimination in estimating the social and environmental costs following the introduction of the ECR system proposed, unlike previous studies that measured the technical and political effects being implemented. Unlike existing IMO policies and policies at the international, national, and regional levels, this study presents a scenario for an ECR scheme that can be implemented in the midterm from an operational perspective, and estimates not on the economic benefits in terms of fuel of ship operator compliance with an ECR strategy, as well as the social and environmental costs associated with reducing air pollutant emissions.

III. Methodology

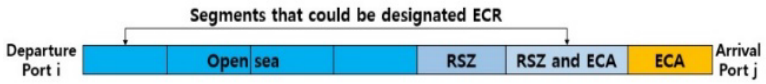
1. Air Quality Improvement Effect According to ECR Designation

The ECR is a sea domain from which sea areas with a high density of voyage trajectories are extracted by collecting the trajectories of container vessels that periodically operate on specific routes, excluding ECA that mandatorily controls SO_X, NO_X, and PM emissions in Fig. 2. Within the ECR domain, the open sea is mainly included, and speed reduction zones (SRZ) could be included if the vessel speed reduction program (VSRP) is implemented according to specific regions.

In the ECR system, it is possible to induce

the participation of ship operators by presenting a recommended speed limit and providing incentives when participating. In the case of the VSRP, incentives are provided when ship operators expropriate the recommended speed in SRZ during port entry. In other words, even if vessels cross the SRZ to navigate to other ports, departure from the port before entry is not considered. However, the ECR scheme reflects the limits of VSRP as well as the spatial limits of ECA.

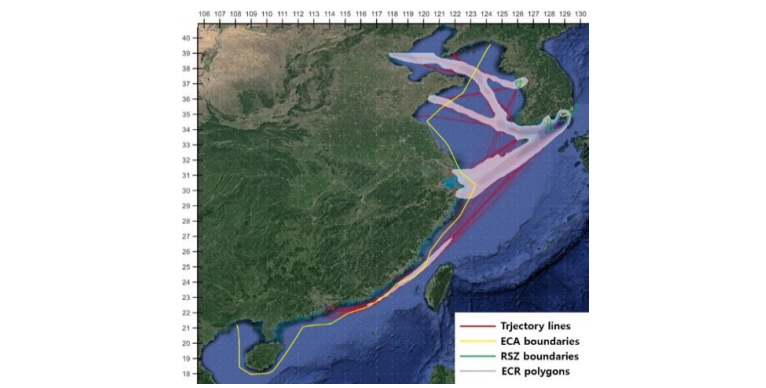
Fig. 2. Distribution of Air Pollutants in Coastal Water and the Open Sea



Source: Authors' drawing based on Hwang and Kim (2023).

The recommended speed range in ECR waters is 10 to 12 knots, which is currently applied by major ports in the United States and South Korea. The ECR conditions of Scenario 1 (12 knots), Scenario 2 (11 knots), and Scenario 3 (10 knots) were created to apply scenarios by speed (DNV, 2020; Port of Los Angeles, 2023; Port of Long Beach, 2022). The ECR strategy is a strategy that recommends vessels maintain a certain speed within designated water bodies based on the scenarios, allowing them to sail below the recommended speeds for non-ECR and Scenario 1 (12 knots), Scenario 2 (11 knots), and Scenario 3 (10 knots). As the initial phase of this study, time-interval data regarding the navigation of port calls (1,728 times) of container ships (387 ships) between ports in South Korea and China from July 1, 2021, to June 30, 2022 (1 year) were collected based on the Automatic Identification System (AIS) to establish ECR boundaries using kernel density estimation (KDE). The KDE is a spatial analysis that uses spatiotemporal information data to estimate density distributions in geographic space, and is suitable for analyzing traffic information (Scheepens et al., 2015; Le et al., 2018; Lee et al., 2020). The ECR domain of the main traffic flow patterns was derived with dynamic AIS data. As a result, the designated ECR domain is shown in Fig. 3.

Fig. 3. Regimes of Emission Control Routes



Source: Authors' drawing based on Hwang and Kim (2023).

Then, the emissions of each air pollutant attributable to container ships were estimated based on each scenario. A bottom-up method was adopted to estimate emissions using AIS data, which provides a more sophisticated emissions estimation using dynamic operation data and vessel specifications than the top-down method, which is based on fuel consumption data (Lee et al., 2021). When navigating above the scenario-specific recommended speed, the standard speed for each scenario was applied. Conversely, when sailing below the recommended speed, the actual speed recorded in the AIS database was applied. The compliance speed for each scenario was substituted to verify the cost-effectiveness of implementing the ECR system over that of the non-ECR case.

Emission factors (EF) for each air pollutant introduced in the emission estimation procedure were applied for the main engine (ME) using residual oil (RO) as fuel and divided into slow speeds (SSDs) and medium speeds (MSDs). In the case of the EF for auxiliary engine (AE) and auxiliary boiler (AB), which use marine diesel, a default value according to the size of the container vessel was applied based on the energy consumption ratio for ME, AE, and AB (Goldsworthy & Renilson, 2013; Song, 2014). Further, for specific fuel oil consumption (SFOC), a variable utilized to estimate the energy input for each ship operation and fuel consumption, two-stroke and four-stroke engines were distinguished, and input variables, such as load factor and MCR, were calculated based on the real-time dynamic data of each vessel. Finally, the total emission reduction effect of each air pollutant from introducing the ECR scheme was estimated as shown in Table 5.

Table 5. Emission Reduction Effect with ECR Scenarios

(Unit: Ton)

Division		Non-ECR	ECR Introduction Effect		
			Scenario 1	Scenario 2	Scenario 3
Air Pollutants	CO_2	15,453,636.92	10,950,823.43 (-29.14%)	9,850,879.94 (-36.26%)	8,707,003.48 (-43.66%)
	CO	256,255.03	192,949.80 (-24.70%)	174,808.18 (-31.78%)	155,368.85 (-39.37%)
	SO_X	136,721.28	102,349.12 (-25.14%)	92,500.52 (-32.34%)	82,425.93 (-39.71%)
	NO_X	19,772.50	14,799.87 (-25.15%)	13,408.32 (-32.19%)	11,917.25 (-39.73%)
	PM_{10}	19,435.67	14,551.19 (-25.13%)	13,183.07 (-32.17%)	11,782.98 (-39.37%)
	$PM_{2.5}$	18,832.95	14,099.76 (-25.13%)	12,774.20 (-32.17%)	11,353.74 (-39.71%)

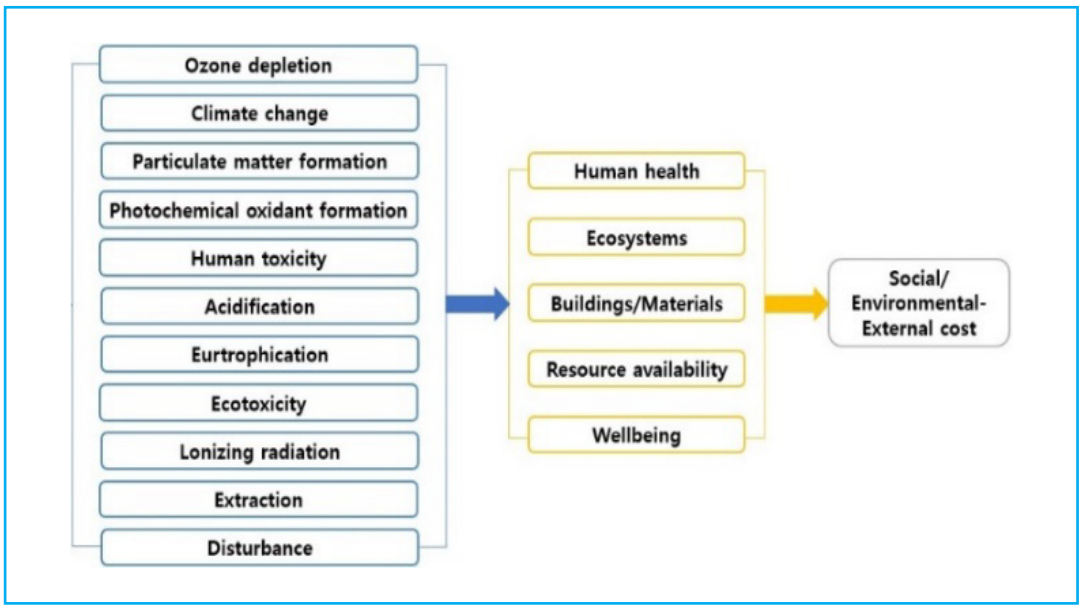
Source: Authors' tabulation based on Hwang and Kim (2023).

2. Research Method

2.1. External Cost Performance Estimation

The effect of external cost reduction from the reduction of air pollutant emissions (CO_2, CO, SO_X, NO_X, PM_{10}, and $PM_{2.5}$) at the scenario level of the ECR strategy was estimated based on Table 5, which presents the air quality improvement effect of each ECR scenario. More than 70% of air pollutants emitted by ships in the ocean can spread over a distance of 400 km from the point of emission (Viana et al., 2009). Hence, this negatively impacts ecosystems, people, and buildings, leading to resource shortages and escalating damages, as shown in Fig. 4. In other words, the effectiveness of policies to regulate air pollutant emissions from ships needs to be examined not only in terms of their effectiveness in reducing air pollutant emissions but also in terms of the resulting social and environmental costs.

Fig. 4. Subcategories of Factors Considered for External Cost



Source: Authors' drawing based on CE Delft (2018).

The scope and intensity of damage caused differ depending on the type of air pollutant. In addition, the socio-environmental costs incurred accordingly are also different. In this study, Equation (1) was introduced as an external cost calculation method based on literature research. In the equation, '$emission_{i,j}$' is represented by the total amount of air pollutant '*j*' emitted by the operation of individual container ships '*i*', and '*SCF* (*USD/ton*)' represents the social and environmental costs of the emission of individual air pollutants. The final result, '*EC*(*USD*)', is the estimated sum of the social-environmental costs caused by liner transportation according to the individual scenario (Song, 2014). The external costs for each air pollutant introduced in this phase are 86 *USD/ton* (CO_2), 144 *USD/ton* (CO), 37,538 *USD/ton* (SO_X), 52,312 *USD/ton* (NO_X), 67,236 *USD/ton* (PM10), and 119,849 *USD/ton* (PM2.5), and are summarized in Table 6.

$$EC = \sum (Emission_{i,j} \times SCF) \quad (1)$$

Where:
EC: Total external cost including social and environmental costs (*USD*)
$emission_{i,j}$: Quantified emissions of air pollutant '*i*' by each port call '*j*' (*ton*)
SCF: External cost measured for each air pollutant (*USD/ton*)

Table 6. SCF Values for Major Air Pollutants

(Unit: Thousand USD/ton)

Division	Type	External Cost
Air Pollutants	Carbon dioxide (CO_2)	86
	Carbon monoxide (CO)	144
	Sulfur oxides (SO_X)	37,538
	Nitrogen oxides (NO_X)	52,312
	Coarse particulates, 10μ or less (PM_{10})	67,236
	Fine particulates, 2.5μ or less ($PM_{2.5}$)	119,849

Source: Authors' tabulation based on CE Delft (2018).

2.2. Effect Estimation of Reducing Fuel Consumption

The speed at which a vessel travels and energy use is mainly governed by the operation of the ME, which is generally powered by RO. Therefore, fuel consumption under the ECR conditions was estimated by using the ME specifications, real-time speed changes, and dynamic information of 387 ships in port calls between South Korea and China.

Additionally, for AE and AB, which exploited MDO-fuel, an AE power of nearly equal to 0.22 times the power of ME was applied (Wang et al., 2020). Specifically, AB power was estimated by applying the ratio of the AE to AB powers, which was categorized as the default value according to ship type (Tran et al., 2022). The introduced fuel consumption function is represented by Equation (2) (Yang, 2019).

$$\text{Fuel Consumption} = (\text{SOG/designed SOG})^3 \times Engine\ Max\ Output \times Duration \times SFOC \quad (2)$$

Where:
Fuel Consumption: Fuel consumed during the voyage (*g*)
SOG: Voyage speed (*knots*)
Designed SOG: Maximum speed by designed (*knots*)
Engine Max Output: Maximum engine power (*kW*)
Duration: Voyage time (*h*)
SFOC: Specific fuel oil consumption of each engine (*g/kWh*)

The ship fuel costs account for approximately 50% – 60% of the total cost of operating a global trading fleet. From an operational perspective, improving the fuel efficiency of ships can not only reduce the economic burden on ship operators but also contribute to improving service levels (Elizabeth, 2018). Therefore, based on the results of the ECR system's calculation of ship fuel consumption by scenario, the ship fuel cost savings while applying each scenario were estimated. In other words, the secondary economic benefits of ship operators adhering to the recommended speeds under the ECR scheme may be higher in the area of fuel costs. Therefore, fuel cost savings for the recommended vessel speeds under Scenarios 1 through 3 compared to those under the non-ECR were estimated.

Due to limited access to fuel type data used for individual ships, this also assumed the current shipping industry practice of using intermediate fuel oil (IFO) for ME operations and marine diesel oil (MDO) for AE and AB operations when ships are on the open sea (Fan et al., 2016; Winther et al., 2017). To measure the amount of fuel cost savings, daily price data for each ship fuel in the global bunker market during the study period were collected, and an average price was applied to the change in oil prices, with a fuel cost of $565.90 USD/Metric Tonne for ME operations, and $897.75 USD/Metric Tonne for AE and AB operations (Ship & Bunker, 2023).

IV. Results of the Empirical Analysis

1. Social and Environmental Cost Reduction by Scenario

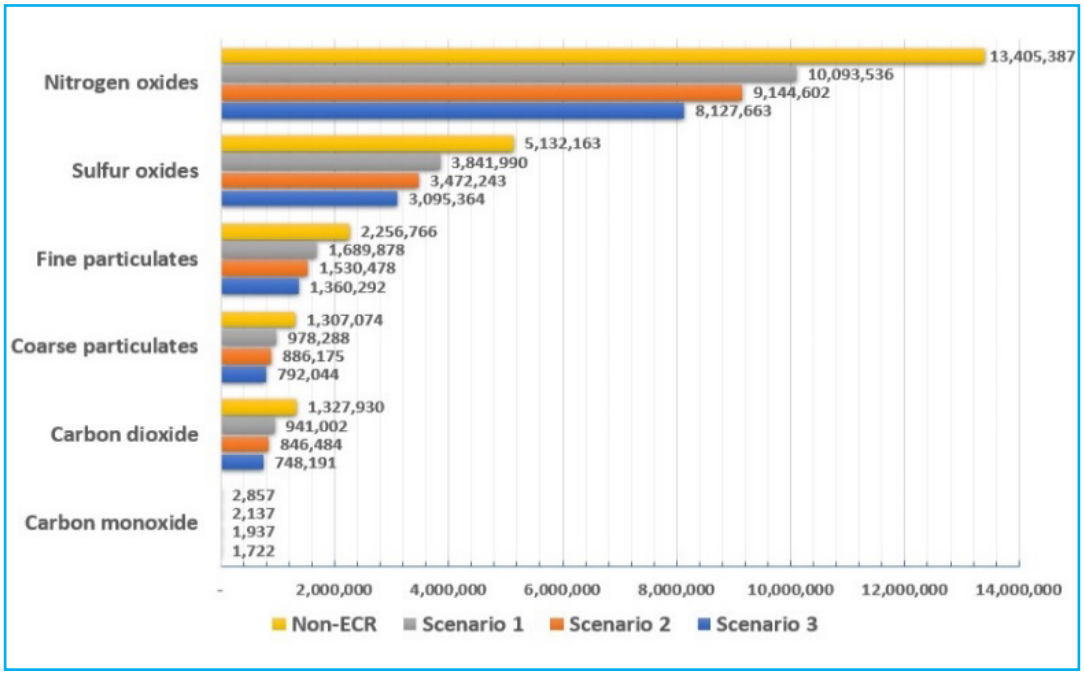
The social and environmental costs of each type of air pollutant are summarized in Fig. 5 based on Table 5, which shows emissions by air pollutants from the previous research phase. The total externality cost of the non-ECR is 23,432,177 thousand USD, which is calculated in the order of $13,405,387 thousand *USD* (NO_X), $5,132,163 thousand USD ($SO_X$), $2.256,766 thousand *USD* ($PM_{2.5}$), $1,307,074 thousand *USD* (PM_{10}), $1,327,930 thousand *USD* (CO_2), and $2,857 thousand *USD* (CO), depending on the air pollutant. For Scenario 1, a total of $17,546,831 thousand *USD*, $10,093,536 thousand *USD* (NO_X), $ 3,841,990 thousand *USD* (SO_X), $1,689,878 thousand *USD* ($PM_{2.5}$), and $978,288 thousand *USD* ($PM_{10}$), depending on the air pollutant that has been estimated. For Scenario 2, $941,002

thousand *USD*(CO_2), $2,137 thousand *USD* (CO), and a total of $15,881,919 thousand *USD,* with $9,144,602 thousand *USD* (NO_X) and $3,472,243 thousand *USD* (SO_X) depending on air pollutants have been calculated. For Scenario 3, $1,530,478 thousand *USD* ($PM_{2.5}$), $886,175 thousand *USD* ($PM_{10}$), $846,484 thousand *USD* ($CO_2$), and $1,937 thousand *USD* (CO), for a total of $14,125,276 thousand USD depending on air pollutants have been evaluated, along with $8,127,663 thousand *USD* (NO_X), $3,095,364 thousand *USD* (SO_X), $1,360,292 thousand *USD* ($PM_{2.5}$), $792,044 thousand *USD* ($PM_{10}$), $748,191 thousand *USD* ($CO_2$), and $1,722 thousand *USD* (CO).

Consequently, the increase and decrease in social and environmental costs by scenario compared to those of the non-ECR are summarized in Table 7. The average percentage of reduction in air pollutant emissions per scenario was found to be −25.12% (Scenario 1), −32.22% (Scenario 2), and −39.72% (Scenario 3). The amount of external cost savings by air pollutants according to scenario was shown to be −24.71% (NO_X), −25.14% (SO_X), −25.12% ($PM_{2.5}$), −25.15% (PM_{10}), −29.14% (CO_2) and −25.20% (CO) for Scenario 1, −31.78% (NO_X), −32.34% (SO_X), −32.18% ($PM_{2.5}$), −32.20% (PM_{10}), −36.26% (CO_2), and −32.20% (CO), for Scenario 2, and −39.37% (NO_X), −39.69% (SO_X), −39.72% ($PM_{2.5}$), −39.40% (PM_{10}), −43.66% (CO_2), and −39.73% (CO) for Scenario 3.

Fig. 5. Level of Social and Environmental Cost by Scenarios

(Unit: thousand USD)



Source: Authors' illustration based on the authors' analysis.

Table 7. Social and Environmental Cost Savings by Scenario

(Unit: %)

Division	Total emissions	NO_X	SO_X	$PM_{2.5}$	PM_{10}	CO_2	CO
Scenario 1	-25.12	-24.71	-25.14	-25.12	-25.15	-29.14	-25.20
Scenario 2	-32.22	-31.78	-32.34	-32.18	-32.20	-36.26	-32.20
Scenario 3	-39.72	-39.37	-39.69	-39.72	-39.40	-43.66	-39.73

Source: Authors' tabulation based on the authors' analysis.

2. Fuel Consumption by Scenario

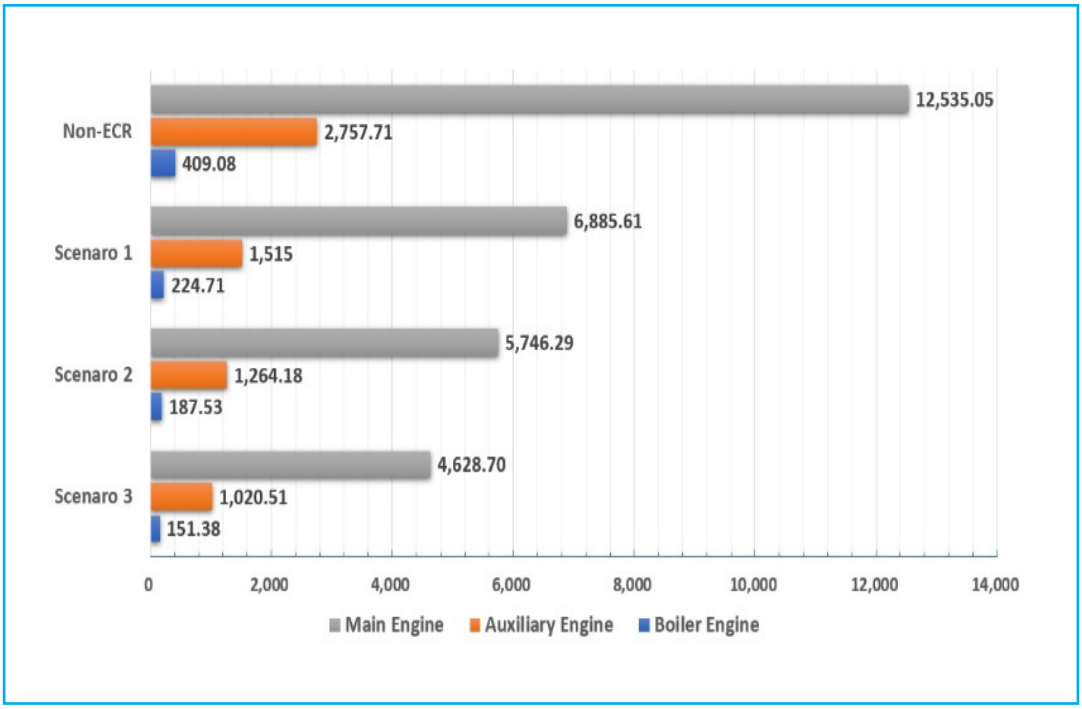
Fuel consumption is summarized in Fig. 6. for the given environment of non-ECR, Scenario 1 (12 knots or less), Scenario 2 (11 knots or less), and Scenario 3 (10 knots or less). Fuel consumption without the ECR strategy is calculated to be 12,535.05 Metric Tonne (ME), 2,757.71 Metric Tonne (AE), and 409.08 Metric Tonne (AB). When ECR scenarios is applied, 6,885.61 Metric

Tonne (ME), 1,514.83 Metric Tonne (AE), and 224.71 Metric Tonne (AB) for Scenario 1, 5,746.29 Metric Tonne (ME), 1,264.18 Metric Tonne (AE), and 187.53 Metric Tonne (AB) for Scenario 2, and 4,638.70 Metric Tonne (ME), 1,020.51 Metric Tonne (AE), and 151.38 Metric Tonne (AB) for Scenario 3.

The reduction in total fuel consumption for each scenario compared to those of non-ECR is −45.07% (Scenario 1), −54.16% (Scenario 2), and −62.99% (Scenario 3). Moreover, the fuel consumption reduction ratio for Scenario 2 compared to that of Scenario 1 is −16.55%, and Scenario 3 compared to that of Scenario 1 is −32.63%. The fuel consumption of a ship's ME operation is sensitive to changes in ship speed.

Fig. 6. Fuel Consumption Estimates per Scenario

(Unit: Metric Tonne)



Source: Authors' illustration based on the authors' analysis.

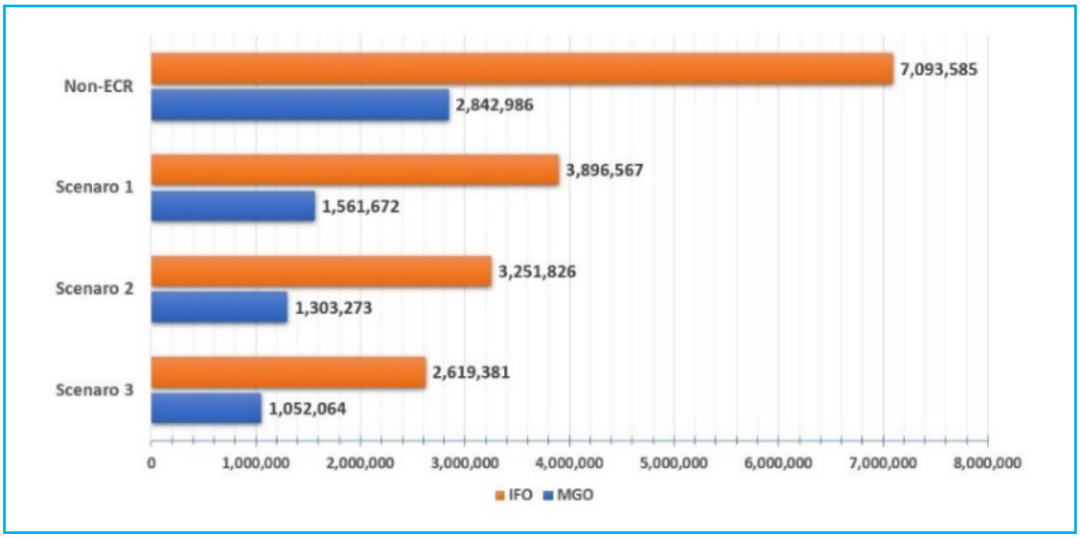
3. Economic Performance of Reduced Fuel Consumption

Based on Fig. 6., which shows the estimated fuel consumption for each scenario, the fuel costs per scenario are shown in Fig. 7. The inputs used for fuel bunkering are $7,093,585 USD (non-ECR), $3,896,567 USD (Scenario 1), $3,251,826 USD (Scenario 2), and $2,619,381 USD (Scenario 3) for IFO. For MGO, it was analyzed to be $2,842,986 USD (non-ECR), $1,561,672 USD (Scenario 1), $1,303,273 USD (Scenario 2), and $1,052,064 USD (Scenario 3). Compared to the non-ECR situation, the fuel cost savings for each scenario are estimated to be −45.07% (Scenario 1), −54.16% (Scenario 2), and −66.99% (Scenario

3) for both IFO and MGO. Hence, it can be seen that the introduction of the ECR system can bring social and environmental cost savings as well as economic cost savings for ship operators.

Fig. 7. Vessel Fuel-Bunkering Costs per Scenario

(Unit: USD)



Source: Authors' illustration based on the authors' analysis.

The cost performance of the ECR scheme was analyzed step-by-step for each scenario, and the final results show savings of USD $23,442,114 (non-ECR), USD $17,552,289 (Scenario 1), USD $16,502,252 (Scenario 2), and USD $14,125,643 (Scenario 3). This is incidentally calculated to be −33.56% (Scenario 1), −42.05% (Scenario 2), −65.95% (Scenario 3) compared to those of the non-ECR environment.

V. Discussion and Conclusion

The IMO's regulation of ship-related air pollution and the establishment of a global GSC network can be very costly, and there might be an imbalance between the economic performance of the shipping market and environmental compliance in the current eco-shipping industry circumstances. Furthermore, air pollution caused by the maritime industry should be approached from the international level to solve the problem with a sense of environmental community. In this study, the ECR scheme was introduced as part of an air pollutant reduction strategy that could be introduced in the process of achieving the IMO2050 slogan regarding the green shipping industry, thereby estimating economic performance in social and environmental sectors after ECR implementation. The ECR strategy can be defined as a differentiated environmental improvement measure at the international level, which can be implemented for maritime transport on the high seas to compensate for the limitations of currently implemented policies and systems to prevent air pollution from ship operations.

We analyzed data collected from the port calls of container ships participating in trade between South Korea and China based on the characteristics of the maritime traffic of liner

shipping that regularly sail certain routes. Consequently, it was found that (i) the social and environmental costs that may occur from CO_2, SO_X, NO_X, PM_{10}, $PM_{2.5}$, and CO emissions, and noticeable indirect costs owing to the ship operation can be reduced by implementing the ECR system. Further, (ii) considering each scenario, if a vessel operator moves at the recommended speed within the ECR, the ship operating costs in terms of fuel consumption can be considerably reduced. Thus, as ship operators can generate economic benefits in ship operating costs and improve ship fuel efficiency through economies of scale in voyage time and ship operations at normal speed, the ECR scheme can motivate ship operators to participate voluntarily with incentives that could be offered, unlike existing IMO regulations. The ECR strategy can be designed as a framework for policy instruments to improve air quality considering the international trend to improve air pollution, and strategic steps to achieve zero emissions.

At a time when global cooperation on the new climate regime is expanding due to the adoption of the Paris Agreement, it is time for the shipping industry to develop a comprehensive plan for environmental cooperation. To this end, it is necessary to establish a framework for international cooperation between relevant international organizations, key countries, and industrial players. The recommended capacity and incentives for compliance with the ECR system need to be considered through an exchange of views between environmental policy-making groups and industrial stakeholders at the international and national levels. As such, given the relationship between policymakers and ship operators that must comply with regulations, a mutually positive effect can be achieved through an ECR scheme. Specifically, the conditions and feasibility of implementing an ECR strategy require cooperation between international organizations, such as the IMO, which is responsible for environmental policy in the global shipping industry, and related countries. In addition, it is possible to create synergistic effect with ETS implemented under various support policies depending on the level of carbon intensity. In the future, organizations designing policies for the green shipping industry should engage in ongoing research to achieve a green environment for the shipping industry via diversifying policy efforts, and multifaceted policies for the green shipping industry should be developed to reduce the economic burden on shipping companies.

Lastly, based on the conceptual design of the ECR system, this study converted the direct and indirect benefits that could be induced into cost values when introducing an ECR scheme for each scenario in the liner shipping between Korea and China. In the future, the complementary relationship between policies and the feasibility of introducing an ECR strategy should be reviewed considering scope, and the direction of the functional change of the ECR system should be regarded when the GSC is extended to the global network, including green ship propulsion technology and green fuel-related technology.

References

Ammar, N. R. (2019). An environmental and economic analysis of methanol fuel for a cellular container ship. *Transportation Research Part D: Transport and Environment, 69*, 66-76. https://doi.org/10.1016/j.trd.2019.02.001

Authority, N. M. (2018). *Air emissions from shipping in the ASEAN region*. https://aseminfoboard.org/wp-content/uploads/2022/10/Air-Emissions-from-Shipping-In.pdf

Berechman, J., & Tseng, P. H. (2012). Estimating the environmental costs of port related emissions: The case of Kaohsiung. *Transportation Research Part D: Transport and Environment, 17*(1), 35-38. https://doi.

org/10.1016/j.trd.2011.09.009

Boemare, C., & Quirion, P. (2002). Implementing greenhouse gas trading in Europe: lessons from economic literature and international experiences. *Ecological Economics, 43*(2-3), 213-230. https://doi.org/10.1016/S0921-8009(02)00213-6

CE Delft (2018). Environmental prices handbook 2017: Methods and numbers of valuation of environmental impacts. https://cedelft.eu/wp-content/uploads/sites/2/2021/03/CE_Delft_7N54_Environmental_Prices_Handbook_2017_FINAL.pdf

Chang, D. S. (2022). An analysis on the possibility of introducing the carbon border adjustment mechanism under the WTO System. *Journal of International Trade & Commerce, 18*(5), 137-157. http://dx.doi.org/10.16980/jitc.18.5.202210.137

Czermański, E., Cirella, G. T., Oniszczuk-Jastrząbek, A., Pawłowska, B., & Notteboom, T. (2021). An energy consumption approach to estimate air emission reductions in container shipping. *Energies, 14*(2), 278. https://doi.org/10.3390/en14020278

DNV (2020). *A new ECA and speed reduction limits in South Korean ports*. https://www.dnv.com/news/a-new-eca-and-speed-reduction-limits-in-south-korean-ports-173622

EGCSA (2021). *Global marine sox emissions regulation*. https://www.egcsa.com/

Elizabeth, S. (2018, January 22). *Fuel costs in ocean shipping.* MoreThanShipping. https://www.morethanshipping.com/fuel-costs-ocean-shipping/

European Commission (2021), *Study on EU ETS for maritime transport and possible alternative options of combinations to reduce greenhouse gas emissions*. https://op.europa.eu/en/publication-detail/-/publication/ba865136-353b-11ec-bd8e-01aa75ed71a1

Fan, Q., Zhang, Y., Ma, W., Ma, H., Feng, J., & Yu, Q. et al. (2016). Spatial and seasonal dynamics of ship emissions over the Yangtze River Delta and East China Sea and their potential environmental influence. *Environmental Science & Technology, 50*(3), 1322-1329. https://doi.org/10.1021/acs.est.5b03965

Global Maritime Forum & McKinsey Company (2021). *The next wave: Green corridors.* https://www.globalmaritimeforum.org/content/2021/11/The-Next-Wave-Green-Corridors.pdf

Global Maritime Forum (2022). *Annual progress report on green shipping corridors.* https://www.globalmaritimeforum.org/content/2022/11/The-2022-Annual-Progress-Report-on-Green-Shipping-Corridors.pdf

Gössling, S., Meyer-Habighorst, C., & Humpe, A. (2021). A global review of marine air pollution policies, their scope and effectiveness. *Ocean & Coastal Management, 212*, 105824. https://doi.org/10.1016/j.ocecoaman.2021.105824

Goldsworthy, L., & Renilson, M. (2013). Ship engine exhaust emission estimates for Port of Brisbane. *Air Quality and Climate Change, 47*(2), 26-36. https://search.informit.org/doi/10.3316/informit.361295868711374

Horowitz, C. A. (2016). Paris agreement. *International Legal Materials, 55*(4), 740-755. https://doi.org/10.1017/S0020782900004253

Hwang, J. H., & Kim, S. H. (2023). Emission control routes in container shipping between Korea-China. *Journal of Korea Trade, 27*(3), 119-146. http://doi.org/10.35611/jkt.2023.27.3.137

IEA (2020). *China's emissions trading scheme: Designing efficient allowance allocation.* https://iea.blob.core.windows.net/assets/d21bfabc-ac8a-4c41-bba7- e792cf29945c/China_Emissions_Trading_Scheme.pdf

International Maritime Organization (IMO) (2018, April 13). *Initial IMO strategy on the reduction of GHG emissions from ships* (Annex 11 resolution MEPC. 304(72)). https://www.imo.org/en

Joung, T. H., Kang, S. G., Lee, J. K., & Ahn, J. (2020). The IMO initial strategy for reducing Greenhouse Gas (GHG) emissions, and its follow-up actions towards 2050. *Journal of International Maritime Safety, Environmental Affairs, and Shipping, 4*(1), 1-7. https://doi.org/10.1080/25725084.2019.1707938

Julio, B., Sonia, Z., & Vicente, D. (2022) Review of ship energy efficiency. *Ocean Engineering, 257*, 111594. https://doi.org/10.1016/j.oceaneng.2022.111594

Kim, S. H., & Jung, Y. K. (2022). Relationship between emissions trading scheme and the cost of debt: Focusing on export concentration. *Journal of International Trade & Commerce, 18*(6), 421-442. http://dx.doi.org/10.16980/jitc.18.6.202212.421

Kitetu, G. M., & Ko, J. H. (2023). U.S. re-entry into the 2015 Paris climate agreement and implications for the EU, Korea, China, and Japan: A CGE approach. *Journal of Global Business and Trade, 19*(3), 129-149. http://dx.doi.org/10.20294/jgbt.2023.19.3.129

Le Tixerant, M., Le Guyader, D., Gourmelon, F., & Queffelec, B. (2018). How can automatic identification system (AIS) data be used for maritime spatial planning?. *Ocean & Coastal Management, 166*, 18-30. https://doi.org/10.1016/j.ocecoaman.2018.05.005

Lee, D. J. & Yoo, J. H. (2022). A study on the economic effects of EU's CBAM on Korea. *Journal of Global Business and Trade*, *18*(6), 59-78. http://dx.doi.org/10.20294/jgbt.2022.18.6.59

Lee, H., Pham, H. T., Chen, M., & Choo, S. (2021). Bottom-up approach ship emission inventory in Port of Incheon based on VTS data. *Journal of Advanced Transportation,* 1-16. https://doi.org/10.1155/2021/5568777

Lee, J. S., Son, W. J., Lee, H. T., & Cho, I. S. (2020). Verification of novel maritime route extraction using kernel density estimation analysis with automatic identification system data. *Journal of Marine Science and Engineering*, *8*(5), 375. https://doi.org/10.3390/jmse8050375

Lee, Y. S. (2022). A study on government commitment, public capital, and trade. *Journal of Global Business and Trade, 18*(4), 91-105. http://dx.doi.org/10.20294/jgbt.2022.18.4.91

Li, C., Borken-Kleefeld, J., Zheng, J., Yuan, Z., Ou, J., & Li, Y. et al., (2018). Decadal evolution of ship emissions in China from 2004 to 2013 by using an integrated AIS-based approach and projection to 2040. *Atmospheric Chemistry and Physics, 18*(8), 6075-6093. https://doi.org/10.5194/acp-18-6075-2018

Mao, X., Rutherford, D., Osipova, L., & Comer, B. (2020). *Refueling assessment of a zero-emission container corridor between China and the United States: Could hydrogen replace fossil fuels?* (Working Paper No.5), ICCT. 1-13. https://theicct.org/wp-content/uploads/2021/06/Zero-emission-container-corridor-hydrogen-3.5.2020.pdf

Ng, S. K., Loh, C., Lin, C., Booth, V., Chan, J. W., & Yip, A. C. et al. (2013). Policy change driven by an AIS-assisted marine emission inventory in Hong Kong and the Pearl River Delta. *Atmospheric Environment, 76*, 102-112. https://doi.org/10.1016/j.atmosenv.2012.07.070

Nunes, R. A., Alvim-Ferraz, M. C. M., Martins, F. G., & Sousa, S. I. (2019). Environmental and social valuation of shipping emissions on four ports of Portugal. *Journal of Environmental Management, 235*, 62-69. https://doi.org/10.1016/j.jenvman.2019.01.039

Port of Los Angeles (2023). *Vessel speed reduction incentive program guidelines*. https://kentico.portoflosangeles.org/getmedia/0e57c1fd-0997-424a-92f3-547f31713b11/VSR-Instruction-Guidelines-2020

Port of Long Beach (2022). *Green flag incentive program*. https://polb.com/business/incentives/#green-flag-program

Qian, X., Xu, G., Li, L., Shen, Y., He, T., & Liang, Y. et al. (2016). Knowledge and perceptions of air pollution in Ningbo, China. *BMC Public Health, 16*, 1-7. https://doi.org/10.1186/s12889-016-3788-0

Safety4Sea (2018, November 29). *Complying with NOx Tier III standards: What you need to know.* https://safety4sea.com/cm-complying-with-nox-tier-iii-standards-what-you-need-to-know/

Sands, P. (1992). The United Nations framework convention on climate change. *Review European, Comparative & International Enviromental Law, 1*, 270. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-9388.1992.tb00046.x

Scheepens, R., Hurter, C., Van De Wetering, H., & Van Wijk, J. J. (2015). Visualization, selection, and analysis of traffic flows. *IEEE Transactions on Visualization and Computer Graphics, 22*(1), 379-388. https://doi.org/10.1109/TVCG.2015.2467112

Ship & Bunker (2023). *World bunker prices*. https://shipandbunker.com/prices

Song, S. (2014). Ship emissions inventory, social cost and eco-efficiency in Shanghai Yangshan port. *Atmospheric Environment, 82*, 288-297. https://doi.org/10.1016/j.atmosenv.2013.10.006

Stillwater Associates (2017). *IMO 2020 Part 1: The evolution of the marine sulfur regulation*. https://stillwaterassociates.com/imo-2020-part-1-marine-fuel-sulfur-content/

Statista (2023). *Value of the carbon market worldwide from 2018 to 2022*. https://www.statista.com/

Tichavska, M., & Tovar, B. (2015). Environmental cost and eco-efficiency from vessel emissions in Las Palmas Port. *Transportation Research Part E: Logistics and Transportation Review, 83*, 126-140. https://doi.org/10.1016/j.tre.2015.09.002

Tran, N. K., Lam, J. S. L., Jia, H., & Adland, R. (2022). Emissions from container vessels in the port of Singapore. *Maritime Policy & Management, 49*(3), 306-322. https://doi.org/10.1080/03088839.2021.1980236

UN (1998). *Kyoto protocol to the United Nations framework convention on climate change.* https://unfccc.int/resource/docs/convkp/kpeng.pdf

Viana, M., Amato, F., Alastuey, A., Querol, X., Moreno, T., & Garcia Dos Santos, S. et al. (2009). Chemical tracers of particulate emissions from commercial shipping. *Environmental Science & Technology, 43*(19), 7472-7477. https://doi.org/10.1021/es901558t

Wan, Z., Zhu, M., Chen, S., & Sperling, D. (2016). Pollution: Three steps to a green shipping industry. *Nature, 530*(7590), 275-7. https://doi.org/10.1038/530275a

Wang, L., Peng, C., Shi, W., & Zhu, M. (2020). Carbon dioxide emissions from port container distribution: Spatial characteristics and driving factors. *Transportation Research Part D: Transport and Environment, 82*, 102318. https://doi.org/10.1016/j.trd.2020.102318

Wang, X., & S. Y., Jin (2023). Environmental, social, and governance performance and corporate sustainable development in China. *Journal of Global Business and Trade*, 19(1), 91-107. http://dx.doi.org/10.20294/jgbt.2023.19.1.91

Winther, M., Christensen, J. H., Angelidis, I., & Ravn, E. S. (2017). *Emissions from shipping in the arctic from 2012–2016 and emission projections for 2020, 2030, and 2050.* Aarhus University. http://dce2.au.dk/pub/SR252. pdf.

Yang, I. S. (2022). The choice of trade policy in an international differentiated duopoly with process R&D investment under uncertainty. *Journal of Global Business and Trade, 18*(5), 117-127. http://dx.doi.org/10.20294/jgbt.2022.18.5.117

Yang, J. (2019). A study on the verification method of ships' fuel oil consumption by using AIS. *The Korean Society of Marine Environment & Safety, 25*(3), 269-277. https://doi.org/10.7837/kosomes.2019.25.3.269

Yoon, S. H. (2022). Assessing potential economic impacts of the EU CBAM on its major trading partners. *Journal of International Trade & Commerce*, *18*(1), 391-411. http://dx.doi.org/10.16980/jitc.18.1.202202.391

Zhao, M., Zhang, Y., Ma, W., Fu, Q., Yang, X., & Li, C. et al. (2013). Characteristics and ship traffic source identification of air pollutants in China's largest port. *Atmospheric Environment, 64*, 277-286. https://doi.org/10.1016/j.atmosenv.2012.10.007

ISSN 1946-5130 (Print), ISSN 2470-4733 (Online)
http://dx.doi.org/10.20294/jgbt.2023.19.5.37

The Journal of Global Business and Trade

Journal of Global Business and Trade

https://www.pfw.edu/jgbt

A Study on the Effect of Technical Barriers to Trade (TBT) Measures on Imports from China and Employment in Korea*

Chan-Hyo Park[a], Dong-Joo Lee[b]**

[a]*Department of International Commerce and Logistics, Pukyong National University, South Korea*
[b]*Division of International Commerce, Pukyong National University, South Korea*

Received 7 August 2023, Revised 7 September 2023, Accepted 5 October 2023

ABSTRACT

Purpose – The number of Korea's Technical Barriers to Trade (TBT) notifications is increasing, and TBT is recognized as a form of trade barrier. Furthermore, Korea is highly dependent on trade, and the proportion of imports from China is large. Therefore, this study analyzed the effect of TBT on imports from China and Korea's employment.

Design/Methodology/Approach – This study aimed to analyze the impact of TBT in Korea on imports and employment in China. Therefore, TBT and other data from 1995 to 2017 were collected to form panel data. A gravity model was used to analyze the import effect of TBT, and import competition was used to analyze the employment effect. A Hausman test was performed to increase the accuracy of the panel analysis.

Findings – TBT had no effect on the import of the entire manufacturing industry and of manufacturing intermediate goods. However, as a result of analysis by detailed industry, TBT decreased the imports of electronic parts, electrical equipment, and steel industries. However, TBT had no effect on the plastics industry, and TBT rather increased the imports of the chemical industry. TBT had a positive effect on the number of employees of the manufacturing industry.

Research Implications – While previous literature conducted in Korea mainly focused on the impact of TBT by trading partners on exports, this study focuses on imports and employment. It is expected to fill gaps in existing studies.

Keywords: import effect, employment effect, non-tariff measures (NTMs), technical barriers to trade (TBT)
JEL Classifications: C33, F13, F16

* *This work was supported by the Pukyong National University Industry-university Cooperation Research Fund in 2023 (202312130001).*
** *Corresponding Author, E-mail: dlee@pknu.ac.kr*
© 2023 International Academy of Global Business and Trade. All rights reserved.

I. Introduction

Over the past 100 years, efforts by countries around the world for free trade have been continuous. Prior to the 2000s, multilateral trade negotiations were conducted under the GATT and WTO systems. After the 2000s, it was difficult to reach an agreement due to the large number of participating countries, so to both multilateral trade negotiations and free trade agreements appeared, in which relatively few countries participated. These have contributed to lower tariff rates; according to World Bank Indicators, the world average tariff rate was 15% in 1990, which has fallen by 5.2% in 2017.

However, after the 2008 global financial crisis, with cases such as the China trade dispute, Brexit, and the China-Australia trade dispute, the world is increasingly moving toward protectionism. The lack of progress in WTO negotiations and the failure to appoint members of the WTO Dispute Settlement Body is weakening the WTO's existing authority for free trade around the world.

In addition, the number of non-tariff measure notifications by each country continues to increase every year. Non-tariff measures can be notified to the WTO for fair trade and the interests of consumers, but they can be an excessive regulation and become a trade barrier. The number of disputes over non-tariff measures also shows an upward curve. Although tariff rates continue to fall, the increase in non-tariff measures shows that protectionism is spreading. The reason non-tariff measures are taken is due to issues of industrial protection and employment (Cho et al., 2017), as well as cultural characteristics unique to different countries (Lee & Yoo, 2022).

Among these non-tariff measures, Technical Barriers to Trade (TBT) are the most used compared to other non-tariff measures. In fact, according to the WTO I-TIP (Integrated Trade Intelligence Portal), which records information on non-tariff measures, in the case of Korea, there were 2,131 non-tariff measures initiated or in force from 1995 to 2021, and TBT accounted for an overwhelmingly large portion with 1,142 cases. These can have a significant impact on trade as they can compulsorily require production methods and evaluation procedures for traded products.

As non-tariff measures, including TBT, account for a large portion of global trade and commerce, many related studies have been conducted. However, most previous studies on the trade effects of non-tariff measures conducted in Korea focused on export effects. Korea's non-tariff measures had a frequency index and coverage ratio of about 90%, which is high enough to rank 10th in the world (WTO, 2021). This means that 90% of imported products and import value were affected by non-tariff measures. Despite these facts, it is difficult to find studies on the effect of TBT on Korea's imports.

In this regard, this study aims to analyze the impact of TBT, which accounts for the largest portion of Korea's non-tariff measures, on imports in the manufacturing industry in China, Korea's number 1 import destination. China is Korea's largest trading partner, and itseconomy has grown rapidly (Qin & Jin, 2022), accounting for a larger share of both exports and imports than any other country. Since the signing of the Korea-China FTA (Park & Liu, 2022), economic and political integration has deepened, and Korea recorded a significant surplus in trade with China (Ahn & song, 2021; Park, 2021) However, the increase in the surplus has slowed since 2019, and the country had the largest deficit in 2022 (Ku & Hong, 2023). Also, China's Technological progress has seen great achievement (Gao & Jin, 2022). These changes in trade structure can affect employment (Koo & Kim, 2020). Considering that the causes of the increase in non-tariff measures are the economic recession and job problems in each country, the impact of TBT on Korea's employment will be further analyzed.

II. TBT and Literature Review

1. TBT Overview

Before the TBT agreement was signed,

technology-related consultations between countries were conducted through the Tokyo Round Standards Code in 1979. However, the Standards Code had the disadvantage of violating the principle of the Most Favored Nation clause as it was an agreement between contracting parties rather than multilaterally. To supplement this, the WTO's TBT Agreement created a Most Favored Nation clause that entered into force on January 1, 1995. In other words, the WTO TBT agreement aims for a multilateral trading system without discrimination between member countries (WTO, 2013).

The WTO's TBT agreements specify the definition, classification, and scope of application of TBT. First, looking at the definition, TBT provides the minimum measures to protect the safety and health of plants and the environment. Here, the minimum measures mean TBT for public interest, such as human safety and environmental protection. At the same time, TBT is prohibited from being an excessive barrier to trade (WTO, 1995).

The classification of TBT can be divided into Technical Regulation, Standard, and Conformity Assessment Procedure. Technical regulations and standards stipulate the methods of production and production methods of products. Technical regulations are regulations implemented by the government and have compliance, but the difference is that the standards are not enforceable. However, the International Organization for Standardization/ International Electrotechnical Committee Guideline 2 states that the standards can be voluntary or compulsory. Conformity procedures refer to all procedures to ensure that products are produced in accordance with the requirements of technical regulations and standards.

2. TBT Status in Korea

Table 1 shows the top 10 countries in the cumulative number of notifications from 1995 to 2021. Compared to Brazil, which ranked second, the United States showed an overwhelming figure, recording about twice the number of notifications, followed by China and the EU. Among the non-tariff measures of the top 10 countries, SPS and TBT accounted for the largest share.

Korea saw 2,131 non-tariff measures, ranking sixth in the world. Similar to the global trend, SPS and TBT recorded 713 and 1,142 cases, respectively, accounting for about 87% of the total. In particular, TBT recorded the highest number of cases with 1,142 cases. Other measures include ADP, SG, and SSG, but their share was only about 10%.

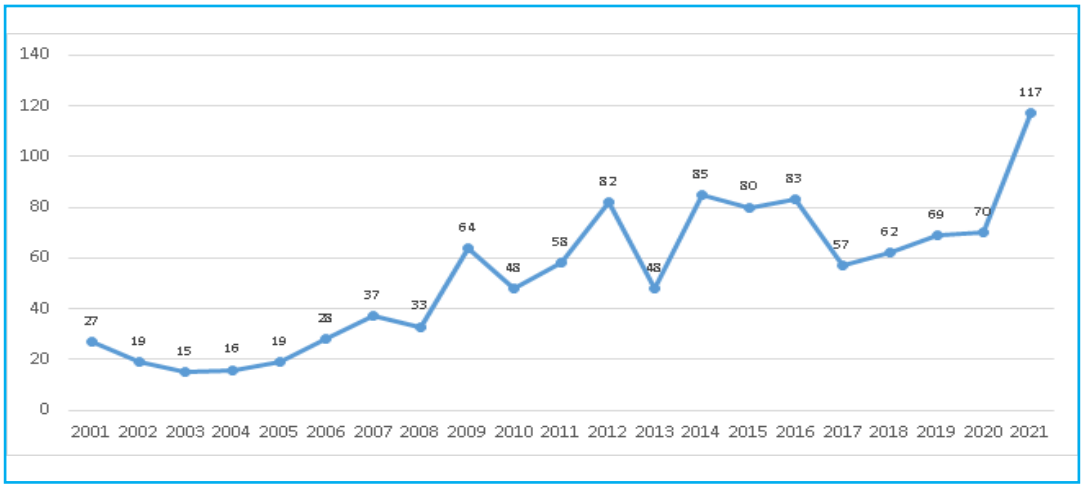
Table 1. Global Ranking of Non-Tariff Measures (1995-2021)

Ranking	Country	SPS	TBT	ADP	CV	SG	SSG	QR	Sum
1	USA	3,199	2015	854	285	13	496	59	6,986
2	Brazil	1,969	1,394	391	12	4	0	0	3,787
3	China	1,350	1,641	288	17	2	0	42	3,394
4	EU	873	1,464	514	78	0	71	18	3,128
5	Canada	1,395	789	289	74	4	0	48	2,634
6	Korea	713	1,142	121	0	4	75	3	2,131
7	Japan	834	948	16	1	1	173	85	2,081
8	Uganda	173	1,530	0	0	0	0	0	1,703
9	India	264	271	976	28	46	0	59	1,669
10	Thailand	506	760	96	0	6	0	69	1,463

Source: WTO, I-TIP (2022).

Fig. 1 shows the number of TBT notifications by year in Korea. There is an increase or decrease from year to year, but it shows an upward trend. The number of TBT notifications in Korea were less than 40 before 2008, but doubled in 2009 compared to the previous year due to the impact of the global financial crisis in 2008, and continued to increase after that, peaking in 2021.

Fig. 1. Korea's TBT Notification Trend



Source: WTO I-TIP (2022).

Table 2 shows the number of TBT notifications by product from 1995 to 2021 in Korea. TBT for mechanical and electronic products was greatest with 190 cases, followed by chemical products, plastics, and rubber products. Products with high technology concentration recorded a high number of notifications, and products that did not recorded a low number of notifications.

3. Theoretical Background and Literature Review

As the number of TBT notifications increases globally, research on its impact on trade has been actively conducted. Unlike trade barriers such as tariffs, TBT does not always have a negative impact on trade. Factors such as technological regulation increase trade costs for exporting firms by incurring information costs and adaptation costs. Here, information cost refers to the cost incurred in researching the TBT of other countries in order to export domestic products, and adaptation cost refers to the cost incurred in modifying export items to suit foreign markets. Nevertheless, adopting the same TBT between two countries can facilitate trade by lowering information costs (Moenius, 2004). In addition, TBT can generate more demand and promote more consumption and trade because it can provide consumers with information about safety and quality (Bao & Chen, 2013; Portugal-Perez et al., 2010).

Meanwhile, Korea is a country highly dependent on trade, and there have been many studies analyzing the effects of TBT on trade. Jang and Seo (2014) analyzed the effect of TBT on Korea's exports and imports by two-unit HS code. As a result of the analysis, it was confirmed overall that TBT has a negative impact on Korea's exports and imports in the short term,

Table 2. Number of TBT Notifications by Product in Korea

HS Code	Product Description	Notice Number
-	Unclassified product	742
84 ~ 85	Machinery and electrical equipment	190
28 ~ 38	Products of the chemical and allied industries	154
39 ~ 40	Resins, plastics and articles; rubber and articles`	90
94 ~ 96	Miscellaneous manufactured articles	89
90 ~ 92	Instruments, clocks, recorders and reproducers	59
16 ~ 24	Prepared foodstuff; beverages, spirits, vinegar; tobacco	59
01 ~ 05	Live animals and products	52
06 ~ 14	Vegetable products	45
86 ~ 89	Vehicles, aircraft and vessels	38
15	Animal and vegetable fats, oils and waxes	36
72 ~ 83	Base metals and articles	35
47 ~ 49	Paper, paperboard and articles	27
44 ~ 46	Wood, cork and articles; basketware	27
68 ~ 70	Articles of stone, plaster; ceramic prod.; glass	26
25 ~ 27	Mineral product	20
50 ~ 63	Textiles and article	16
97	Works of art and antiques	5
41 ~ 43	Hides, skins and articles; saddlery and travel goods	1
64 ~ 67	Footwear, headgear; feathers, artif. flowers, fans	1
71	Pearls, precious stones and metals; coin	1
93	Arms and ammunition	1

Source: WTO I-TIP (2022).

but they have a positive impact in the long term. In addition, it was confirmed that the higher the technology level, the greater the negative impact. Choi et al. (2015) analyzed that the impact of TBT on trade was not significant because most trade between Korea, China, and Japan consists of intermediate goods. Hwang (2020a) analyzed the effects of TBT and SPS applied to Korea's six-unit HS exports by country import level and industry. As a result of the analysis, it was found that non-tariff measures created by high-import countries restricted Korea's exports, but in the case of low-import countries, the results were reversed. The results showed that the export effects of TBT and SPS in industries other than the chemical industry were not significant. Also, in the case of trade with China, it was judged that TBT would have a positive impact because intermediate goods account for most trade. Park et al. (2019) analyzed the impact of ASEAN's TBT on Korea's exports of 85 types of electrical appliances, which are Korea's No. 1 export products to ASEAN. As a result, it was found that all 85 products and intermediate goods were not affected. Yoon and Jang (2019) analyzed the effects of TBT and SPS on halal food imports in Muslim and Southeast Asian countries. As a result, it was confirmed that the certification process has a positive effect on imports in Islamic countries, but in Southeast Asia, the certification process is difficult and has a negative effect.

TBT can indirectly affect employment through trade. TBT may reduce imports. At this time, domestic employment must be increased for domestic production to fill the insufficient demand. Additionally, exporting countries can increase employment by making foreign direct investments to bypass the importing country's TBT. However, only a few studies on this have been conducted.

Leonardi and Maschi (2021) looked at the impact of non-tariff measures imposed on China, the largest importing partner of the United States, on imports, employment, and wages. The United States continued to have a trade deficit due to trade with China, and therefore, the analysis focused on employment and wages in contested regions. To analyze the impact of China's non-tariff measures on employment, the import competition presented by Autor et al. (2014) was used as a control variable. As a result of the analysis, it was found that non-tariff measures curb imports and have a positive effect on employment and wages. Hwang (2020b) analyzed the impact of non-tariff measures by trading country on Korea's exports and employment. It was found that non-tariff measures had a negative impact on both exports and employment. In addition, industries with high capital intensity showed a relatively larger negative impact.

Summarizing the results of the study, TBT has relatively fewer trade-restricting effects for developed countries than developing countries. In addition, the trade effect of TBT was found to be negative when the technology level of the industry was higher. Studies with no effect were presented. In the case of China, the impact of TBT was not negative because it has a large trade in intermediate goods with Korea. In a study analyzing by terms of employment, it was found that non-tariff measures had a positive effect on notifying country.

As such, it is difficult to clearly define how non-tariff measures affect trade. In addition, most previous studies analyzed the export effect in Korea, and it is difficult to find a study that analyzed the import effect. Therefore, this study analyzed the effect of TBT on imports and employment from China, Korea's number one importing country. In addition, by reflecting the results of previous studies that revealed the trade effect differs by intermediate goods and industry, it was further analyzed by industry, wherein Korea's TBT is mainly imposed.

III. Methodology

1. Analysis Method

This study aimed to analyze the impact of TBT in the Korean manufacturing industry on imports

from China and employment in Korea. The entities used for both analyses are HS products and industries. The analysis period used 23 years of data from 1995 to 2017. These two objects are repeated by year and judged as panel data. In this case, it is appropriate to analyze using a panel model. For the panel model, the fixed effect model and the random effect model are mainly used. In this study, both models were used, and the Hausman Test results and LM Test were presented in each analysis result table.

The import effect referred to the gravity model, and the employment effect referred to the import competition variable presented by Autor et al. (2014), and the model by Leonardi and Maschi (2021).

1.1. Import Effect Model

The gravitational model is a model applied to international economics from Newton's law of universal gravitation, and explains the scale of trade between two countries. Tinbergen (1962), who first applied the gravity model to empirical analysis, explained that the size of trade was influenced by three factors. For trade to occur, exporting countries need the economic power to export, and importing countries need the economic power to consume the exported goods. In other words, the size of the economies of the two countries is a factor that determines the size of trade, and the size of trade increases proportionally. The last factor is the distance between the two countries. The closer the distance between the two, the lower the transportation cost. In other words, the size of trade is determined in inverse proportion to the distance. An analysis model was established by adding a control variable to this gravity model, and the following (1) is shown.

$$\ln(IMP_{jt}) = \beta_0 + \beta_1 TBT_{jt} + \beta_2 \ln(1+Tariff_{jt}) + \beta_3 \ln(CHNGDP_t) + \beta_4 \ln(KORGDP_t) + \mu_t + \varepsilon_{jt} \quad (1)$$

Wherein:

IMP_{jt}: value of imported product j in time t

TBT_{jt}: the number of TBT notifications to product j in time t

$Tariff_{jt}$: Most-favored nation tariff applied to product j in time t

$CHNGDP_t$: China real GDP per capita in time t

$KORGDP_t$: Korea real GDP per capita in time t

μ_t: individual error terms that do not change with time for products

ε_{jt}: st ochastic residual term

β_i (i=0,1,2,3,4): the parameters of the model

1.2. Employment Effect Model

The formula for analyzing the employment effect is shown in Equation (2) below.

$$\ln(Y_{it}) = \beta_0 + \beta_1 \ln(TBT_{it} + 1) + \beta_2 \Delta Imexp_{it} + \beta_3 \ln(Wage_{it}) + \beta_4 \ln(Cap_{it}) + \mu_t + \varepsilon_{it} \quad (2)$$

Wherein:

Y_{it}: the number of employees in industry j in time t

TBT_{it}: sum of the number of TBT notifications corresponding to the 6-unit HS code corresponding to industry j in time t

$Imexp_{it}$: the degree of exposure to imports from China to industry j in time t

$Wage_{it}$: the per capita wage in the industry i in time t

Cap_{it}: the capital intensity of industry i in time t

μ_t: individual error terms that do not change with time for products

ε_{it}: stochastic residual term

β_i (i=0,1,2,3,4): the parameters of the model

2. Analysis Data

In this study, TBT data by country provided by the Vienna Institute for International Economics were used. Non-tariff measures including TBT are notified to the WTO, and TBT data accumulated since 1995 can be obtained from the WTO I-TIP,

but the data has many missing values. Actually, there are 1,142 TBT notifications in Korea, with only 101 notifications providing HS codes are not suitable for analysis.

In order to compensate for these disadvantages, the Vienna Institute for International Economics worked to link HS code with the notice of non-tariff measures. The WTO's TBT notice provides the ICS (International Classification for Standards) code used by the International Organization for Standardization for product classification, so it was used to link the HS code. Through this work, data on more than 5,000 products notified to the WTO during the period from 1995 to 2019 were linked to 6 units of HS codes, and the omission rate of HS codes in all notifications was 55% decreased below 25% (Ghodsi et al. 2017).

For import amounts and tariffs, data from WITS (World Integrated Trade and Solution) were used. WITS provides international trade information based on the UNCTAD-TRINS database. The data of the Vienna Institute for International Economics and WITS provided information based on the combined HS codes (HS Combined), so the data could be linked. GDP per capita was provided by World Development Indicators (WDI), and the HS code of intermediate goods used in the additional analysis referred to the BEC code presented by the UN.

For industrial classification, the 10th Korea Standard Industrial Classification (KSIC) provided by the National Statistical Office was utilized. The National Statistical Office prepared the KSIC according to the International Standard Industrial Classification (ISIC) presented by the United Nations for the accuracy of Korean industrial statistics. The classification structure of KSIC consists of 21 letters as the main category, and 77 numbers as the middle category.

Data provided by the Industrial Statistics Analysis System (ISTANS) of the Korea Institute for Industrial Economics and Trade were used for the number of employees, import competition, tangible fixed assets, and per capita wages for each industry. Although the industry classification system of the data of the Korea Institute for Industrial Economics and Trade is different from that of KSIC, it provides a linkage table with KSIC, so it is linked according to the standards of KSIC.

For the HS code corresponding to each industry, the integrated economic classification linkage table provided by the statistical classification portal of the National Statistical Office was used. It is provided in HS 6 units corresponding to the KSIC code, and the corresponding import amount and TBT are linked. Table 4 shows the Expected Sign and sources of the variables.

Table 4. Variable Source

Variable	Expected Sign	Source
IMP	Dependent variable	World Integrated Trade Solutions
TBT	-	Integrated Trade Intelligence Portal
GDP	+	World Development Indicators
Tariff	-	World Integrated Trade Solutions
Intermediate HS		UN Trade Statistics
Y	Dpendent variable	The data collected by Industrial Research Institute (ISTANS) corresponded to KSIC.
ΔImexp	-	
Wage	-	
Cap	-	

Table 5 shows the descriptive statistics of the variables. The average amount of imports, which is the dependent variable used in the import effect analysis, was $17,866,949, and 1.43 TBT measures were taken on average for each product. The average number of employees used in the employment effect analysis was 111,065, and TBT+1 showed that 313 measures were implemented for each industry.

Table 5. Descriptive Statistic

Variable	Obs.	Average	Standard Deviation	Minimum Value	Maximum Value	Median	Mode
IMP (Dollar)	39,589	17,866,949	118,765,134.9	1	8,292,635,531	950,037	5,399
TBT	32,932	1.43	2.86	0	39	0	0
1+Tariff (%)	39,531	8.74	19.56	1	687	9	9
CHNGDP (Dollar)	39,589	3,916.563	2,855.69	609.66	8,816.99	3,468.30	8,816.99
KORGDP (Dollar)	39,589	20,834.6	6,811.42	8,281.70	31,616.84	21,743.48	31,616.84
Y (Person)	529	111,065	100,932.07	1,951	454,078	87,888	-
Wage (Million Won)	529	27.65	13.11	9.33	83.62	24.94	15.14
TBT+1	506	313.61	693.72	1	6,046	61	1
Cap (Million Won)	529	185.85	314.39	12.07	2,669.85	101.23	-
ΔImexp	529	0.54	1.60	-12.69	7.89	0.32	-

IV. Analysis Results

As a result of the Hausman test, the fixed effect model was found to be more appropriate in the import model, but the LM Test result was statistically significant, so the random effect model is also appropriate. Additionally, the import effect analysis showed consistent results regardless of the analysis model.

First, Table 6 shows the effect of TBT on imports of manufacturing and intermediate goods. Tariffs and GDP, which were used as control variables, all showed a statistically significant effect on the amount of imports. First, in the case of tariff rates, a 1% increase in the tariff rate in the manufacturing industry results in a decrease of approximately 0.58% in the amount of imports.

When the real GDP per capita of Korea and China increases by 1%, the amount of imports in each country rises by about 1.8% and 0.34%, respectively. This shows results consistent with predictions before analysis. TBT, the main

variable, did not statistically affect both the total manufacturing industry and the import amount of intermediate goods. A study by Choi et al. (2016) on middle intra-regional trade between Japan, Korea, and Chinais consistent with the result that intermediate goods are mostly unaffected by TBT.

Table 6. Regression Results of TBT to Manufacturing Product Imports of Korea

Variable	Total Manufacturing Industry		Manufacturing Intermediate Goods	
	FE (Fixed Effect)	RE (Random Effect)	FE (Fixed Effect)	RE (Random Effect)
TBT	0.004 (0.004)	0.001 (0.004)	0.007 (0.006)	0.004 (0.006)
ln(1 + Tariff)	-0.587*** (0.038)	-0.537*** (0.033)	-0.654*** (0.046)	-0.555*** (0.04)
ln(CHNGDP)	0.338*** (0.034)	0.330*** (0.034)	0.283*** (0.04)	0.273*** (0.041)
ln(KORGDP)	1.799*** (0.089)	1.801*** (0.09)	1.878*** (0.107)	1.902*** (0.108)
Constant		-6.584*** (0.666)		-7.080*** (0.802)
Observations	32,883	32,883	23,729	23,729
R^2	0.225	0.191	0.221	0.184
Adjusted R^2	0.169	0.191	0.166	0.184
F-Statistic	2,231.379*** (df = 4; 30656)	8,423.418***	1,574.372*** (df = 4; 22143)	5,912.076***
Hausman Test	chisq = 70.305***, df = 4		chisq = 40.438***, df = 4	
LM Test	chisq = 91103***, df = 1		chisq = 91122***, df = 1	

Notes: 1. ***is significant at the 1% level, **is significant at the 5% level, and *is significant at the 10% level.
2. ( ) indicates standard error.

However, the analysis of detailed industries showed different results. Table 7 shows the effect of TBT on imports in the plastic and steel industries. In the case of the plastics industry, TBT did not have a statistically significant effect, but the steel industry showed a negative effect.

Table 8 shows the import effect of TBT in the electronic parts and electrical equipment industries. For these industries, TBT was found to have a negative effect on the amount of imports. Table 9 shows the effect of TBT on the import value of the chemical industry. Unlike other industries, the chemical industry was found to have a positive effect on the amount of imports. In contrast, tariffs did not appear to affect import values.

In summarizing the import effect by industry, it did not match the results of previous studies that found that the higher the level of technology, the more negatively they were affected by TBT.

Table 7. Regression Results of TBT to Plastic and Steel Industry Imports of Korea

Variable	Plastic Industry		Steel Industry	
	FE (Fixed Effect)	RE (Random Effect)	FE (Fixed effect)	RE (Random effect)
TBT	-0.027 (0.018)	-0.022 (0.018)	-0.255*** (0.051)	-0.248*** (0.051)
ln(1 + Tariff)	-2.271*** (0.459)	-2.448*** (0.459)	-0.536*** (0.065)	-0.501*** (0.061)
ln(CHNGDP)	0.567*** (0.089)	0.553*** (0.091)	0.113 (0.104)	0.089 (0.106)
ln(KORGDP)	2.377*** (0.212)	2.336*** (0.219)	3.907*** (0.259)	3.879*** (0.264)
Constant		-16.117*** (1.998)		-24.895*** (1.909)
Observations	2,459	2,459	6,306	6,306
R^2	0.557	0.518	0.348	0.307
Adjusted R^2	0.533	0.517	0.31	0.306
F-Statistic	733.091*** (df = 4; 2329)	2,707.343***	795.331*** (df = 4; 5952)	2,911.656***
Hausman Test	chisq = 48.294***, df = 4		chisq = 43.535***, df = 4	
LM Test	chisq = 7243.9***, df = 1		chisq = 10541***, df = 1	

Notes: 1. ***is significant at the 1% level, **is significant at the 5% level, and *is significant at the 10% level.
2. ( ) indicates standard error.

The electronic parts and electrical equipment industries are high-tech industries, and it can be judged that imports are restricted as the number of TBT notifications increases. On the other hand, the steel and plastic industries showed different results from the same low- and middle-tech industries. In the case of the plastics industry, it can be interpreted that it is not affected because it is a medium-low technology industry. In the steel industry, the number of TBT notifications was relatively low compared to other industries, but due to China's steel oversupply, it seems that these results resolve the middle trade friction in some cases. In the case of the chemical industry, TBT has a positive effect on imports, whereas tariffs have no effect on imports. This is because the chemical industry includes products that are highly dependent on Chinese imports, such as crude oil, natural gas, coal, and cosmetics.

In addition, in comparing these results with those of previous studies to discuss the results, in the case of Hwang (2020a), it was found that non-tariff measures in Korea's chemical industry had a positive effect on exports. This was explained by reducing information asymmetry. This explanation is partially consistent with the results of this study. In other words, this study also found that non-tariff measures had a positive effect on trade in the

case of the chemical industry. Additionally, the chemical industry recorded the second highest number of notifications, but this means that the content of the notifications is more important than the number of notifications (Heo, 2022).

A study by Jang and Seo (2014) presented the result that the higher the level of technology in the industry, the greater the negative impact of TBT. The reason for the inconsistency with the results of this study can be interpreted as the fact that TBT was influenced by the characteristics of each industry rather than the technological level of each industry, and the range of analysis data was different.

Table 8. Regression Results of TBT on the Electric Industry Imports of Korea

Variable	Electronics Industry		Electrical Equipment Industry	
	FE (Fixed Effect)	RE (Random Effect)	FE (Fixed Effect)	RE (Random Effect)
TBT	-0.158*** (0.021)	-0.156*** (0.021)	-0.044*** (0.008)	-0.043*** (0.008)
ln(1 + Tariff)	-0.859*** (0.094)	-0.904*** (0.09)		0.281** (0.126)
ln(CHNGDP)	0.738*** (0.171)	0.722*** (0.172)	0.990*** (0.076)	0.987*** (0.076)
ln(KORGDP)	1.491*** (0.393)	1.473*** (0.395)	1.549*** (0.174)	1.545*** (0.174)
Constant		-3.001 (2.789)		-15.840*** (1.212)
Observations	2013	2013	3,636	3,636
R^2	0.312	0.326	0.525	0.51
Adjusted R^2	0.273	0.325	0.5	0.509
F-Statistic	216.277*** (df = 4; 1904)	877.131***	1,272.215*** (df = 3; 3459)	3,775.445***
Hausman Test	chisq = 3.0365***, df = 4		chisq = 3.5469***, df = 3	
LM Test	chisq = 5101.3***, df = 1		chisq = 19215***, df = 1	

Notes: 1. *** is significant at the 1% level, ** is significant at the 5% level, and *is significant at the 10% level.
2. ( ) indicates standard error.
3. Tariffs in the electrical equipment industry remain unchanged, so there is no effect in the fixed effect model.

Table 9. Regression Results of TBT to the Chemical Industry Imports of Korea

Variable	Chemical Industry	
	FE (Fixed Effect)	RE (Random Effect)
TBT	0.022*** (0.004)	0.021*** (0.004)
ln(1 + Tariff)	-0.146 (0.118)	-0.107 (0.108)
ln(CHNGDP)	0.594*** (0.047)	0.576*** (0.048)
ln(KORGDP)	1.356*** (0.114)	1.353*** (0.117)
Constant		-5.267*** (0.908)
Observations	13,377	13,377
R^2	0.303	0.266
Adjusted R^2	0.261	0.266
F-Statistic	1,370.673*** (df = 4; 12618)	5,003.563***
Hausman Test	chisq = 48.294***, df = 4	
LM Test	chisq = 34031***, df = 1	

Notes: 1. ***is significant at the 1% level, ** is significant at the 5% level, and *is significant at the 10% level.
2. ( ) indicates standard error.

In contrast, the random effect model was found to be more appropriate for the employment effect model, unlike the import effect model, and the LM Test result was also statistically significant.

Table 10 shows the effect of TBT on the number of employees in the manufacturing industry. The analysis results show that both per capita wage and capital intensity have a statistically significant effect on the number of employees. When per capita wage and capital intensity increase by 1%, respectively, the number of employees increases by 0.012% and decreases by 0.311%, respectively. However, import competition did not have a significant effect on the number of employees. TBT, the main variable, showed different results depending on the analysis model. In the fixed effect model, it was found that the number of employees was not affected, but in the random effect model, as the number of TBT notifications affected by the industry increased, and the number of employees increased by 0.012%. This was partially consistent with the study results of Leonardi and Maschi (2021). The results of this study showed that TBT and SPS had a positive effect on employment growth while reducing US manufacturing imports. In this study, TBT had a positive effect on the increase in the number of employees, but did not affect the decrease in imports.

These results suggest that there are differences in the purpose of TBT utilization by country. Although employment increased in both countries, the U.S. TBT aimed at restricting imports, which affected imports, and Korea's TBT aimed at compliance with international standards and advanced technology, so it had a positive effect on the increase in the number of employees. This difference in goals seems to have arisen because the size of the manufacturing base in the US differs greatly from that in Korea.

The analysis of the import effect of TBT showed different results when analyzed by industry. Therefore, it is reasonable to analyze employment by industry, but the analysis could not be performed due to the small number of samples and limitations in data collection.

Table 10. Regression Results of TBT on Employment of Korea

Variable	Employment	
	FE (Fixed Effect)	RE (Random Effect)
ln(Wage)	0.012*** (-0.002)	0.012*** (-0.002)
ln(cap)	-0.310*** (-0.045)	-0.311*** (-0.045)
ln(TBT + 1)	0.011 (-0.007)	0.012* (-0.007)
ΔImexp	0.0001 (-0.006)	0.0002 (-0.006)
Constant		12.196*** (-0.265)
Observations	506	506
R^2	0.105***	0.1
Adjusted R^2	0.056	0.093
F-Statistic	14.047***(df = 4; 479)	55.826***
Hausman Test	chisq = 0.47014, df = 4	
LM Test	chisq = 3.5623*, df = 1	

Notes: 1. ***is significant at the 1% level, **is significant at the 5% level, and *is significant at the 10% level.
2. ( ) indicates standard error.

V. Conclusion

As the instability of the global economy continues, the frequency of use of tariffs, a representative means of protectionism in most countries, is gradually decreasing, while the number of notifications of non-tariff measures is increasing. Reflecting this situation, many studies

have been conducted that have analyzed the trade effects of non-tariff measures. Since Korea is a country highly dependent on trade, many studies have been conducted that have analyzed the trade effects of non-tariff measures, and most studies have analyzed the impact of non-tariff measures on exports. However, although the number of notifications of Korea's non-tariff measures is so high that it ranks sixth in the world, it is difficult to find studies on the import effect of such non-tariff measures in Korea. Accordingly, this study analyzed the effects of Korea's TBT on imports from China and employment in Korea.

First, as a result of analyzing the effect of Korea's TBT on imports from China, it was found that China's entire manufacturing industry and manufacturing intermediate goods were not affected by Korea's TBT. However, as a result of analysis by detailed industry, it was found that imports of the steel, electronic parts, and electrical equipment industries had a negative impact, but there was no impact in the plastic industry, and there was a positive impact in the case of the chemical industry. In other words, if TBT increases in Korea, total imports from China's manufacturing industry will not decrease, but the effect is different for each industry, so it is necessary to establish a TBT imposition policy suitable for each industry.

As a result of analyzing the effect of Korea's TBT on Korea's employment, it was found that increasing TBT increases the number of employees. In other words, TBT was analyzed to help improve domestic economic conditions along with its role as a trade barrier.

In conclusion, like the results of the other preceding studies reviewed above, TBT does not affect trade, and rather has a positive effect. In addition, in the case of the manufacturing industry as a whole, TBT did not reduce imports, and increased the number of employees. However, negative effects have been found in the electrical equipment, electronic parts, and steel industries, so it is necessary to make a careful decision through various analyses when imposing TBT on these industries.

Just as a trade surplus is not necessarily a positive sign, whether or not non-tariff measures such as TBT ultimately help Korea's economic growth need to be analyzed from a long-term perspective. In other words, even if the industry is protected in the short term through TBT, it is necessary to review the long-term growth potential of the industry. This is because the increase in trade barriers means that the exports of trading partners are restricted, so if the economic situation of trading partners worsens, another retaliatory non-tariff measure may be invoked.

Currently, the WTO Dispute Settlement Body is not functioning properly, protectionism is intensifying, and the global economic outlook is also poor due to the global spread of COVID-19. Therefore, if non-tariff measures continue to increase, the Korean economy, which is highly dependent on trade, will inevitably be negatively affected. In order to respond to this situation, it is necessary to create a standard TBT that promotes trade through cooperation between trading countries, notify when necessary, and ease protectionism.

This study has the following limitations. First, this study analyzed China, Korea's number 1 importing country, but was unable to analyze other countries. The United States and Japanare Korea's second and third largest importers, and the number of cases filed with Korea's TBT to the WTO is greater than that of China, so an analysis of these countries is also necessary. Second, there are limitations in that it was not analyzed in consideration of the qualitative aspect of TBT. Even one TBT may have different effects on trade depending on the details, so it is necessary to analyze this by taking it into account. Third, it is necessary to analyze the impact of TBT on employment by detailed industry. Since the employment effect of TBT is expected to be different depending on industry, an analysis by industry seems necessary. The limitations of this study will be left for follow-up studies.

References

Ahn, S. K. & Song J. G. (2021). A study on the international competitiveness of Korea and China in service trade. *Journal of International Trade & Commerce, 17*(6), 127-144. http://doi.org/10.16980/jitc.17.6.202112.127

Autor, D. H., Dorn, D., Hanson, G. H., & Song, J. (2014). Trade adjustment: Worker-level evidence. *The Quarterly Journal of Economics*, *129*(4), 1799-1860. https://doi.org/10.1093/qje/qju026

Bao, X., & Chen, W. C. (2013). The impacts of technical barriers to trade on different components of international trade. *Review of Development Economics*, *17*(3), 447-460. https://doi.org/10.1111/rode.12042

Cho, M. H., Kim, J. D., Park, H. R., & Chung, M. C. (2017). *A study on the effects of non-tariff measures* (Working Paper No.17-24). Korea Institute for International Economic Policy.

Choi, B. Y., Bang, H. K., Lee, B. R., & Yoo, S. B. (2016). *A proposal to lower non-tariff barriers of China, Japan and Korea* (World Economy Brief 15-24). Korea Institute for International Economic Policy.

Gao, Y., & Jin, S. (2022). How does financial technology drive enterprise innovation in China?. *Journal of Global Business and Trade, 18*(1), 25-45. http://doi.org/10.20294/jgbt.2022.18.1.25

Ghodsi, M., Grübler, J., Reiter, O., & Stehrer, R. (2017). *The evolution of non-tariff measures and their diverse effects on trade* (Wiiw Research Report NO. 419). Econstor. https://www.econstor.eu/bitstream/10419/204191/1/wiiw-research-rep-419.pdf

Heo, I. A. (2022). A study on the regulatory similarity between Korea and the CPTPP member states: Focusing on TBT. *Journal of International Trade & Commerce, 18*(1), 373-390. http://doi.org/10.16980/jitc.18.1.202202.373

Hwang, U. J. (2020a). Effects of non-tariff measures on exports. *Korea Trade Review*, *45*(1), 101-118. http://doi.org/10.22659/KTRA.2020.45.1.101

Hwang, U. J. (2020b). The effect of non-tariff measures on employment. *Journal of Industrial Economics and Business*, *33*(3), 743-765. http://doi.org/10.22558/jieb.2020.6.33.3.743

Jang, Y. J., & Seo, J. M. (2014). The impact of technical barriers to trade on bilateral trade: A case of Korea. *Journal of International Trade and Industry Studies*, *19*(1), 1-33.

Koo, K. H., & Kim, H. H. (2020). *The effects of the increase in Korea's trade with China and Vietnam on Korean labor market and policy implications* (Working Paper No. 20-19). Korea Institute for International Economic Policy.

Ku, K. B., & Hong, K. S. (2023). A study on the factors worsening Korea''s trade balance with China. *Korea-China Social Science Association, 21*(3), 136-158., http://doi.org/10.36527/KCSSS.21.3.7.

Lee, D. J., & Yoo, S. J. (2022). Psychic distance and its effect on the degree of internationalization of firms in Korea. *Journal of International Trade & Commerce*, *18*(2), 1-17. http://doi.org/10.16980/jitc.18.2.202204.1

Leonardi, M., & Maschi, E. (2021). Do non-tariff barriers to trade save American jobs and wages?. *Institute of Labor Economics*, 14162. https://dx.doi.org/10.2139/ssrn.3798915

Moenius, J. (2004). *Information versus product adaptation: The role of standards in trade.* SSRN. https://dx.doi.org/10.2139/ssrn.608022

Park, D. J., & Liu. S. (2022). Impact of COVID-19 on Korea-China import and export trade and countermeasures. *Journal of Global Business and Trade, 18*(6), 19-31. http://doi.org/10.20294/jgbt.2022.18.6.19

Park, H. J., Wang, J. B., & Oh, K. Y. (2019). The effects of technical barriers to trade on Korean exports to ASEAN countries. *Korea Trade Review*, *44*(3), 289-305. http://doi.org/10.22659/KTRA.2019.44.3.289

Park, S. J. (2021). A study on the differences of payment practice between Korea and China. *The Journal of International Trade & Commerce, 17*(1), 323-332. http://doi.org/10.16980/jitc.17.1.202102.323

Portugal-Perez, A., Reyes, J. D., & Wilson, J. S. (2010). Beyond the information technology agreement: Harmonisation of standards and trade in electronics. *The World Economy*, *33*(12), 1870-1897. https://doi.org/10.1111/j.1467 9701.2010.01300.x

Qin, Z., & Jin, X. (2022). A study on rural finance, rural industry revitalization, and rural logistics development: An empirical analysis based on panel data from 30 provinces in China. *Journal of Global Business and Trade, 18*(5), 39-58. http://doi.org/10.20294/jgbt.2022.18.5.39

Tinbergen, J. (1962). *Shaping the world economy: Suggestions for an international economic policy.* Twentieth Century Fund.

WTO (1995). *Agreement on technical barriers to trade*. https://www.wto.org/english/tratop_e/tbt_e/tbt_e.htm

WTO (2013). *Technical barriers to trade, The WTO agreements series*. https://www.wto.org/english/res_e/publication s_e/tbttotrade_e.pdf

WTO (2021). *World tariff profiles 2021*. https://www.wto.org/english/res_e/booksp_e/tariff_profiles21_e.pdf

WTO I-TIP (2022, September 3). *Intergrated trade intelligence portal*. http://i-tip.wto.org/goods/default.aspx?language = en

Yoon, J. H., & Jang, Y. J. (2019). The effects of TBT and SPS measures on halal food exports. *Journal of International Trade and Industry Studies*, 24(2), 1-22. http://doi.org/10.23030/katis.2019.24.2.001

ISSN 1946-5130 (Print), ISSN 2470-4733 (Online)
http://dx.doi.org/10.20294/jgbt.2023.19.5.55

The Journal of Global Business and Trade

Journal of Global Business and Trade

https://www.pfw.edu/jgbt

Linking Supply Chain Alliance Orientation to Market Performance: Evidence from South Korean Firms*

Charles Arthur Robb[a], Minhyo Kang[b], Aaron Rae Stephens[c], Seogsoo Kim[d]**

[a]*Linton Global School, Global Business, Hannam University, South Korea*
[b]*Department of Business Administration, Dongguk University WISE Campus, South Korea*
[c]*Department of Business Administration and Accounting, Hartwick College, USA*
[d]*Graduate School of International Studies, Pusan National University, South Korea*

Received 24 July 2023, Revised 28 August 2023, Accepted 5 October 2023

ABSTRACT

Purpose – This research aims to provide a greater understanding of the constructs that aid in the mitigation of supply chain disruptions. Recent anomalies in the global supply chain have negatively influenced the performance of institutions throughout the globe. It is therefore advantageous to examine various antecedents of firm performance through the spectrum of supply chain management. To achieve this, an SOR framework was utilized for this study.

Design/Methodology/Approach – A hypothesized model was developed to examine the relationship between the study constructs. The sample for this research comprised of 200 South Korean firms. Data were analyzed using Smart PLS-SEM analysis. All the constructs were analyzed through a SOR framework.

Findings – Supply chain alliance orientation and supply chain resilience had a significantly positive effect on market performance. Likewise, it was found that supply chain dynamism encouraged supply chain alliance orientation in a supply chain. Further, the mediating effects of alliance orientation showed a positive effect on supply chain resilience and market performance. Similarly, supply chain resilience had a favorable mediating relationship between supply chain alliance orientation and market performance.

Research Implications – The SOR framework can be used as model for understanding organizational behavior in the context of supply chain management. Also, the study findings suggest the importance of developing alliances to strengthen organizational operations during periods of supply chain disruptions.

Keywords: market performance, SOR, supply chain alliance orientation, supply chain dynamism, supply chain resilience

JEL Classifications: L10, L20, M19, M39

* *This work was supported by 2023 Hannam University Research Fund.*
** *Corresponding Author, E-mail: mh2023@dongguk.ac.kr*
© 2023 International Academy of Global Business and Trade. All rights reserved.

I. Introduction

Global supply chains are complex in nature. Institutions within these supply chains are highly exposed to supply chain disruption risks caused by unexpected global events (Hosseini & Ivanov, 2019; Yoon et al., 2022). For example, ongoing US-China trade disputes, and geopolitical issues related to Ukraine and Russia have weighed heavily on the world's highly integrated supply chain network (IMF, 2023). Further, the recent global pandemic (Magableh, 2021) has contributed to dispirited prospects for global growth (Li et al., 2021: Park & Liu, 2022). Additionally, other major emerging economies have experienced fragmented supply chains (Aiyar et al., 2023). Throughout this period of uncertainty, major economic contractions ensued as the world supply chains were encumbered. Supply chain shocks are now the norm as global shipping activities decrease, resulting in reduced manufacturing activities and business closures (Ivanov & Das 2020). Initial institutional policies related to government lockdowns during the pandemic also created ripple effects in markets, as suppliers are unable to meet deadlines due to obstructions in obtaining parts from sub-suppliers further down their supply chains (Ozdemir et al., 2022).

While the dynamic nature of the global supply chain is seen as advantageous for certain firms, augmented levels of uncertainty remain a significant challenge for many firms. For instance, Yu et al. (2019) confirmed that a dynamic environment encouraged certain companies in the supply chain to develop organizational capabilities. Such capacities included collaborative mechanisms, information processing capabilities, and adaptive capabilities (Yu et al., 2019). However, these benefits could be nonlinear, meaning that negative effects could appear in highly uncertain and turbulent environments (Zhou & Benton, 2007). Therefore, certain resources and abilities need to be advanced in order for firms to achieve a competitive advantage in their supply chains (Aldrich & Meyer, 2015). This appraisal stems from the observation that supply chains are multi-tier complex linkages of supply, and are distributed globally (Hosseini & Ivanov, 2019), which increases supply chain vulnerability under risks and uncertainty (Gölgeci & Ponomarov, 2015).

Compounding the complex and dynamic nature of supply chains is the composite disposition of globalization. Firms are required to understand and measure disruptions through an evolving lens in regard to outsourcing (Ozdemir et al., 2022), social capital (Inkpen & Tsang, 2005), networking (Gölgeci & Kuivalainen, 2020), and supply chain resilience (Ivanov, 2020). The impacts of these measures are increasingly important fields of research (Wamba et al., 2020). Additionally, traditional theoretical perspectives are deemed ineffective in comprehending these concerns (Ivanov, 2020). For example, Magableh (2021) concluded that the impacts of events, such as the recent pandemic would continue and exert lasting effects on businesses and policies for the foreseeable future (Magableh, 2021).

In order to contribute to the existing literature and advance the discussion regarding firm performance and supply chain resilience, this research explores the impact of collaboration and strategic alliances in the global supply chain. This contribution will expand upon the potential of supply chain alliances to mitigate disruptions' influence on the success of companies. To achieve this, the current literature focuses on utilizing the stimulus–organism–response (S-O-R) model (Mehrabian & Russell, 1974). While the theory is relatively new in supply chain literature (Matos & Krielow, 2019), it is an exceptional tool with which to structure the research model (Stephens et al., 2022). Next, the introduction of the SOR framework is an opportunity for this research to uniquely measure the study variables. According to the framework, the variables comprising the firm can be seen as organisms within a disruptive environment. This approach lends organic, life-like behavior to each construct. Therefore, the company is an organism within a constantly changing environment. Finally, the SOR framework offers a holistic perspective in which

to understand alliance orientation in several ways. For instance, supply chain dynamism can be interpreted as a stimulus that will ultimately demand a resilient response to achieve a firm performance. In this relationship, supply chain alliance orientation acts as an organism that bridges the gap between stimuli and performance.

The introduction of alliance orientation and the importance of resilience in supply chain literature continues to attract interest. Consequently, this research will further contribute to the expansion of the field. After the introductory section, the literature review establishes support for the research theory, constructs, and hypotheses. Following the review, details regarding the methods employed for data collection will be explained, and the results are presented. Subsequently, the concluding remarks discuss the implications of the findings. Lastly, this study addresses specific limitations with recommendations for future research.

II. Literature Review

1. Theoretical Underpinning

Lately, literature has recommended expanding the foundational theories that underpin management (Foltean, 2019); moreover, diversifying the theory that explicates organizational behavior will continually enrich business literature. Therefore, this research sought out a less frequently used theory to construct the framework of this research model. Ultimately, the stimulus-organism-response (SOR) model fit. SOR theory was successively developed and sophisticated to describe how individuals make decisions in response to stimuli in their environment (Bagozzi, 1986; Hebb, 1966; Mehrabian & Russell, 1974). It has been extensively used to understand how consumers respond to advertisements or commercial stimuli. To a lesser extent, it has been employed in research regarding organizational behavior in response to stimuli (Robb & Stephens, 2021; Stephens et al., 2022). The SOR model is especially appropriate for this research as an organizational stimulus (supply chain dynamism) is modeled. Additionally, the organism is theorized here as a new strategic orientation, supply chain alliance orientation. Finally, the response is supply chain resilience with the following variable, performance. Researchers do not note performance when studying individuals; however, when examining organizations, performance should be measured. Indeed, it is a significant factor for continuing or discontinuing a behavior for most organizations.

2. Hypothesis Development

2.1. Supply Chain Dynamism

The dynamic nature of the commercial domain has remained a topic of interest, especially within the context of supply chain literature (Dubey et al., 2020). As the business environment evolves and novel technologies are introduced, supply chains are more susceptible to disruptions and uncertainties. The impacts of a firm's properties, abilities, and competencies on its behavior and operations are dependent on supply chain dynamism signs (Tajeddini et al., 2020). The rate of transformation in supply chain products and processes is known as supply chain dynamism (Yu et al., 2019). According to this definition, dynamism in the supply chain is evaluated through three key elements. These encompass the frequency of product innovations, the speed of process innovation, and the percentage of revenue derived from new products (Zhou & Benton, 2007). Consequently, firms are encouraged to apply diverse supply chain practices in response to the level of environmental dynamism (Jain et al., 2017).

Companies that are able to comprehend the degree of change in their commercial environment demonstrate greater operational capabilities than firms that fail to understand dynamism (Wamba et al., 2020; Zhou & Benton, 2007). For example, Kumar and Bhatia (2021) established a correlation

between dynamism and an organization's ability to implement strategies aimed at mitigating supply chain disruptions (Yu et al., 2019). Therefore, there is continued backing for a comprehensive exploration of the aspects involved in examining how supply chain dynamism can bolster supply chain resilience and enhance performance (Dubey et al., 2020). Further, Zhou and Benton (2007) determined that supply chain dynamism could affect how information was processes in the firm. Similarly, Lee et al. (2016) corroborated the positive impact of supply chain dynamism on inter-organizational relationships and the effective dissemination of information, which in turn enhanced supply chain performance (Dubey et al., 2020). These capabilities also reduced uncertainty associated with the environment (Zhou & Benton, 2007).

Interestingly, Chung et al. (2018) discovered that supply chain dynamism serves as a catalyst for organizational ambition. This includes practices such as acquiring shared knowledge and collectively utilizing information for the benefit of all participants in the supply chain (Dubey et al., 2020). Furthermore, proactive behavior by firms during dynamic periods encourages the establishment of relationships with other supply chain partners and the development of alliance capabilities (Chung et al., 2018; Reimann et al., 2019). Ultimately, the presence of uncertainty in the business environment compels companies to cultivate competencies to mitigate risks. When approached collectively, these strategies are more feasible, allowing for the effective enhancement of strategic competitiveness during times of environmental ambiguity. By leveraging the relationships forged during such periods, organizations can expand their strategic competitiveness more effectively (Gligor et al., 2018). Regarding the above, it seems dynamism drives urgency within the supply chain which likely leads to cooperation among partners; thus, the following hypothesis is proposed:

H1: Supply chain dynamism increases supply chain alliance orientation.

2.2. Supply Chain Alliance Orientation

The establishment of alliance networks was found to potentially reduce adverse situations (Aldrich & Meyer, 2015). This approach is particularly beneficial for resource scarcity while operating in dynamic markets. Extensive research (Gligor et al., 2018) has explored the significance of network relationships in achieving success during disruptive events (Aldrich & Meyer, 2015). Alliances in the supply chain offer a critical relational resource (Chung et al., 2018), enabling firms to leverage these relationships in times of sudden disruptions (Jain et al., 2017). By fostering collective action, alliances encourage firms to navigate changes in the supply chain. Moreover, this collaboration of alliances provides firms with additional distribution channels, enabling each partner to adapt and survive in the face of adverse changes within the supply chain (Aldrich & Meyer, 2015).

Shekarian and Parast (2019) identified several themes in supply chain collaboration where firms could enjoy mutual benefits. Throughout alliances, firms collect resources that enable businesses with constrained resources to activate achieving supply chain resilience (Joseph, 2020). According to the authors, an orientated approach increases closer associations with various supply chain partners and enhanced operational tasks related to operative forecasting and the sharing of risky endeavors (Shekarian & Parast, 2019). Supply chain alliance orientation confers a competitive advantage (Shekarian & Parast, 2019). The collaborative nature of this orientation is associated with reduced operational costs and uncertainties within the supply chain (Aldrich & Meyer, 2015; Shekarian & Parast, 2019). Cultivating a company culture that supports collaborative alliances has been linked to enhanced supply chain competitiveness (Reimann et al., 2019; Choi & Ha, 2022). Moreover, an alliance orientation promotes information sharing and the opening of communication channels among supply chain partners, fostering supply chain visibility and

improving firm competitiveness (Chung et al., 2018). Simultaneously, it mitigates supply chain uncertainties, particularly during periods of adversity (Wang, 2018).

Several authors have associated collaborative behavior with a tendency to establish resilience in the supply chain (Gölgeci & Ponomarov, 2015; Tukamuhabwa et al., 2015). Jain et al. (2017) related organizational capabilities such as collaboration and flexibility with embellishing resilience in response to disruptions in the supply chain (Simchi-Levi et al., 2018). Forming alliances and cooperating with global supply chain partners enables the reinforcement of the supply chain network's resilience (Philsoophian et al., 2021). In a review of over twenty different strategies suggested as essential for achieving supply chain resilience, Tukamuhabwa et al. (2015) mentioned the necessity of improving supply chain agility, forming collaborative supply chain relationships, and creating redundancy. In accordance to this discussion, the next hypothesis is presented:

H2: Supply chain alliance orientation increases supply chain resilience.

Research has shown that collaboration between actors in the supply chain is related to organizational performance (Cao et al., 2010). Supply chain alliances as strategic alliances are a significant source of assets and know-how and generate competitiveness (Ireland et al., 2002). However, some studies have found that negative aspects associated with risks in alliances similarly exist (Shekarian & Parast, 2021). Therefore, an in-depth exploration of supply chain alliance orientation and its impact on market performance is required. Several risks are associated with the establishment of alliances based on the supply chain. For example, control risks are prevalent when partners are unequal based on their position of power (Li et al., 2015). Also, partnerships become obsolete when companies extend their control through vertical or horizontal integration within the chain to more directly access customers (Shekarian & Parast, 2021). Further networking risks associated with alliance orientation are the result of unsuccessful collaborative forecasting and planning systems or a failure to establish supply chain transparency for each partner (Chopra & Sodhi, 2004). Another issue related to alliance orientation in the supply chain was exhibited by Hartmann and Moeller (2014); according to the authors, the aspect of chain liability could damage the performance of a firm. Hartmann and Moeller (2014) noted that the supply chain is composed of many supplier tiers. A violation in one of these tiers could affect companies not directly associated with a firm or their partners. However, consumers would in all likelihood find an organization guilty of something that an upstream or downstream supplier was involved in (Hartmann & Moeller, 2014).

Supply chain alliance orientation also offers other advantages, which could significantly impact a firm's performance. Partnership commitment as a supply chain alliance is observed as a valuable relational mechanism in governing opportunism and encouraging cooperation in mutual relationships, which could affect progress in innovation and market performance (Shin et al., 2019). Li et al. (2015) noted that alliances in the supply chain could reduce process risks. Knowledge and information sharing through collaboration also augment the performance of a supply chain (Anderson et al., 2023). In other research, the creation of knowledge through a partnership in a supply chain contributed to additional benefits such as resource sharing, decision synchronization, and incentive alignment (Anderson et al., 2023; Dekker et al., 2019; Kauppila, 2015). In a related study, Li et al. (2015) discovered that the sharing of information and mechanisms related to risk management boosted financial performance. Subsequently, the association between alliance orientation and performance requires further study. Thus, the following is suggested:

H3: Supply chain alliance orientation increases market performance.

2.3. Supply Chain Resilience

The recent pandemic and current geopolitical occurrences have transformed the operative environments of many organizations. During these inconsistent times, global supply chains are particularly impacted (Ivanov, 2020). The unpredictable business environment has brought about a renewed interest in the concept of resilience (Seo et al., 2021). Consequently, the notion of understanding resilience is fundamental in supply chain management (Ivanov & Das, 2020). The resilience of the supply chain is basically its capability to reinstate or maintain performance and functionality following a significant transformation in the company's system and environmental situations (Ivanov & Sokolov, 2019). Resilience in a supply chain can be categorized as an ability to adapt to unheralded events. Ponomarov and Holcomb (2009) defined resilience as the capacity to adapt and prepare for unpredicted events, and follow this readied state with a response and recovery from the disruption (Zhang et al., 2023). Resilience also embodies the aptitude to preserve current firm operations at a desired level of connectedness, while confirming that the organization's structure and function are not jeopardized (Ponomarov & Holcomb, 2009). Accordingly, a resilient supply chain can attenuate the impact of disruptive events, and make a firm more robust in dealing with the adverse effects of an intrusive episode (Tukamuhabwa et al., 2015).

Zhang et al. (2023) suggest that a capability centered on resilience could assist in the recovery of supply chain operations following a crisis. This approach toward resilience also helped the firm limit the scope of a disruption (Zhang et al., 2023). A further advantage of resilience is connected to the recovery efforts following an intrusive event. During the recovery stage, a resilient supply chain can reduce the composite costs and risks associated with the event (Tukamuhabwa et al., 2015). Wong et al. (2020) have proclaimed that as firms enhance resilience in supply chains; moreover, they are able to achieve increased levels of market performance. Supply chain resilience is a crucial capability that can progress the response to uncertain, adverse, or turbulent incidents (Gölgeci & Ponomarov, 2015). Gölgeci and Kuivalainen (2020) also revealed that advancing supply chain resilience in a complex situation could also create sustained customer value. While the overall benefits of supply chain resilience are extensive, certain conditions need to be met. For example, Dolgui et al. (2020) mention that the establishment of resilience demands varying strategies contingent on the type, and effect of the disruption, or even the position of the firm in the supply chain. In the aftermath of the pandemic and other geopolitical anomalies, many companies are faced with pressures related to high government debt levels, and high inflation rates, further highlighting the need for supply chains to build resilience (IMF, 2023). Observing the importance of resilience the following hypothesis is proposed:

H4: Supply chain resilience increases market performance.

2.4. Mediation Effects

Recent consumer demand variability, coupled with natural disasters, and geopolitical upheavals has impacted the networks of firms operating in global supply chains (Gölgeci & Ponomarov, 2015). Consequently, firms are encouraged to collaborate with other companies in the supply chain, especially when the market environment is dynamic (Gligor et al., 2018). Wang (2018) mentions that the management of a supply chain is an all-encompassing effort that requires collaborative activities. Thus, the success of the supply chain in a dynamic environment is reliant on the cooperative efforts of the actors present in the chain (Chung et al., 2018; Dubey et al., 2020; Reimann et al., 2019). Also, during stages of environmental volatility, a greater understanding of resilient firm processes and market anomalies is encouraged. Wamba et al. (2020) have recognized supply chain resilience and environmental dynamism as a critical factor to

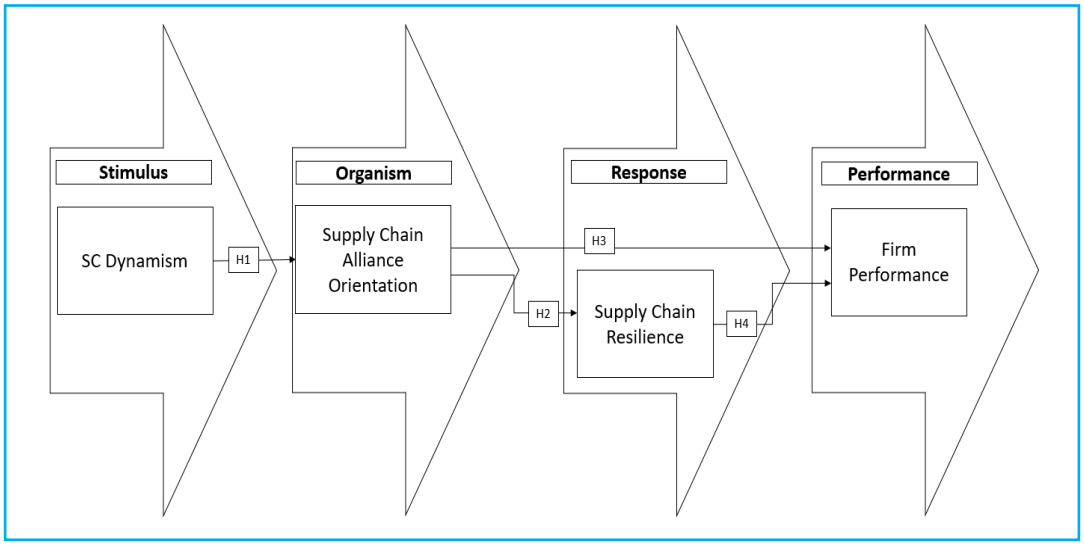
be investigated while dealing with performance-related issues (Gölgeci & Ponomarov, 2015). For these reasons, this research felt it necessary to additionally measure several mediation effects based on the empirical model (see Fig. 1). Three mediation hypotheses are proposed. These relationships shed light on the mediating role of supply chain alliance orientation and supply chain resilience in the relationships between supply chain dynamism and market performance. Consequently, the following hypotheses are stated:

H5a: Supply chain alliance orientation mediates the relationship between supply chain dynamism and supply chain resilience.

H5b: Supply chain alliance orientation mediates the relationship between supply chain dynamism and market performance.

H5c: Supply chain resilience mediates the relationship between supply chain alliance orientation and market performance.

Fig. 1. Conceptual Framework



III. Methodology

1. PLS-SEM

PLS-SEM remains the ideal methodology for the analysis of smaller datasets that are less likely to satisfy the requirements of covariance-based analysis methods such as SPSS and AMOS as suggested by Henseler and Sarstedt (2013) and (Hair et al., 2021). Indeed, the capacity of PLS-SEM to provide significant results with smaller sample sizes is the prevailing reason for researchers to choose this method of analysis (Hair et al., 2021). Therefore, based on its recommended use and capacity to provide significant results with smaller sample sizes, Smart PLS-SEM analysis was adopted for this analysis.

2. Sample

A sample set of 200 South Korean firms was distilled from a survey run in April 2021 amidst the COVID-19 pandemic. Sample demographics of

the firms were characterized by size (number of employees and total sales), age (number of years in operation), and industry. Based on employee counts, most of the organizations could be considered small and medium-sized enterprises (SMEs). As illustrated in Table 1, 63 (32%) firms had 20 or fewer employees. Large firms, those with 500 or more employees, made up 34 (16%) of the respondents. The majority of respondents were medium-sized firms: 60 (30%) firms had 21 – 149 employees, 27 (14%) had 150 – 249 employees, and 16 (8%) firms had 250 – 499 employees.

Total annual sales were used as another measure of firm size. Many firms returned slightly different numbers but again the majority could be classified as SMEs. Accordingly, 59 (30%) firms exhibited $5 million in sales or less, 27 (14%) had between $5 and $10 million in revenue, another 27 (14%) revealed between $10 and $20 million in sales, 33 (17%) had between $20 and $50 million while 54 (25%) showed $50 million or more in sales.

Age was stated in the number of years the firm had been in operation. Four intervals were detailed with the following results: 1 to 5 years, 26 (13%) firms, 6 to 10 years, 50 (25%) firms, 11 to 25 years, 71 (36%) firms, and 53 (26%) firms with 26 or more years in business. Additionally, firms were categorized by industry with the majority falling within unspecified (the other category), 130 (64%) firms. Electronics and electrical comprise the next largest group, 24 (12%) firms. Building materials encompassed the next sizable portion, 21 (11%) firms. Machinery and automobiles contributed 15 (8%) firms. Petrochemicals were the smallest portion, 10 (5%) firms. No additional demographics were assessed.

Table 1. Demographics of the Sample

Number of Employees						
Interval	Less than 20	21 - 149	150 – 249	250 - 499	500 +	Total
Count (%)	63 (32%)	60 (30%)	27 (14%)	16 (8%)	34 (16%)	200 (100%)
Number of Years in Operation						
Interval	1 to 5 years	6 to 10	11 to 25	26 +		Total
Count (%)	26 (13%)	50 (25%)	71 (36%)	53 (26%)		200 (100%)
Annual Sales						
Interval	$5mil. or less	$5-$10 mil.	$10-$20 mil.	$20-50 mil.	50 mil. +	Total
Count (%)	59 (30%)	27 (14%)	27 (14%)	33 (17%)	54 (25%)	200 (100%)
Industry						
Industry Type	Machinery, automobiles	Building materials	Chemical and petrochemical	Electronics and electrical	Others	Total
Count (%)	15 (8%)	21 (11%)	10 (5%)	24 (12%)	130 (64%)	200 (100%)

3. Research Instrument

The research instrument constitutes psychosomatic variables measured by survey questions that were sent in Korean to South Korean managers in April of 2021. The instrument includes four variables: supply chain dynamism, supply chain alliance orientation, market performance, and supply chain resilience. Each variable was recognized on the basis of literature with further explication in the following paragraphs. According to Becker et al. (2012), the variables utilized in this research constitute reflective constructs. Items in reflective variables illustrate parts of the variable itself rather than form the variable (Becker et al., 2012).

According to Zhou and Benton (2007), supply chain dynamism is a measure of the degree to which a firm is experiencing change within its supply chain. The research variable was adopted in several recent research papers (Robb & Stephens, 2021; Stephens et al., 2022; Yu et al., 2019). Zhou and Benton (2007) emphasized several points including new products and services, new technologies, and changes to operations; specific items can be reviewed in Table 2.

For this research, supply chain alliance orientation is operationalized as the degree to which an organization builds alliances within its supply chain to avoid disruptions. This variable measures two key components of supply chain alliance orientation: firstly, that supply chain disruptions are a concern of management, and second, that supply chain alliances are being formed and relied on to alleviate those concerns. Items were adapted from Bode et al. (2011) and Carey et al. (2011).

Market performance is the degree to which a firm is able to perform well within the market (Carey et al., 2011). The variable was applied in previous research (Kang et al., 2022; Stephens et al., 2022). According to Carey et al. (2011), several components should be included: customer loyalty, satisfaction, company image, market growth, and industry growth. This particular variable is questioned in comparison to the firm's competition. In this case, market performance is subjective without specific reference to financial performance in order to ease concerns from managers completing the survey; furthermore, market performance is generally a relative measure of the achievement of marketing goals set out by the management (Vorhies & Morgan, 2003).

Supply chain resilience is the degree to which a firm maintains its supply chain operations even amid disruptions (Gölgeci and Ponomarov, 2015). Gölgeci and Ponomarov (2015) emphasized the ability of the firm to either maintain or quickly resume operations after a disruption. They also felt it was important to even consider whether the firm returned to a better state than it was previously. Indeed, this variable was employed throughout the pandemic (Kang et al., 2022; Stephens et al., 2022).

IV. Analysis

1. Outer Model Assessment: Reliability and Validity

When conducting PLS-SEM analysis it is necessary to first examine the reliability and validity of the outer model (Hair et al., 2021). Reliability of the outer model can be tested through one of two measures of internal consistency reliability (Cronbach's alpha or composite reliability); either statistic should exhibit values above 0.7 (Hair et al., 2021). According to the PLS-SEM analysis displayed in Table 3, all values of reliability are far above the minimum threshold of 0.7. Two forms of validity (convergent validity and discriminant validity) should be tested before the outer model. Convergent validity is found with average variance explained (AVE). When AVE values are above 0.5 as indicated in Table 3, convergent validity is complete (Hair et al., 2021). Additionally, discriminant validity is scrutinized in three ways: a review of standard loadings, HTMT, or the Fornell and Larcker criterion. The Fornell and Larcker criterion is considered the most

Table 2. Operationalisation of the Research Instrument

Variable	Operational definition	Measurement items	Prior research
Supply Chain Dynamism	The degree to which an organisation learns from and prepares for SC disruptions.	At my company, new products account for most of total revenue. At my company, products and services are changed frequently. At my company, operations become outdated quickly. At my company, unexpected and disruptive events happen frequently (e.g., shocks, disruptive technologies).	Zhou and Benton (2007)
Supply Chain Alliance Orientation	The degree to which an organization learns from and prepares for Supply Chain disruptions.	At my company, we feel the need to be alert for possible supply chain disruptions at all times. At my company, we expect that supply chain disruptions are always looming. The relationship with the major supplier is characterized by close interaction at multiple levels. The relationship with the major supplier is characterized by high levels of reciprocity.	Bode et al. (2011), Carey et al. (2011)
Market Performance	The degree to which this firm is able to perform well within the market.	Comparing with our major competitor(s), our firm has higher/better customer loyalty. Comparing with our major competitor(s), our firm has higher/better customer satisfaction. Comparing with our major competitor(s), our firm has higher/better company image. Comparing with our major competitor(s), our firm has higher/better growth in market penetration. Comparing with our major competitor(s), our firm has higher/better growth in industry competitiveness.	Carey et al. (2011)
Supply Chain Resilience	The degree to which a firm maintains its supply chain operations even amid disruptions.	Our firm's supply chain can quickly return to its original state after being disrupted. Our firm's supply chain has the ability to maintain a desired level of connectedness among its members at the time of disruption. Our firm's supply chain has the ability to maintain a desired level of control over structure and function at the time of disruption. Our firm's supply chain has the knowledge to recover from disruptions and unexpected events. Our firm's supply chain is well prepared to deal with the financial outcomes of supply chain disruptions.	Gölgeci and Ponomarov (2015)

stringent test of discriminant validity; however, the factor loadings are more frequently used (Henseler et al., 2009). Loadings were used to initially remove items that did not fit; furthermore, item SCR6 was omitted because of weak loadings. Loadings should be above 0.7. Fornell and Larcker criterion compares the squared AVE values of each variable to their correlation statistics (Fornell & Larcker, 1981). If the squared AVEs are higher than the corresponding correlation values then discriminant validity is ample (Hair et al., 2021). HTMT has recently become a popular measure of discriminant validity with a threshold of 0.9 recognized by Gold et al. (2001). Table 5 illustrates the values for HTMT and confirms that discriminant validity is achieved. With all measures of reliability and validity confirmed, the inner model can now be examined.

Table 3. Outer Model Assessment

Variable	Factors	Standard load	AVE (AVE > 0.5)	Construct Reliability (C.R > 0.7)	Cronbach's Alpha (α > 0.6)
Supply Chain Dynamism	SCD1	0.859	0.689	0.898	0.850
	SCD2	0.828			
	SCD3	0.830			
	SCD4	0.823			
Supply Chain Alliance Orientation	SCAO1	0.809	0.626	0.870	0.803
	SCAO2	0.721			
	SCAO3	0.802			
	SCAO4	0.828			
Market Performance	MP1	0.862	0.733	0.932	0.909
	MP2	0.863			
	MP3	0.857			
	MP4	0.858			
	MP5	0.841			
Supply Chain Resilience	SCR1	0.762	0.674	0.912	0.879
	SCR2	0.844			
	SCR3	0.859			
	SCR4	0.801			
	SCR5	0.835			

Table 4. Fornell-Larcker Criterion

	MP	SCAO	SCD	SCR
MP	**0.804**			
SCAO	0.684	**0.726**		
SCD	0.448	0.556	**0.788**	
SCR	0.719	0.687	0.495	**0.788**

Table 5. HTMT matrix

	MP	SCAO	SCD	SCR
MP				
SCAO	0.863			
SCD	0.537	0.752		
SCR	0.839	0.876	0.621	

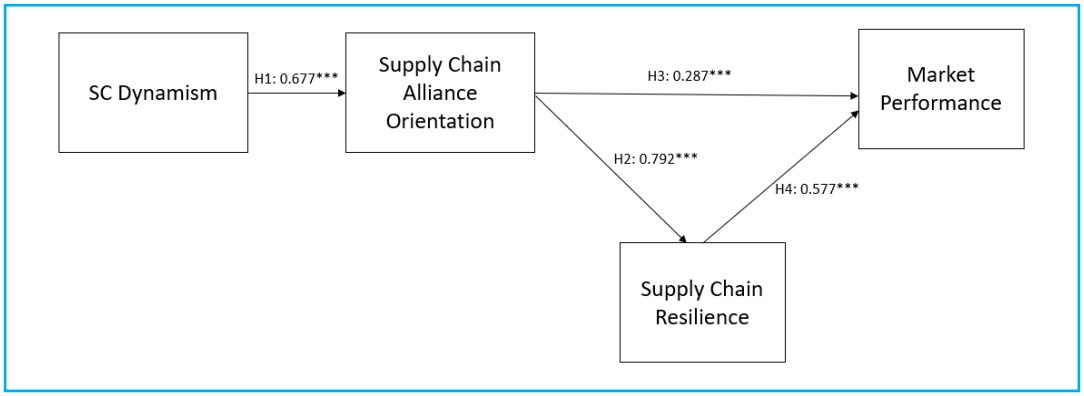
2. Inner Model Assessment

The inner model assessment is the examination of the pathway coefficients and the significance values for each. Accordingly, all hypotheses were approved at the highest degree of confidence as Table 6. When operating PLS-SEM it is necessary to perform the bootstrapping method to test for significance. In this case, significance was acknowledged with bootstrapping at 2000 samples. The pathway coefficient from supply chain dynamism to supply chain alliance orientation was accepted at 0.677. Supply chain alliance orientation to supply chain resilience (0.792) and market performance (0.287) were both affirmed. Finally, supply chain resilience to market performance was also significant at 0.577. Higher pathway values indicate stronger effects; therefore, the pathway from supply chain alliance orientation to supply chain resilience is the strongest while supply chain alliance orientation to market performance is the weakest.

Table 6. Pathway Assessment

Hypotheses	Pathways	Pathway Coefficient	t-stats	p-value	Results
H1	Supply Chain Dynamism → Supply Chain Alliance Orientation	0.677	15.152	0.000	**accepted**
H2	Supply Chain Alliance Orientation → Supply Chain Resilience	0.792	26.421	0.000	**accepted**
H3	Supply Chain Alliance Orientation → Market Performance	0.287	3.863	0.000	**accepted**
H4	Supply Chain Resilience → Market Performance	0.577	7.905	0.000	**accepted**

Fig. 2. Result



Additionally, a structural model assessment should be conducted to measure the strength of the explanatory value of the model; that means measuring the coefficient of determination (R2) and the cross-validated redundancy (Q2) for dependent variables. The structural model assessment can be reviewed in Table 7. A coefficient of determination is the percent of variance described by the model (Hair et al., 2021); thus, 45.8% of the variance is explicated for supply chain alliance orientation, 67.9% of the variance is defined for market performance, and 62.8% of the variance is presented for supply chain resilience. Values for cross-validated redundancy are evidenced; moreover, any value over 0 is acceptable (Hair et al., 2021). Size effect (f2) can be used to test the strength of different models. We tested the value of f2 for models including pathways from SCD to MP and SCD to SCR. The f2 values with additional pathways indicated weaker size effects. Therefore, the current research model (excluding SCD to MP and SCD to SCR) is the best research model.

Table 7. Structural Model Assessment

Endogenous variables	R^2	Q^2
Supply Chain Alliance Orientation	0.458	0.275
Market Performance	0.679	0.490
Supply Chain Resilience	0.628	0.415

Finally, Goodness-of-Fit (GoF) should be measured. Unfortunately, there is no universally agreed-upon measure of GoF; however, several measures have emerged as acceptable including Wetzels et al. (2009). It is calculated as the square root of the product of the AVE cutoff and the average coefficient of determination. Higher values represent a better fit. 0.542 as indicated for this model is an excellent model fit. Higher values represent a better fit. For this model, 0.542

indicates an excellent model fit; moreover, the cut-off value for a large model fit is 0.36 (Wetzels et al., 2009).

3. Mediation Effects

Mediation is generally demarcated when conducting SEM analysis. Mediation tests examines the indirect effects to determine whether there is a compounding impact from any mediating variables. In this case, all middle variables were tested for mediation by means of the Sobel test, the most commonly employed test of mediation effects (Hair et al., 2021). Mediation was indicated in all cases with the highest degree of significance as Table H; therefore, supply chain alliance orientation mediates the relationships between (1) supply chain dynamism and supply chain resilience and (2) supply chain dynamism and market performance. Additionally, supply chain resilience mediates the relationship between supply chain alliance orientation and market performance.

Table 8. Mediation Effects of the Sobel Test

Mediating Pathways	Mediation Effect (Z-value)	P-value
H5: Supply Chain Dynamism → **Supply Chain Alliance Orientation** → Supply Chain Resilience	13.071	0.000
H6: Supply Chain Dynamism → **Supply Chain Alliance Orientation** → Market performance	3.755	0.000
H7: Supply Chain Alliance Orientation → **Supply Chain Resilience** → Market performance	7.572	0.000

Note: Mediating variables are in bold.

V. Discussion

Supply chain risks and uncertainties can originate from within an institution, but can also emerge from supply chain members (Ponomarov & Holcomb, 2009), or the supply chain's environment (Ozdemir et al., 2022). These disruptions make relying solely on internal resources and capabilities impractical for the long-term survival and overall performance of firms (Aldrich & Meyer, 2015). Consequently, research considers the impact of supply chain alliances on the success of the supply chain (Inkpen & Tsang, 2005). Alliances are fundamental external resources which firms can utilize to build supply chain resilience and improve performance (Gölgeci & Kuivalainen, 2020). However, research linking alliances and resilience have produced inconsistent results (Aldrich & Meyer, 2015). Possessing an alliance orientation agenda is seen as an enabler (Johnson et al., 2013) of resilience, but the impact of this approach could be contingent on situational factors related to the disruption (Aldrich & Meyer, 2015). While the literature regarding supply chain reliance has been thoroughly interpreted (Gölgeci & Kuivalainen, 2020; Gölgeci & Ponomarov, 2015; Yu et al., 2019), empirical evidence consolidating resilience to increased performance requires further study (Tukamuhabwa et al., 2015). Accordingly, a discussion of the findings will be presented next. It is assumed that the research results will contribute to supply chain literature and offer

a greater understanding of the constructs to scholars and practitioners.

Hypothesis 1 successfully explored the relationship between supply chain dynamism and alliance orientation. In past research (Yu et al., 2019), dynamism was found to be an antecedent of financial performance and supply chain resilience (Belhadi et al., 2023). In other research, supply chain dynamism also establishes supply chain integration between various supply chain members (Dekker et al., 2019; Yu et al., 2019). When an environment becomes dynamic, supply chain dynamism encourages the advancement of inter-organizational controls. These controls promote partnership contracts which augments mutual performance management systems (Lee & Ha, 2018). This work confirms these results and establishes a clear and significant relationship between the two variables. These findings not only contribute to the existing literature but also motivate further exploration into the nuanced interactions and underlying factors that drive this relationship. In this study, Hypothesis 2 was concerned with the positive relationship between supply chain alliance orientation and supply chain resilience. These results are consistent with others (Tukamuhabwa et al., 2015; Yu et al., 2019). The authors identified several strategies for achieving supply chain resilience (Tukamuhabwa et al., 2015). Some of these strategies were related to the advancement of alliances, and included the formation of collaborative supply chain relationships, coopetition (Urciuoli et al., 2014), creating public-private partnerships (Stewart et al., 2009), and building social capital and relational competences (Wieland & Wallenburg, 2013). Hypothesis 3 and 4 recognized the relationship between alliance orientation, resilience, and performance. Firm performance indicators remain a relevant topic of discussion in supply chain literature (Yu et al., 2019). During recent supply chain disruptions, the augmentation of performance features to measure firm's enhancement are further considered in the literature (Stephens et al., 2022; Wong et al. 2020). However, findings regarding firm performance have given conflicting results when they are used as a procedure for supply chain success (Bode et al., 2011; Chopra & Sodhi, 2004). In the context of a supply chain, firm or market performance is relent on various actors positioned throughout the chain. This can often skew or differentiate the perceptions of performance in the supply chain depending on the company (Ambulkar et al., 2015). Consequently, companies differ in their assessment of market performance based on various features. During a disruption to the supply chain, these factors could comprise, the adoption of disruption practices (Chopra & Sodhi, 2004), the attainment of organizational goals (Ambulkar et al., 2015), or even the management of benchmarking standards against others in the chain (Bode et al., 2011). Regardless of the confrontational nature of supply chain performance, the construct remains an important assessor of firm advancement during periods of disruption (Yu et al., 2019; Wong et al., 2020). Therefore, the current research is expected to make significant contributions to the field of supply chain management through its discerning findings and assessments.

1. Theoretical Implications

While the importance of network orientation is widely accepted in the literature (Gölgeci & Ponomarov, 2015), its influence during periods of uncertainty is not yet well understood (Ponomarov & Holcomb, 2009). For instance, the impact of network capabilities following a disaster typically varies based on the depth of the relationships involved (Aldrich & Meyer, 2015). Organizations face challenges in effectively utilizing their networks during times of turbulence and adversity. The influence of these network relationships appears to differ significantly among supply chains in promoting survival and recovery efforts following episodes of uncertainty (Gölgeci & Kuivalainen, 2020; Tukamuhabwa et al., 2015). Existing literature on supply chain resilience has focused on various types of disruptions. Some researchers suggest that disruptions related to the pandemic are unique and unpredictable (Ali

et al., 2021). These knock-on effects of the most recent pandemic, along with other geopolitical issues, have underscored the need for a better understanding of disruptions in the current commercial environment (Gölgeci & Kuivalainen, 2020; Ozdemir et al., 2022). Furthermore, supply chain resilience is regarded as a critical capability necessary for firms to thrive in dynamic environments (Gölgeci & Ponomarov, 2015). However, despite its significance, empirical evidence linking supply chain resilience to increased performance is scarce (Tukamuhabwa et al., 2015).

Notably, findings from this research contribute to a more comprehensive assessment of the link between network orientation and supply chain resilience in future supply chain studies. By further exploring the dynamics and effects of network orientation in uncertain environments, future research can gain a deeper understanding of how organizations can effectively leverage their networks for enhanced performance and resilience. Additionally, the findings of this study highlight the need for a nuanced understanding of the unique disruptions faced by firms, particularly in the context of the recent pandemic. Future research should aim to identify and analyze the specific challenges and dynamics associated with different types of disruptions, enabling companies to tailor strategies and capabilities that enhance their resilience and ability to thrive in rapidly changing business environments.

2. Practical Implications

Enterprises that were unable to withstand recent disruptive changes ultimately faced failure, and some ceased to exist (Hollnagel & Fujita, 2013). Given these severe consequences, both researchers and practitioners have emphasized the importance of designing resilient supply chains that can effectively handle disruptions and adverse changes (Kamalahmadi & Parast, 2016). Consequently, concepts such as alliance orientation and supply chain resilience have gained significant prominence in recent years. The augmentation of networks through alliance orientation is seen as an external resource that enables supply chain resilience and fosters collaborative efforts among key stakeholders (Gölgeci & Kuivalainen, 2020). Organizations should actively seek out alliance opportunities and cultivate strong relationships with key participants, leveraging collective resources, knowledge, and capabilities of the network to enhance their resilience and responsiveness to disruptions, ultimately improving overall supply chain performance.

Moreover, the dynamic shifts in the business environment in recent years have renewed attention on the importance of resilience in supply chains (Ponomarov & Holcomb, 2009). Research has indicated that practicing supply chain resilience allows firms to identify strategies to minimize the impact of disruptions. To achieve this, companies should adopt a mindset of continuous enhancement and adaptability, regularly evaluating and reassessing their operational procedures, supply chain design, and resource allocation. Embracing technological advancements, fostering a culture of innovation, and staying well-informed of industry trends and market dynamics are vital components for enhancing resilience and ensuring long-term success (Gölgeci & Ponomarov, 2015; Ivanov & Das, 2020). By incorporating these practices, firms can effectively navigate disruptions and proactively adapt their supply chains to changing conditions. Changes to global supply chains are also worth considering in order to build processes and policies geared at strengthening operations. For example, the IMF (2023) emphasized the need to build resilience and diversification in supply chains. They note that recent initiatives, and the uncertainties surrounding supply chains have reshaped global value chains along geopolitical lines and have affected production and sourcing strategies (Ozdemir et al., 2022). From a macro perspective, several examples have been cited. The topical proposal of a US Chip 4 alliance

with three key Asian economies to establish a semiconductor industry supply chain independent of China, and the EU's proposed European Chips Act aimed at boosting the bloc's semiconductor industry are noteworthy illustrations of changes in global supply chains.

VI. Conclusions

1. Contributions

Recent supply chain disruptions brought about major changes in the structure of companies, industries, and supply chains. The sheer rate of change left countless organizations unprepared and unable to establish and apply the risk-aversion strategies required to survive (Ali et al., 2021). Accordingly, a deeper understanding of the linkage between supply chain dynamism and firm performance is needed. Within this context, it is also encouraged to assess which operational procedures resources will support a firm in their augmentation of a more robust supply chain. Accordingly, our research has recognized the operational procedures and resources that effectively support organizations in developing robust and adaptable supply chains, empowering them to navigate disruptions and strengthen their competitive advantage. Thus, the link between supply chain resilience, alliance orientation, and firm market performance should be established and empirically tested further to determine their value in the supply chain (Gölgeci & Kuivalainen, 2020). Also, in terms of theory there is a possibility that a mediating effect of the model could exist between S-O and/or O-R. Accordingly, this study investigated the mediation effect of the variables classified under the SOR framework (Robb & Stephens, 2021). By successfully investigating the mediating effects of alliance orientation and supply chain resilience, this study has made a contribution to the existing literature, shedding light on the mechanisms through which these factors influence firm performance within the context of supply chain dynamics.

2. Limitations and Future Research

Although the study was conducted comprehensively, it is important to acknowledge certain limitations associated with this research. The current research included a diverse collection of firms ranging in size and industry. Future studies would benefit from controlling for factors such as firm size. For example, Kauppila (2015) found that smaller organizations in the supply chain were more susceptible to conflict and discrepancies which impacted firm performance negatively. Therefore, an analysis of alliance orientation focused on smaller firms could provide an interesting avenue for supply chain research. This study was primarily focused around the events of the recent Covid-19 pandemic and subsequent geopolitical proceedings in Europe. The collection of data during this time disposes the results to certain biases related to the period. According to Shekarian and Parast (2021), the categorization of supply chain risks could benefit future research. So, literature could concern itself with process, demand, supply, or even environmental risk (Shekarian & Parast, 2021). Thus, practitioners should consider controlling for the risk itself. Supply chain risks come in a variety of forms. These risks may well influence resilience, alliance orientation, and performance differently. Finally, this research exhibits a tendency towards homogeneity in its interpretation of supply chains. While the ultimate goal of this research was to assess performance by examining the influence of alliance orientation and supply chain resilience, a potential avenue for deeper insights in supply chain literature could be explored by narrowing the sample to a specific industry. For example, in the automotive industry, the surge in demand for electric vehicles and related components could present unique challenges and opportunities that differ from other sectors.

References

Aiyar, S., Chen, J., Ebeke, C., Garcia-Saltos, R., Gudmundsson, T., & Ilyina, A. et al. (2023, January 15). *Geoeconomic fragmentation and the future of multilateralism* (Staff Discussion Note, No. 2023/001). International Monetary Fund. https://www.imf.org/en/Publications/Staff-Discussion-Notes/Issues/2023/01/11/Geo-Economic-Fragmentation-and-the-Future-of-Multilateralism-527266

Aldrich, D. P., & Meyer, M. A. (2015). Social capital and community resilience. *American Behavioral Scientist*, *59*(2), 254-269.

Ali, M. H., Suleiman, N., Khalid, N., Tan, K. H., Tseng, M. L., & Kumar, M. (2021). Supply chain resilience reactive strategies for food SMEs in coping to COVID-19 crisis. *Trends in Food Science & Technology*, *109*, 94-102. https://doi.org/10.1016/j.tifs.2021.01.021

Ambulkar, S., Blackhurst, J., & Grawe, S. (2015). Firm's resilience to supply chain disruptions: Scale development and empirical examination. *Journal of Operations Management*, *33*, 111-122.

Anderson, H., Müllern, T., & Danilovic, M. (2023). Exploring barriers to collaborative innovation in supply chains: A study of a supplier and two of its industrial customers. *Business Process Management Journal*, *29*(8), 25-47.

Bagozzi, R. P. (1986). *Principles of marketing management*. Science Research Associates.

Becker, J. M., Klein, K., & Wetzels, M. (2012). Hierarchical latent variable models in PLS-SEM: Guidelines for using reflective-formative type models. *Long Range Planning, 45*(5), 359-394.

Belhadi, A., Kamble, S., Jabbour, C. J. C., Gunasekaran, A., Ndubisi, N. O., & Venkatesh, M. (2021). Manufacturing and service supply chain resilience to the COVID-19 Outbreak: Lessons learned from the automobile and airline industries. *Technological Forecasting and Social Change*, *163*, 120447. DOI:10.1016/j.techfore.2020.120447

Bode, C., Wagner, S. M., Petersen, K. J., & Ellram, L. M. (2011). Understanding responses to supply chain disruptions: Insights from information processing and resource dependence perspectives. *Academy of Management Journal*, *54*(4), 833-856.

Cao, M., Vonderembse, M. A., Zhang, Q., & Ragu-Nathan, T. S. (2010). Supply chain collaboration: Conceptualisation and instrument development. *International Journal of Production Research*, *48*(22), 6613-6635.

Carey, M. P., Sanderson, B. L., Barnas, K. A., & Olden, J. D. (2012). Native invaders–challenges for science, management, policy, and society. *Frontiers in Ecology and the Environment, 10*(7), 373-381.

Choi, S., & Ha, M. (2022). A study on the effect of conflict response between supply chain participating companies on social capital and supply chain integration in the shipping port logistics industry. *Journal of International Trade & Commerce*, 18(3), 153-171.

Chopra, S., & Sodhi, M. S. (2004). Managing risk to avoid supply chain breakdown. *MIT Sloan Management Review*, *46*(1), 53-61.

Chung, B. D., Kim, S. I., & Lee, J. S. (2018). Dynamic supply chain design and operations plan for connected smart factories with additive manufacturing. *Applied Sciences*, *8*(4), 583.

Dekker, H., Donada, C., Mothe, C., & Nogatchewsky, G. (2019). Boundary spanner relational behavior and inter-organizational control in supply chain relationships. *Industrial Marketing Management*, *77*, 143-154.

Dolgui, A., Ivanov, D., & Rozhkov, M. (2020). Does the ripple effect influence the bullwhip effect? An integrated analysis of structural and operational dynamics in the supply chain. *International Journal of Production Research*, *58*(5), 1285-1301. https://doi.org/10.1080/00207543.2019.1627438.

Dubey, R., Gunasekaran, A., Childe, S. J., Papadopoulos, T., Luo, Z., & Roubaud, D. (2020). Upstream supply chain visibility and complexity effect on focal company's sustainable performance: Indian

manufacturers' perspective. *Annals of Operations Research*, *290*, 343-367.

Foltean, F. S. (2019). Bridging marketing theory-practice gap to enhance firm performance: Introduction to the special issue. *Journal of Business Research*, *104*, 520-528. https://doi.org/10.1016/j.jbusres.2019.06.008

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39-50. https://doi.org/10.1177/002224378101800104

Gligor, D., Bozkurt, S., Russo, I., & Omar, A. (2018). A look into the past and future: theories within supply chain management, marketing and management. *Supply Chain Management: An International Journal, 24*(1), 170-186.

Gölgeci, I., & Kuivalainen, O. (2020). Does social capital matter for supply chain resilience? The role of absorptive capacity and marketing-supply chain management alignment. *Industrial Marketing Management*, *84*, 63-74.

Gölgeci, I., & Ponomarov, S. Y. (2015). How does firm innovativeness enable supply chain resilience? The moderating role of supply uncertainty and interdependence. *Technology Analysis & Strategic Management*, *27*(3), 267-282.

Hair, J. F., Sarstedt, M., Ringle, C. M., & Gudergan, S. P. (2021). *Advanced issues in partial least squares structural equation modeling (PLS-SEM).* Sage.

Hartmann, J., & Moeller, S. (2014). Chain liability in multitier supply chains? Responsibility attributions for unsustainable supplier behavior. *Journal of Operations Management*, *32*(5), 281-294. https://doi.org/10.1016/j.jom.2014.01.005

Hebb, D. O. (1966). *A textbook of psychology* (2nd ed.). Saunders.

Henseler, J., Ringle, C. M. & Sinkovics, R. R. (2009). The use of partial least squares path modelling in international marketing. *Advances in International Marketing*, *20*, 277-320.

Henseler, J., & Sarstedt, M. (2013). Goodness-of-fit indices for partial least squares path modeling. *Computational Statistics, 28*, 565-580.

Hollnagel, E., & Fujita, Y. (2013). The Fukushima disaster–systemic failures as the lack of resilience. *Nuclear Engineering and Technology*, 45(1), 13-20.

Hosseini, S., & Ivanov, D. A. (2019). A new resilience measure for supply networks with the ripple effect considerations: A Bayesian network approach. *Annals of Operations Research*, *319*, 581-607.

Inkpen, A. C., & Tsang, E. W. K. (2005). Social capital, networks, and knowledge transfer. *Academy of Management Review*, *30*(1), 146-165.

IMF (2023). *World economic outlook: A Rocky recovery*. https://www.imf.org/en/Publications/WEO/Issues/2023/04/11/world-economic-outlook-april-2023

Ireland, R. D., Hitt, M. A., & Vaidyanath, D. (2002). Alliance management as a source of competitive advantage. *Journal of Management*, *28*, 413-446.

Ivanov, D. (2020). Predicting the impacts of epidemic outbreaks on global supply chains: A simulation-based analysis on the coronavirus outbreak (COVID-19/SARS-CoV-2) case. *Transportation Research Part E: Logistics and Transportation Review*, *136*, 1-14. https://doi.org/10.1016/j.tre.2020.101922

Ivanov, D., & Das, A. (2020). Coronavirus (Covid-19/sars-cov-2) and supply chain resilience: A research note. *International Journal of Integrated Supply Management*, *13*(1), 90-102. DOI:10.1504/IJISM.2020.107780

Ivanov, D., & Sokolov, B. (2019). Simultaneous structural–operational control of supply chain dynamics and resilience. *Annals of Operation Research, 283*, 1191-1210. doi.org/10.1007/s10479-019-03231-0.

Jain, V., Kumar, S., Soni, U., & Chand, C. (2017). Supply chain resilience: Model development and empirical analysis. *International Journal of Production Research*, *55*(22), 6779-6800.

Johnson, N., Elliott, D., & Drake, P. (2013). Exploring the role of social capital in facilitating supply chain resilience. *Supply Chain Management: An International Journal*, *18*(3), 324-336.

Joseph, K. (2020). Firm resilience to an economic crisis among micro and small enterprises in emerging economies: A response to effects of Covid 19. *International Journal of Management and Commerce Innovations*, *8*(1), 196-203.

Kamalahmadi, M., & Parast, M. M. (2016). A review of the literature on the principles of enterprise and supply chain resilience: Major findings and directions for future research. *International Journal of Production Economics*, 171, 116-133.

Kang, M., Robb, C., & Stephens, A. (2022). A comparative analysis of South Korean and US firms: Ambidextrous innovation, supply chain resilience, and market performance. *Operations and Supply Chain Management: An International Journal*, *15*(4), 565-581.

Kauppila, O. P. (2015). Alliance management capability and firm performance: using resource-based theory to look inside the process black box. *Long Range Plan*, *48*(3), 151-167.

Kim, T., Huh, J., & Kim, Y. (2022). The influence of social crowdedness in retail stores on consumers' shopping satisfaction in the COVID-19 Era, *Journal of Global Business and Trade*, 18(2), 1-15.

Kumar, S., & Bhatia, M. S. (2021). Environmental dynamism, industry 4.0 and performance: Mediating role of organizational and technological factors. *Industrial Marketing Management*, *95*, 54-64.

Lee, H. Y., Seo, Y. J., & Dinwoodie, J. (2016). Supply chain integration and logistics performance: The role of supply chain dynamism. *The International Journal of Logistics Management, 27*(3), 668-685.

Lee, C. H., & Ha, B. C. (2018). The impact of buyer-supplier relationships' social capital on bi-directional information sharing in the supply chain. *Journal of Business & Industrial Marketing*, *33*(3), 325-336.

Li, G., Fan, H., Lee, P. K., & Cheng, T. C. (2015). Joint supply chain risk management: An agency and collaboration perspective. *International Journal of Production Economics*, *164*, 83-94.

Li, J., Seo, Y., & Yin, S. (2021). A study of management problems and countermeasures of home appliance manufacturing enterprises based on a green supply chain during COVID-19. *Journal of International Trade & Commerce*, *17*(1), 235-247.

Magableh, G. M. (2021). Supply chains and the COVID-19 pandemic: A comprehensive framework. *European Management Review*, *18*(3), 363-382. DOI: 10.1111/emre.12449

Matos, C. A. D., & Krielow, A. (2019). The effects of environmental factors on B2B e-services purchase: Perceived risk and convenience as mediators. *Journal of Business & Industrial Marketing*, *34*, 767-778.

Mehrabian, A., & Russell, J. A. (1974). *An approach to environmental psychology*. The MIT Press.

Ozdemir, D., Sharma, M., Dhir, A., & Daim, T. (2022). Supply chain resilience during the COVID-19 pandemic. *Technology in Society*, *68*, 101847. DOI: 10.1016/j.techsoc.2021.101847

Park, D., & Liu, S. (2022). Impact of Covid-19 on Korea-China import and export trade and countermeasures. *Journal of Global Business and Trade*, *18*(6), 19-31.

Philsoophian, M., Akhavan, P., & Abbasi, M. (2021). Strategic alliance for resilience in supply chain: A bibliometric analysis. *Sustainability*, *13*, 12715. doi.org/10.3390/su132212715

Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *The International Journal of Logistics Management*, *20*(1), 124-143.

Reimann, M., Xiong, Y., & Zhou, Y. (2019). Managing a closed-loop supply chain with process innovation for remanufacturing. *European Journal of Operational Research*, *276*(2), 510-518.

Robb, C. A., & Stephens, A. R. (2021). The effects of market orientation and proactive orientation on the export performance of South African SMEs. *Journal of Global Marketing, 34*, 392-410.

Seo, Y., Tatschner, R., Pandianc, S., & Kwak, D. (2021). Understanding Supply chain agility in the FMCG context: An analysis of interactions among agility enablers. *Journal of International Trade & Commerce*, 17(3), 129-146.

Shekarian, M., & Parast, M. M. (2021). An integrative approach to supply chain disruption risk and resilience management: A literature review. *International Journal of Logistics Research and Applications*,

24(5), 427-455. DOI:10.1080/13675567.2020.1763935

Shin, N., Park, S., & Park, S. (2019). Partnership-based supply chain collaboration: Impact on commitment, innovation, and firm performance, *Sustainability*, *11*(2), 449, https://doi.org/10.3390/su11020449

Simchi-Levi, D., Wang, H., & Wei, Y. (2018). Increasing supply chain robustness through process flexibility and inventory. *Production and Operations Management*, *27*(8), 1476-1491.

Stephens, A. R., Kang, M. H., & Robb, C. A. (2022). Linking supply chain disruption orientation to supply chain resilience and market performance with the stimulus–organism–response model. *Journal of Risk and Financial Management*, *15*(5), 227. https://doi.org/10.3390/jrfm15050227

Stewart, G., Kolluru, R., & Smith, M. (2009). Leveraging public-private partnerships to improve community resilience in times of disaster. *International Journal of Physical Distribution & Logistics Management*, *39*(5), 343-364.

Tajeddini, K., Martin, E., & Ali, A. (2020). Enhancing hospitality business performance: The role of entrepreneurial orientation and networking ties in a dynamic environment, *International Journal of Hospitality Management*, *90*, 102605. https://doi.org/10.1016/j.ijhm.2020.102605

Tukamuhabwa, B. R., Stevenson, M., Busby, J., & Zorzini, M. (2015). Supply chain resilience: Definition, review and theoretical foundations for further study. *International Journal of Production Research*, *53*(18), 5592-5623.

Urciuoli, L., Mohanty, S., Hintsa, J., & Boekesteijn, E. G. (2014). The resilience of energy supply chains: A multiple case study approach on oil and gas supply chains to europe. *Supply Chain Management: An International Journal*, *19*(1), 46-63.

Vorhies, D. W., & Morgan, N. A. (2003). A configuration theory assessment of marketing organization fit with business strategy and its relationship with marketing performance. *Journal of Marketing, 67*, 100-115.

Wamba, S. F., Dubey, R., Gunasekaran, A., & Akter, S. (2020). The performance effects of big data analytics and supply chain ambidexterity: The moderating effect of environmental dynamism. *International Journal of Production Economics*, *222*, 107498.

Wang, M. (2018). Impacts of supply chain uncertainty and risk on the logistics performance. *Asia Pacific Journal of Marketing and Logistics, 30*(3), 689-704.

Wetzels, M., Odekerken-Schröder, G., & Van Oppen, C. (2009). Using PLS path modeling for assessing hierarchical construct models: Guidelines and empirical illustration. *MIS Quarterly*, 177-195.

Wieland, A., & Wallenburg, C. (2013). The influence of relational competencies on supply chain resilience: A relational view. *International Journal of Physical Distribution & Logistics Management*, *43*(4), 300-320.

Wong, C. W., Lirn, T. C., Yang, C. C. & Shang, K. C. (2020). Supply chain and external conditions under which supply chain resilience pays: An organizational information processing theorization. *International Journal of Production Economics*, *226*, 107610.

Yoon, S., & Ko, J. (2022). The impact of COVID-19 on the world economy, *Journal of Global Business and Trade, 18*(2), 79-98.

Yu, W., Jacobs, M. A., Chavez, R., & Yang, J. (2019). Dynamism, disruption orientation, and resilience in the supply chain and the impacts on financial performance: A dynamic capabilities perspective. *International Journal of Production Economics, 218*, 352-362.

Zhang, Z. J., Srivastava, P. R., Eachempati, P., & Yu, Y. (2023). An intelligent framework for analyzing supply chain resilience of firms in China: A hybrid multicriteria approach. *The International Journal of Logistics Management*, *34*(2), 443-472. https://doi.org/10.1108/IJLM-11-2020-0452

Zhou, H., & Benton, W. C. (2007). Supply chain practice and information sharing. *Journal of Operation Management*, *25*(6), 1348-1365.

ISSN 1946-5130 (Print), ISSN 2470-4733 (Online)
http://dx.doi.org/10.20294/jgbt.2023.19.5.77

The Journal of Global Business and Trade

Journal of Global Business and Trade

https://www.pfw.edu/jgbt

The Influence of Seller Reputation and Trust in Streamers on Live Stream Shopping Purchase Intention: The Moderation Effect of Country Image

Fan Zhou[a], De-Kui Li[b]*, Ki-Hyung Bae[c]

[ac]*Department of Economics, Sejong University, South Korea*
[b]*Department of E-business, Liaocheng University, China*

Received 12 July 2023, Revised 25 August 2023, Accepted 5 October 2023

ABSTRACT

Purpose – Live streaming e-commerce continues to increase Chinese consumer enthusiasm for purchasing foreign products. The current research focus in the field of live streaming e-commerce is on exploring the impact of various factors on consumer purchase attitudes and intentions. This study aims to investigate the effects of seller reputation in traditional e-commerce and trust in streamers in live streaming e-commerce on consumer purchase intentions. Additionally, it aims to analyze how the country image of Korea moderates the effects of seller reputation and trust in streamers on purchase intentions.

Design/Methodology/Approach – This study used the SmartPLS statistical software package to analyze a sample of 341 respondents. Structural Equation Modeling (SEM) was used to conduct path analysis and moderation effect analysis

Findings – This study found that in live streaming e-commerce, seller reputation and trust in streamer significantly influence consumer purchase attitudes. Country image plays a moderating role in the relationship between seller reputation and attitude. However, country image does not moderate the relationship between trust in streamer and attitude. These findings contribute to our understanding of the factors that shape consumer attitudes, and illuminate the role of the country image as a moderator in e-commerce.

Research Implications – This study has found that product country image plays a moderating role in the relationship between seller reputation and consumer purchase attitudes. It makes a theoretical contribution to existing e-commerce research, and explores the positive impact of product country image in cross-border e-commerce.

Keywords: country image, live streaming e-commerce, seller reputation, trust in streamer
JEL Classifications: C12, D81, M31, L81

* *Corresponding Author, E-mail: jerryinkorea@gmail.com*
© 2023 International Academy of Global Business and Trade. All rights reserved.

I. Introduction

As the purchasing power of Chinese consumers continues to rise, the popularity of buying foreign products through live streaming e-commerce has also increased. In 2022, the total value of cross-border e-commerce imports reached 570 billion yuan, with a year-on-year growth rate of 4.9% (Syntun, 2022). The image of a country can significantly influence consumer perceptions of products manufactured at a specific destination (Tseng & Balabanis, 2011). In the context of live streaming e-commerce, country of origin can play a role in consumer decision making. Consumers may have preferences for products from certain countries due to the perceived quality, reputation, or unique attributes associated with that country (Butt et al., 2022). Country image can be a valuable marketing tool for companies to increase product trust and attract Chinese consumer.

According to data from the China Internet Network Information Center, the proportion of live streaming e-commerce users has been continuously increasing, and more than 40% of Internet users are live stream e-commerce users (CNNIC, 2022). Among them, more than one-third of users watch live streams every day, and half of the users utilize the interactive features of live streaming e-commerce before and after making purchases. Live streaming e-commerce became a new type of online marketing model in which businesses or streamers interact with consumers in real time through live streaming media to sell products or services (Lu et al., 2023). In China, the live streaming e-commerce market has exceeded 3.48 trillion yuan, with an annual growth rate of 53.7 %. It is expected to exceed 4.9 trillion yuan by 2023 (Syntun, 2022). As a result, major brands and manufacturers are actively adopting live streaming e-commerce strategies. Attracting and retaining customers has become a critical issue for businesses to survive and succeed in the live streaming e-commerce industry.

The emergence of live streaming e-commerce has attracted researchers to explore consumer motivations for adopting this shopping mode and factors influencing purchase intentions (Lu et al., 2023). Most studies have focused on the consumer's perspective. However, there has been little comprehensive and systematic discussion of the marketing factors and country image that influence consumer purchases or audience engagement from the seller's perspective.

Some scholars have adopted the Technology Acceptance Model (TAM) and demonstrated its significance in exploring the factors influencing consumer behavior in live streaming e-commerce (Kim et al., 2023; Li et al., 2023). In the live streaming e-commerce shopping environment, consumers are exposed to various external stimuli, including marketing-related information, seller evaluations, and host evaluations. They then make purchases based on their internal attitudes. In fact, in the live streaming e-commerce shopping environment, consumers are exposed to various external stimuli, including marketing-related information (Alsyouf et al., 2023), seller reputation (Chen et al., 2022), and trust in streamers (Zhang et al., 2022), and they make purchase decisions based on their internal attitudes.

It is very important to understand the shopping behaviors of consumers in the context of live streaming e-commerce. However, there are few studies examining the shopping behavior of consumers in live streaming e-commerce from the perspective of country image. The purpose of this study is twofold. One is to use the TAM model to examine the impact of seller reputation and streamer trust on consumer purchase intentions in live streaming e-commerce. The other is to study the influence of country image in live streaming e-commerce. This study explores the moderating role of Korea's country image in live e-commerce.

The next section provides a theoretical background on live streaming e-commerce and country image, along with a literature review on seller reputation, streamer trust, and purchase intention in live streaming e-commerce using the TAM framework. Hypotheses are presented based on the proposed research model. The third section

explains the research methodology, including data collection and measurement. The fourth section presents the results of the hypothesis model and other models. The fifth section discusses the findings, the theoretical and practical implications, and some directions for future research.

II. Theoretical Background

1. Country Image

In the literature on country image, a study by Han (1989) is one of the most frequently cited studies. Han's research suggests that country image can be used by consumers as either a halo or summary construct in product evaluations. The halo construct describes situations in which consumers rely on country image for products about which they have limited knowledge, while the summary construct operates when consumers become familiar with products from a particular country and form beliefs about their attributes. Country image can serve as a construct that summarizes consumer beliefs about product attributes. Han (1990) identified country image solely based on cultural dimensions. Becker (2014) conducted a study on the country image of Japanese products among American consumers. The results showed that a "halo effect" exists surrounding the image of Japanese products.

Therefore, further research is needed to determine whether the use of product category dimensions alone is sufficient to capture country image, or whether it is necessary to include product dimensions in the measurement of country image, regardless of product category. Parameswaran and Yapark (1987) conducted research focusing on the effects of country image on consumer perceptions and evaluations of products. They examined the impact of three key factors: general country attributes, general product attributes, and special attributes (Haryanto et al., 2022; Parameswaran & Yaprak, 1987).

Papadopoulos (1993) made a significant and widely cited contribution to the country image literature by criticizing the narrow and misleading concept of country image. He argued that the concept assumes a single place of origin for a product, but in reality, a product may be manufactured in one country and designed, assembled, branded in another country. To account for the multidimensional nature of product/brand images and the involvement of multiple locations in a global production system, Papadopoulos proposed the term "country product image".

Although Lin and Chen (2006) did not specifically examine the brand/country image relationship, they examined the overall effect of country image on consumer purchase decisions. They found that country image had a positive effect on consumer decisions to purchase, even after controlling for varying levels of product involvement or interest. In another study by Tseng and Balabanis (2011), country image was related to consumer purchase decisions, and the authors examined how country image varied across different product types. They introduced the concept of "typicality", which refers to the extent to which a product is perceived to represent a particular country or ethnic group. Therefore, products that are typically associated with a particular country or ethnicity tend to have a more favorable impact on consumer attitudes than atypical products.

Extensive research has been conducted in the area of country image within marketing studies. Koubaa's (2008) study evaluated the role of country image in the context of brand image, and found that a brand's country of origin influences overall consumer perceptions of that brand. While the extent of this influence varies depending on the reputation and strength of the brand, the impact of country image on brand image is strong enough to overshadow the brand name itself, which can be detrimental in the case of a negative country image.

These studies highlight the importance of country image in shaping consumer perceptions and purchase decisions. It is clear that country image plays a significant role in brand evaluation and consumer behavior. Understanding the complexities and dynamics of country image can

help marketers and brand managers effectively manage and leverage country image perceptions to enhance product competitiveness and increase consumer satisfaction.

In the area of online shopping, there has been growing research interest in the role of country image based on the Technology Acceptance Model (TAM). A study by Butt et al. (2022) extended the TAM model to include trust and country image, and found that trust has the most significant impact on intention to purchase from a particular country. Furthermore, significant differences in trust levels between countries were observed.

Drawing upon Butt's research framework, this study concurrently investigates the roles of trust and national image within the live streaming e-commerce context, aiming to comprehensively examine the influence on consumer purchase intentions. Additionally, this study operationalizes the broader concepts of general country attributes and general product attributes, as outlined in Parameswaran and Yaprak's (1987) framework of country image.

2. Technology Acceptance Model

The Technology Acceptance Model (TAM) was one of the original models that focused on how perceived usefulness, perceived ease of use, and social norm influenced the acceptance of information systems (Davis, 1989). The technology acceptance model suggests that the use of a system is determined by behavioral intention, which is influenced by attitude toward use and perceived usefulness. In turn, attitude toward use is determined by perceived usefulness and ease of use. Perceived usefulness is influenced by perceived ease of use and external variables. Perceived ease of use is determined by external variables.

The TAM model has always been the most basic model for studying consumer behavior in e-commerce, and its adaptability has been verified in a large number of studies. Gefen et al. (2003) introduced TAM to the context of e-commerce and developed an online consumer trust model based on the TAM theory to study online shopping behavior. Ingham et al. (2015) identified trust, perceived risk, perceived entertainment, and social impact as the most commonly examined additional variables in TAM. Ahuja and Khazanchi (2016) identified perceived entertainment, perceived quality, and trust as the primary factors influencing consumer acceptance of e-commerce. Liébana-Cabanillas et al. (2017) expanded the technology adoption model by introducing external variables and investigated consumer adoption of e-commerce. Kim (2021) conducted research on the adoption factors of providers in e-commerce platforms.

Recently, the TAM model has been extensively applied to explain influencing factors in the field of live-streaming e-commerce (Gantulga et al., 2021). Zhong et al. (2023) found that age and gender d trust in live-streaming e-commerce based on TAM, which subsequently impacted the usage of live-streaming e-commerce. Li et al. (2023) introduced *Guanxi* into the study of live-streaming e-commerce, and found that relationships can influence the purchase intention of live streaming e-commerce. Kim et al. (2023), based on the TAM model, conducted a study on the influencing factors of live streaming e-commerce, particularly focusing on social factors. This study also uses the TAM model as the basic model of the study.

3. LiveStreamer Trust

Trust is the belief that another party in a social exchange will behave morally and not exploit opportunism (Gefen & Straub, 2003). Trust has been widely studied and recognized as a driving factor in e-commerce. El Amri and Akrout (2020) and Khan et al. (2020) have found that factors such as social support, quality of information, and social presence can help sellers to gain the trust of customers.

Existing studies tend to treat trust as a general concept (Ko, 2021). However, empirical evidence suggests that customer behavioral intentions depend not only on the expectations of the product

but also on attitudes toward the individuals providing the service (Yang et al., 2021). Different types of trust have different effects on customer behavioral intentions.

Even in the context of online live streaming, trust, which is a critical factor for the success of e-commerce, has been proven to have a significant impact on customer behavioral intentions (Pavlou & Gefen, 2004; Söllner et al., 2013). However, relatively little attention has been paid to uncovering how trust develops and its role in live streaming e-commerce. Musarra et al. (2022) found a streamer is no longer seen as a spokesperson for the company or product, and the live streaming process is no longer just the seller's self-presentation. This means that trust in live streaming e-commerce is formed through the combined interaction between the streamer and the product information, further influencing customer behavioral intentions.

Liu and Oda (2021) found that consumer trust in the products is positively influenced by trust in the live streamers. The expertise of the live streamers is crucial for sellers to earn consumer trust. Chandrruangphen et al. (2022) proposed a framework to investigate the influence of live streamer trust on purchase intention for fashion clothing. The results showed that consumer trust in a streamer positively influenced trust in the product. These findings provide opportunities for sellers to focus on important live streaming attributes, build trust with customers, and increase viewing and purchase intentions.

Zhang et al. (2022) used a TAM model to explore the impact of social and technological drivers on trust, and the results showed that user trust in streamers affects user attitudes toward continuing to use the platform. Based on this framework, this study also examines the impact of trust in a streamer on the platform's attitude.

4. Seller Reputation

After years of research, in the field of e-commerce, reputation has become a basic indicator to judge the credibility of information sources (Duradoni et al., 2018). A seller's reputation affects trust in e-commerce services (Haas & Unkel, 2017) and influences the decision-making process of consumers (Reyes-Menendez et al., 2019). In fact, reputation is a clue to understanding acceptable behavior within a group. The "reputation system" of an e-shopping represents a norm within the system by profoundly influencing the seller's behavior in an economical and perceived human-computer interaction manner (Duradoni et al., 2021).

Jullien and Park (2009) argued that reputation of seller in online shopping could be divided into two dimensions. Reputation reflects the seller's ability to provide high quality goods/services that potential customers can trust. It also means the "trust" that potential customers have in the seller based on the information provided by the seller prior to the transaction, which includes aspects such as quality and suitability (Fang et al., 2014).

According to Ma et al. (2021), in an e-commerce market where there are numerous different sellers, buyers tend to prefer sellers with the highest "reputation" in terms of value for money. Through simulated experiments, they concluded that seller reputation plays a crucial role in transactions in the e-commerce market. Trust has a significant impact on transactions in e-commerce platforms. Wahab and Giwah (2020) found that seller reputation is often calculated based on buyer reviews, such as numerical ratings and written comments on platforms such as Taobao. Chen et al. (2022) pointed out that higher product sales and seller reputation ratings may indicate greater reliability, more accurate product descriptions, and better customer service. This study takes seller reputation as a factor affecting attitude to verify the changing trend of seller reputation under country image.

5. Purchase Intention in Live Streaming E-Commerce

In live streaming commerce, consumer decision making happens in real time and is more dynamic, influenced by the streamer, barrage comments, and the overall live streaming atmosphere (Liu

et al., 2023). The theoretical results obtained in traditional e-commerce environments are unable to accurately and quickly capture consumer needs in the live streaming commerce environment, making it challenging for sellers and platforms to provide consumers with sufficient satisfaction to make purchase decisions.

Existing research on live streaming e-commerce mostly relies on the Technology Acceptance Model (TAM). This model is based on the assumption that consumer behavior is explored through passive stimulus (Alsyouf et al., 2023; Liu et al., 2023). Liu et al. (2023) indicated that in the context of live streaming e-commerce, the main factors that attract consumers are the streamer, content, and platform. Streamers, sellers, and platforms should not only focus on consumer usage of the live streaming environment but must also pay attention to how consumers utilize the environment and which features they value.

III. Hypotheses Development

1. The Relationship between Attitude toward Live Stream Shopping and Purchase Intention

The TAM is based on the assumption of a causal relationship: Beliefs → Attitude → Intention. In particular, Davis et al. demonstrated a strong correlation between attitude and intention (Davis, 1989, Zhao et al., 2022). This expectation is partially validated based on the theory of reasoned action, which suggests that if an attitude holder has a positive (or negative) evaluation component toward an object, their behavioral intentions toward that object will be positively (or negatively) influenced. In the field of live streaming commerce, Kim et al. (2023) also validated the influence of attitude on intention based on the TAM model. Therefore, the following hypothesis is proposed.

H1: Attitude toward live streaming shopping positively affects consumer purchase intention.

2. The Relationship between Seller Reputation and Attitude toward Live Stream Shopping

In general, most e-commerce platforms have established mechanisms to evaluate sellers and share information (Wang et al., 2016). While sellers make efforts to facilitate sales through communication, the evaluation system tends to generate more persuasive information if the sources of communication are perceived to be fair. In addition, many individual sellers actively engage in obtaining positive reviews on e-marketplace platforms; however, consumers still face trust issues, which are a major concern in online purchasing activities (Lai et al., 2017).

Business transactions in e-commerce depend not only on consumer adoption of the channel and its technologies but also, especially, the recognition of trustworthy merchants (Pavlou, 2003). Wahab and Giwah (2020) verified that seller reputation calculated from buyer reviews can help improve consumer purchase intention. Chen et al. (2022) verified that higher product sales and seller reputation ratings may indicate higher reliability, more accurate product descriptions, and better customer service, which in turn lead to improved consumer attitudes toward purchases.

Applying this causal relationship from TAM to the construct of trust beliefs and their continuous formation, it is expected that the reputation of live streaming commerce sellers and trust in streamers can influence purchase intentions through attitudes toward live streaming commerce (Doanh et al., 2022). Therefore, the following hypothesis is proposed.

H2: Seller reputation positively affects customer attitudes toward live streaming shopping.

3. The Relationship between Trust in Streamers and Attitude toward Live Stream Shopping

Huang et al. (2021) found that celebrity streamers promote purchases through consumer

emotional trust, while corporate streamers provide more accurate product information, enhance consumer trust in products and sellers, and help consumers make more rational consumption decisions. These two types of streamers change shopping attitudes and affect purchase intentions by enhancing consumer trust.

The expertise of live streamers can enhance consumer trust and influence purchase intentions (Liu & Oda, 2021). Consumer trust in the live streamers enables them to focus on important product attributes and increases the attitude and willingness to purchase (Chandrruangphen et al., 2022). Therefore, the following hypothesis is proposed.

H3: Trust in streamers positively affects customer attitudes toward live streaming shopping.

4. The Moderation Effect of Country Image

In explaining consumer behavior, national image plays an important role. Consumers often hesitate when purchasing unfamiliar products, and in such cases, they are more likely to evaluate the quality of the product based on the image of the country of origin (Nisbett & Wilson, 1977). There are many definitions of country image. From the perspective of marketing, Parameswaran and Yapark (1987) divided national image into national general image and national product image.

Country image is an important aspect of shopping because it significantly influences consumer perceptions and decision making processes (Zhang et al., 2016, Lee & Robb, 2016). Wang et al. (2012) found that consumer behavior varieds depending on country image. Vijaranakorn and Shannon (2017) demonstrated the role of country image in enhancing product value and consumer purchase intention.

There are two main types of country image influences; one is used as an independent variable to affect other factors, and the other is used as a moderate factor to affect the relationship between other factors. Islam and Hussain's (2022) research showed that country image reduces consumer uncertainty and increases purchase intention. Huang et al. (2023) found that country image plays a moderating role in the relationship between brand reputation and well-being, and between brand preference and word of mouth. Haryanto et al. (2022) verified that the country general image and country product image had different impacts on consumer purchase behaviors. Therefore, the following hypotheses are proposed.

H4a: Country general image moderates the relationship between seller reputation and consumer attitudes toward live streaming shopping.

H4b: Country general image moderates the relationship between trust in live streamers and consumer attitudes toward live streaming shopping.

H5a: Country product image moderates the relationship between seller reputation and consumer attitudes toward live streaming shopping.

H5b: Country product image moderates the relationship between trust in live streamers and consumer attitudes toward live streaming shopping.

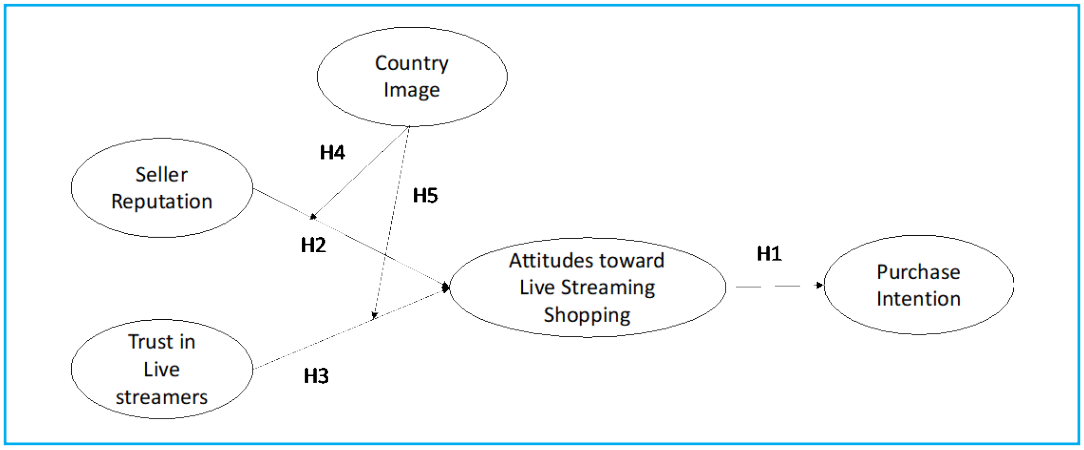
The research model is shown in Fig. 1.

IV. Research Methodology

1. Questionnaire

The questionnaire consists of 28 items that measure six concepts. The five items measuring country general image and six items measuring country product image were based on previous studies (Haryanto et al., 2022; Parameswaran & Yaprak, 1987). Three items measuring purchase intention were drawn from previous studies

Fig. 1. Research Model



(Alsyouf et al., 2023; Liu et al., 2023; Jung & Liu, 2022). Four items to measure trust in streamers were drawn from previous studies (Liu & Oda, 2021; Zhang et al., 2022). The three items measuring seller reputation were modified from previous studies (Puranik & Bansal, 2014). Three items measuring attitude toward live stream shopping come from previous studies (Kim et al., 2023; Li et al., 2023). All items have been modified according to the e-commerce platform. These items were measured on the Likert scale (1= completely disagree, 5= very agree). The constructs and survey items are shown in Table 1.

2. Sampling Design and Data Collection

The purpose of this study is to investigate consumer perceptions of seller reputation and trust in streamers, and attitudes toward live streaming shopping, as well as the moderating effect of South Korea's country image.

The survey was conducted in June of 2022 using a combination of online and offline questionnaires. The samples in this study are mainly young people in Shandong Province familiar with Korean products, so the main location of distribution is near the university in Jinan City, Shandong Province. A total of 400 questionnaires were distributed, and 341 valid questionnaires were recovered after deleting dishonest questionnaires. The study used SmartPLS for reliability and validity analysis, as well as path analysis and moderation effect analysis.

The demographic characteristics of the respondents are as follows. Since live streaming shopping consumers are mainly women, the study increased the proportion of women in the sample. The ratio of female to male samples was 2:1. The age of the respondents was mainly concentrated between 20 and 30 years old, of which 81% of the total sample size was between 20 and 30 years old. In terms of monthly income, families with a monthly income of 5,000-10,000 yuan in the sample dominate.

V. Results

1. Validity and Reliability of the Measures

First, this study conducted reliability analysis on six variables, as shown in Table 2. The α coefficients of the latent variables were found to be greater than 0.8, which significantly exceeded the minimum critical value of 0.7. This indicates that the internal consistency of each variable in

Table 1. Construct and Questions Items

Construct	Item	Statement	Source
General Country Image	CGI1	Korea's ecological environment is good.	Parameswaran and Yapark (1987) Haryanto et al. (2022)
	CGI2	Korea's natural environment is clean and pollution-free.	
	CGI3	Korea's economic development level is high.	
	CGI4	Koreanshave a higher standard of living.	
	CGI5	Koreans are highly educated.	
Country Product Image	CPI1	Korean products are natural and original.	
	CPI2	Korean products are natural without additives.	
	CPI3	Korean products are green and pollution-free.	
	CPI4	Korean products are made with meticulous workmanship.	
	CPI5	Korean produces highly technological products.	
	CPI6	The inspection standard of Korean products is high.	
Purchase Intention	PI1	It is a good idea to use live stream shopping on Taobao to buy goods.	Alsyouf et al. (2023) Liu et al. (2023)
	PI2	I have a positive attitude toward live stream shopping on Taobao.	
	PI3	I like live stream shopping on Taobao.	
Trust in Streamer	TSR1	The streamer on Taobao is like a real expert in evaluating the products.	Zhang et al. (2022) Liu & Oda (2021)
	TSR2	The streamer on Taobao has my interests in mind.	
	TSR3	I consider this Taobao streamer to have integrity.	
	TSR4	I do not think Taobao's streamer would take advantage of me.	
Seller Reputation	SR1	I undertake live stream shopping when a seller has a good reputation.	Puranik and Bansal (2014) Zahara et al. (2021)
	SR2	I undertake live stream shopping when a seller has higher rankings.	
	SR3	I undertake live stream shopping when a seller has better reviews.	
Attitude toward Live Streaming Shopping	ATT1	I think it is a good idea to use live stream shopping on Taobao to buy goods	Kim et al. (2023) Li et al. (2023)
	ATT2	I have a positive attitude toward live stream shopping on Taobao.	
	ATT3	I like to use liveg stream shopping on Taobao.	

the scale was good. Second, the total correlation coefficients of each question item were over 0.6, meeting the standard of over 0.4. Finally, a combined reliability (CR) score greater than 0.70 indicates good reliability of the factor. The CR of each variable was greater than 0.8, indicating good factor loading.

In the convergent validity analysis, the factor loading value of each item on the corresponding latent variable was greater than 0.8. The average variance extracted (AVE) of each latent variable was greater than 0.5. This indicated that the model had good convergent validity.

Table 2. Reliability Analysis and Validity Analysis Results

Construct	Item	Factor Loading	Cronbach's alpha	CR	AVE
Country General Image (CGI)	CGI1	0.859	0.85	0.883	0.825
	CGI2	0.847			
	CGI3	0.784			
	CGI4	0.855			
	CGI5	0.791			
Country Product Image (CPI)	CPI1	0.878	0.92	0.923	0.815
	CPI2	0.877			
	CPI3	0.854			
	CPI4	0.837			
	CPI5	0.791			
	CPI6	0.832			
Purchase Intention	PI1	0.911	0.899	0.91	0.831
	PI2	0.914			
	PI3	0.91			
Trust in Streamer	TSR1	0.866	0.936	0.938	0.839
	TSR2	0.94			
	TSR3	0.923			
	TSR4	0.933			
Seller Reputation	SR1	0.948	0.93	0.93	0.877
	SR2	0.947			
	SR3	0.914			
Attitude toward Live Stream Shopping	ATT1	0.882	0.885	0.9	0.812
	ATT2	0.936			
	ATT3	0.884			

To assess discriminant validity, it is necessary to evaluate the correlations between the measurement items of different latent variables. A model has good discriminant validity if the square root of the average variance extracted (AVE) for each variable is greater than the correlation coefficient between the variable and others (Huang & Hong, 2022). The square root of the AVE for each variable was greater than the correlation coefficient, indicating that the model had good discriminant validity based on the results of the discriminant validity analysis (as shown in Table 3).

Table 3. Discriminant Validity Analysis

	Attitude	CGI	CPI	Purchase Intention	Seller Reputation	Trust in Streamer
Attitude	0.901					
CGI	0.337	0.791				
CPI	0.373	0.777	0.845			
Purchase Intention	0.680	0.358	0.412	0.912		
Seller Reputation	0.612	0.377	0.389	0.536	0.937	
Trust in Streamer	0.434	0.254	0.226	0.374	0.532	0.916

2. Common Method Bias

The data for this research were collected using the same survey method from online and offline sources. Scholars have proposed that when data are collected from a single source, there is the possibility of common method bias (CMB) in the data set (Lindell and Whitney, 2001).

In this study, to reduce concerns over common method bias, several remedies were undertaken before and after data collection, following the recommendations of Podsakoff et al. (2003).

First, we assured our respondents on the privacy and confidentiality of their responses; second, well-established scale designs were used to avoid vagueness. Third, the questionnaire was pre-tested, and any necessary revisions were made before data collection. Finally, this study uses the marker variable to test the common method bias, and inserts a variable unrelated to the study in the middle of the questionnaire. We check the correlation coefficient between the marker variable and other variables, and if the correlation coefficient between the label variable and other variables exceeds 0.3, it is believed that there is a common method bias (Hair et al., 2019), and the result of correlation coefficients between marker variable and other variables are all less than 0.15.

3. Structural Parameter Estimates

In this study, SmartPLS was used to draw the fit diagram of the theoretical model and test the proposed theoretical hypotheses. Model fit refers to the degree of match between the structural equation model (SEM) and the observed values of the questionnaire sample. The results of the model fit analysis revealed that the absolute fit index of RMSEA was 0.067 (<0.08), which falls within the acceptable range, and the relative fit index of NFI was 0.849 (>0.8), indicating a good level of model fit.

Using the partial least squares regression method, the theoretical assumptions of the research model were examined. As shown in Table 4, the results indicated that, based on the path coefficients and significance analysis, Hypotheses 1, 2, and 3 were accepted.

Table 4. Path Coefficients and Hypothesis Testing Results

Hypothesized Path	Standardized Estimate	t-value	Result
H1: Attitude -> Purchase Intention	0.681	17.149***	Accepted
H2: Seller Reputation -> Attitude	0.533	11.139***	Accepted
H3: Trust in Streamers -> Attitude	0.15	3.409***	Accepted

Note: *p<0.05, **p<0.005, ***p<0.001.

SmartPLS was used to test the moderation effects. Additionally, 95% confidence interval estimates and 5,000 repeated sampling (bootstrap) estimates were employed, as recommended by Hayes (Hayes and Preacher, 2014, Kim, 2023).

Table 5 presents the results of the moderation test for general country image. The moderation effect of general country image on respect for the seller reached a significant level, but the moderation effect on trust in the streamer was not significant, thus supporting Hypothesis 4a, and rejecting Hypothesis 5a.

Table 6 displays the results of the moderation test for country product image. The moderation effect of country product image on respect for the seller reached a significant level, but the moderation effect on trust in the streamer was also not significant, thus supporting Hypothesis 4b, and rejecting Hypothesis 5b.

The results indicate that country general image has a moderating effect on reputation for seller and attitude. Country product image also has a moderating effect on reputation for seller and attitude. However, country image does not moderate the relationship between trust in the streamer and attitude. This confirms that in live streaming e-commerce, consumer perceptions of country image do not change with the level of trust in the streamer, but still influence other traditional factors in e-commerce, such as reputation for the seller.

Table 5. Moderating Effect of Country General Image

Hypothesized Path	Standardized Estimate	t-value	Result
Attitude -> Purchase Intention	0.681	17.164***	
CGI -> Attitude	0.127	2.665**	
Seller Reputation -> Attitude	0.498	9.14***	
Trust in Streamers -> Attitude	0.123	2.701**	
H4a: CGI x Seller Reputation -> Attitude	0.163	2.806**	Accepted
H5a: CGI x Trust in Streamers -> Attitude	-0.038	0.849	Rejected

Note: *p<0.05, **p<0.005, ***p<0.001.

Table 6. Moderating Effect of Country Product Image

Hypothesized Path	Standardized Estimate	t-value	Result
Attitude -> Purchase Intention	0.68	17.098***	
CGI -> Attitude	0.15	3.635***	
Seller Reputation -> Attitude	0.486	9.054***	
Trust in Streamers -> Attitude	0.126	2.77**	
H4b: CPI x Seller Reputation -> Attitude	0.089	2.353**	Accepted
H5b: CPI x Trust in Streamers -> Attitude	-0.034	0.792	Rejected

Note: *p<0.05, **p<0.005, ***p<0.001.

VI. Conclusions

1. Summary of Results

The purpose of this study was to explore the purchase behavior of Chinese consumers in live streaming e-commerce from the perspective of Korea's country image. The study adopted the Technology Acceptance Model (TAM) to examine the influence of traditional seller reputation and trust in streamers on consumer purchase intention. In addition, this study also examined the moderating effect of Korea's general country image and Korea's product image on seller reputation, trust in streamers, and consumer attitudes toward live streaming e-commerce.

According to the Technology Acceptance Model (TAM), this study found that consumer attitudes toward live streaming e-commerce had a positive effect on their purchase intention. This finding underscores the importance of attitudes in determining consumer purchase intentions. This conclusion is partially consistent with previous research findings, and supports the effectiveness of TAM in explaining consumer behavior.

At the same time, in traditional e-commerce, seller reputation has a significant impact on consumer purchase attitudes, and this relationship has also been verified in live streaming e-commerce (Kim, 2023). This shows that seller reputation plays a key role in different shopping environments, whether traditional e-commerce or live streaming e-commerce. This finding reminds companies of the importance of maintaining and enhancing the reputation of sellers on live e-commerce platforms to promote consumer purchase intention (Wahab & Giwah, 2020).

In addition, the research results also indicate that trust in streamers in live streaming e-commerce has a positive impact on consumer attitudes toward live streaming e-commerce (Liu & Oda, 2021; Zhang et al., 2022; Liu et al., 2023). This shows that the streamer plays an important role in live streaming e-commerce, and trust has a significant impact on consumer attitudes and purchase decisions. Establishing this trust may involve factors such as streamer professionalism, reliability, and interaction with consumers.

In this study, to further investigate the moderating effect of country image, the researchers examined the influence of Korea's country image on the relationship between seller reputation, trust in streamers, and consumer attitudes toward live streaming e-commerce (Musarra et al., 2022;

Zhang et al., 2022). Based on previous studies, country image is divided into general country image and country product image (Hwang et al., 2023).

The results revealed some interesting findings. First, general country image and country product image play a moderating role in the relationship between seller reputation and attitude. That is, Korea's country image can affect the relationship between seller reputation and consumer attitude toward live streaming e-commerce to some extent. This may indicate that overall consumer impressions of Korea and perceptions of Korean products play a role in evaluating seller reputation. For example, positive consumer impressions of Korea may increase trust in Korean sellers, which in turn affects attitudes toward live-streaming e-commerce.

Interestingly, however, country image did not show a moderating effect on the relationship between streamer trust and attitudes toward live e-commerce (Chandrruangphen et al., 2022). This may mean that consumer trust in streamers is, to some extent, not influenced by country image, but rather by other factors (such as the streamer's personal charm and professionalism).

Taken together, these findings provide a deeper understanding that the impact of country image on consumer attitudes and purchase behavior in live streaming e-commerce may be complex and varied. General country image and country product image may play a moderating role in some aspects, but have no impact on others. This highlights the importance of considering multiple factors when studying the relationship between country image and consumer behavior, and provides new ideas for research in related areas. However, further studies are needed to delve deeper into the mechanisms of these modulations, as well as other influencing factors that may exist.

2. Implications and Limitations

The theoretical implications of this study are as follows.

With the popularity of live streaming e-commerce, the mechanisms influencing consumer live stream purchase behavior are significantly different from traditional e-commerce. This study extends the application of the Technology Acceptance Model (TAM) to the context of live streaming e-commerce. By including traditional seller reputation and the crucial factor of trust in streamers in live streaming e-commerce as dependent variables, this study explores the pathways of the impact on consumer purchase intention. In addition, the study examines the moderating role of country image, an important factor in e-commerce research, to validate the moderating effect of South Korea's country image in live streaming e-commerce in China.

The practical implications of this study are as follows.

As more foreign products enter the Chinese market, the country image of products significantly influences consumer purchasing decisions. In live streaming e-commerce, although trust in streamers influences consumer purchase attitudes, relying solely on streamer advertisement and consumer attitudes toward a streamer may not be sufficient to influence the purchase decision process when selling foreign products with which consumers are unfamiliar. On the contrary, seller reputation is crucial. In the absence of sufficient information about foreign products, the country image of the product positively moderates the relationship between seller reputation and purchase attitude. Therefore, when selling foreign products in China, it is important to select sellers with a good reputation.

The limitations of this study are as follows.

The study focused only on the country image of South Korea, and further comparative research on the country images of other countries is needed. Regarding the research model, only two influencing factors were selected, and more factors should be validated. In addition, the study sample consisted only of individuals aged 20 and above, which may limit the generalizability of the findings.

References

Ahuja, V., & Khazanchi, D. (2016). Creation of a conceptual model for adoption of mobile apps for shopping from e-commerce sites: An indian context. *Procedia Computer Science*, *91*, 609-616.

Alsyouf, A., Lutfi, A., Alsubahi, N., Alhazmi, F. N., Al-Mugheed, K., & Anshasi, R. J. et al. (2023). The use of a technology acceptance model (TAM) to predict patients' usage of a personal health record system: The role of security, privacy, and usability. *International Journal of Environmental Research and Public Health*, *20*(2), 1347.

Becker, K. (2015). Halo effect influences on the Japanese product price/quality relationship. In N. Malhotra (Ed.) *Proceedings of the 1986 academy of marketing science (AMS) annual conference* (pp. 111-114). Springer. https://doi.org/10.1007/978-3-319-11101-8_23

Butt, I., Mukerji, B., Shareef, M. A., Ahmed, J. U., & Huda, S. S. (2022). Effect of trust on e-shopping adoption: An emerging market context. *Journal of Internet Commerce*, *21*(3), 320-340.

China Internet Network Information Center (CNNIC) (2022, September 1). *The 50th "Statistical report on internet development in China" released.* http://www.gov.cn/xinwen/2022-09/01/content_5707695.htm

Chandrruangphen, E., Assarut, N., & Sinthupinyo, S. (2022). The effects of live streaming attributes on consumer trust and shopping intentions for fashion clothing. *Cogent Business & Management*, *9*(1), 2034238.

Chen, Z., Zhu, Y., Shen, T., & Ye, Y. (2022). The optimal pricing strategy to evaluate the reputations of sellers in online platforms using the game theory model. *Operations Management Research*, *15*(3), 953-964.

Davis, F. D. (1989). Technology acceptance model: TAM. *Al-Suqri, MN, Al-Aufi, AS: Information Seeking Behavior and Technology Adoption*, 205-219.

Doanh, N. K., Do Dinh, L., & Quynh, N. N. (2022). Tea farmers' intention to participate in Livestream sales in Vietnam: The combination of the technology acceptance model (TAM) and barrier factors. *Journal of Rural Studies*, *94*, 408-417.

Duradoni, M., Collodi, S., Perfumi, S. C., & Guazzini, A. (2021). Reviewing stranger on the internet: The role of identifiability through "reputation" in online decision making. *Future Internet*, *13*(5), 110.

Duradoni, M., Paolucci, M., Bagnoli, F., & Guazzini, A. (2018). Fairness and trust in virtual environments: The effects of reputation. *Future Internet*, *10*(6), 50.

El Amri, D., & Akrout, H. (2020). Perceived design affordance of new products: Scale development and validation. *Journal of Business Research*, *121*, 127-141.

Fang, Y., Qureshi, I., Sun, H., McCole, P., Ramsey, E., & Lim, K. H. (2014). Trust, satisfaction, and online repurchase intention. *MIS Quarterly*, *38*(2), A407-A409.

Gantulga, U., Sampil, B., & Davaatseren, A. (2021). Analysis of e-commerce adoption in Ulaanbaatar, Mongolia. *Journal of International Trade & Commerce*, *17*(1), 67-80.

Gefen, D., & Straub, D. (2003). Managing user trust in B2C e-services. *e-Service*, *2*(2), 7-24.

Gefen, D., Karahanna, E., & Straub, D. W. (2003). Trust and TAM in online shopping: An integrated model. *MIS Quarterly*, 51-90.

Haas, A., & Unkel, J. (2017). Ranking versus reputation: perception and effects of search result credibility. *Behaviour & Information Technology*, *36*(12), 1285-1298.

Hair, J., Hollingsworth, C. L., Randolph, A. B., & Chong, A. Y. L. (2017). An updated and expanded assessment of PLS-SEM in information systems research. *Industrial Management & Data Systems*, *117*(3), 442-458.

Han, C. M. (1989). Country image: Halo or summary construct?. *Journal of Marketing Research*, *26*(2), 222-229.

Han, C. M. (1990). Testing the role of country image in consumer choice behaviour. *European Journal of*

Marketing, *24*(6), 24-40.

Haryanto, B., Gunawan, J. A. P., Fenitra, R. M., & Abbas, A. (2022). The role of culture adoption in moderating the influence of country image, corporate image, brand image on brand attitude and purchase intention toward foreign brands. *International Journal of Business Performance and Supply Chain Modelling*, *13*(1), 89-108.

Hayes, A. F., & Preacher, K. J. (2014). Statistical mediation analysis with a multicategorical independent variable. *British Journal of Mathematical and Statistical Psychology*, *67*(3), 451-470.

Huang, C., & Hong, S. (2022). SEM based study on the influencing factors of the integration of China''s smart elderly care industry chain. *Journal of Global Business and Trade*, *18*(4), 107-122.

Huang, M., Ye, Y., & Wang, W. (2021). The interaction effect of broadcaster and product type on consumers' purchase intention and behaviors in livestreaming shopping. *Nankai Business Review international*, *25*, 1-21.

Hwang, J., Joo, K., & Kim, I. (2023). Identifying Chinese tourists' shopping values and their consequences in the context of a duty-free shop: The moderating role of country image. *Sustainability*, *15*(6), 5304.

Ingham, J., Cadieux, J., & Berrada, A. M. (2015). e-Shopping acceptance: A qualitative and meta-analytic review. *Information & Management*, *52*(1), 44-60.

Islam, T., & Hussain, M. (2022). How consumer uncertainty intervene country of origin image and consumer purchase intention? The moderating role of brand image. *International Journal of Emerging Markets*. (ahead-of-print).

Jullien, B., & Park, I. U. (2009, October 7). *Seller reputation and trust in pre-trade communication*. https://ssrn.com/abstract=1483863

Jung, J. S., & Liu, H. F. (2022). The effect of CSR attributes on purchase intention in both Korea and China. *Journal of Global Business and Trade, 18*(3), 61-80.

Khan, S. A. R., Yu, Z., Belhadi, A., & Mardani, A. (2020). Investigating the effects of renewable energy on international trade and environmental quality. *Journal of Environmental Management*, *272*, 111089.

Kim, J. (2021). Platform quality factors influencing content providers' loyalty. *Journal of Retailing and Consumer Services*, *60*, 102510.

Kim, J., He, N., & Miles, I. (2023). Live commerce platforms: A new paradigm for e-commerce platform economy. *Journal of Theoretical and Applied Electronic Commerce Research*, *18*(2), 959-975.

Kim, Y. G. (2023). The influence of VR tourism's perceived benefits on value experience and intention to visit: The moderation effect of involvement. *Journal of Global Business and Trade*, *19*(2), 13-26.

Ko, B. M. (2021). A comparative study of consumer trust in major digital trade agreements. *Journal of International Trade & Commerce, 17*(3), 147-165.

Koubaa, Y. (2008). Country of origin, brand image perception, and brand image structure. *Asia Pacific Journal of Marketing and Logistics*, *20*(2), 139-155.

Lai, C. Y., Li, Y. M., & Lin, L. F. (2017). A social referral appraising mechanism for the e-marketplace. *Information & Management*, *54*(3), 269-280.

Lee, Y. K., & Robb, C. A. (2016). Moderating effect of country familiarity and country image on product purchase intention in South Africa. *Journal of International Trade & Commerce*, *12*(4), 237-256.

Li, X., Ma, J., Zhou, X., & Yuan, R. (2023). Research on consumer trust mechanism in China's B2C e-commerce platform for second-hand cars. *Sustainability*, *15*(5), 4244.

Liébana-Cabanillas, F., Marinković, V., & Kalinić, Z. (2017). A SEM-neural network approach for predicting antecedents of m-commerce acceptance. *International Journal of Information Management*, *37*(2), 14-24.

Lin, L. Y., & Chen, C. S. (2006). The influence of the country-of-origin image, product knowledge and product involvement on consumer purchase decisions: An empirical study of insurance and catering services in Taiwan. *Journal of consumer Marketing*, *23*(5), 248-265.

Lindell, M. K., & Whitney, D. J. (2001). Accounting for common method variance in cross-sectional research designs. *Journal of Applied Psychology*, *86*(1), 114.

Liu, C., Sun, K., & Liu, L. (2023). The formation and transformation mechanisms of deep consumer engagement and purchase behavior in e-commerce live streaming. *Sustainability*, *15*(7), 5754.

Liu, X., & Oda, T. (2021). *The impact of the Live streamer on trust in China during COVID-19 pandemic*. The ISPIM Conference Proceedings, 1-16.

Lu, Y., He, Y., & Ke, Y. (2023). The influence of e-commerce live streaming affordance on consumer's gift-giving and purchase intention. *Data Science and Management*, *6*(1), 13-20.

Ma, Q., Huang, J., Başar, T., Liu, J., & Chen, X. (2021). Reputation and pricing dynamics in online markets. *IEEE/ACM Transactions on Networking*, *29*(4), 1745-1759.

Musarra, G., Kadile, V., Zaefarian, G., Oghazi, P., & Najafi-Tavani, Z. (2022). Emotions, culture intelligence, and mutual trust in technology business relationships. *Technological Forecasting and Social Change*, *181*, 121770.

Nisbett, R. E., & Wilson, T. D. (1977). The halo effect: Evidence for unconscious alteration of judgments. *Journal of Personality and Social Psychology*, *35*(4), 250.

Papadopoulos, N. (1993). What product and country images are and are not. *Product-country Images: Impact and Role in International Marketing*, *12*(1), 3-38.

Parameswaran, R., & Yaprak, A. (1987). A cross-national comparison of consumer research measures. *Journal of International Business Studies*, *18*, 35-49.

Pavlou, P. A. (2003). Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model. *International Journal of Electronic Commerce*, *7*(3), 101-134.

Pavlou, P. A., & Gefen, D. (2004). Building effective online marketplaces with institution-based trust. *Information Systems Research*, *15*(1), 37-59.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879-903.

Puranik, R., & Bansal, A. (2014). A study of internet users' perception towards e-shopping. *Pacific Business Review International*, *6*(9), 37-44.

Reyes-Menendez, A., Saura, J. R., & Martinez-Navalon, J. G. (2019). The impact of e-WOM on hotels management reputation: Exploring tripadvisor review credibility with the ELM model. *IEEE Access*, *7*, 68868-68877.

Söllner, M., Pavlou, P. A., & Leimeister, J. M. (2013). *Understanding trust in IT artifacts: A new conceptual approach*. https://ssrn.com/abstract=2475382

Syntun. (2022, October 21). *2022 Live stream e-commerce trend development analysis report.* http://www.syntun.com.cn/xing-tu-shu-ju-gun-zhi-bo-dian-shang-qu-shi-fa-zhan-fen-xi-bao-gao.html

Tseng, T. H., & Balabanis, G. (2011). Explaining the product-specificity of country-of-origin effects. *International Marketing Review*, *28*(6), 581-600.

Vijaranakorn, K., & Shannon, R. (2017). The influence of country image on luxury value perception and purchase intention. *Journal of Asia Business Studies*, *11*(1), 88-110.

Wahab, H. K. A., & Giwah, B. (2020). The effect of celebrity firms on customer commitment in e-commerce setting: The mediating roles of trust and identification. *International Knowledge Sharing Platform*, *11*(8), 111-127.

Wang, C. L., Li, D., Barnes, B. R., & Ahn, J. (2012). Country image, product image and consumer purchase intention: Evidence from an emerging economy. *International Business Review*, *21*(6), 1041-1051.

Wang, Q., Cui, X., Huang, L., & Dai, Y. (2016). Seller reputation or product presentation? An empirical investigation from cue utilization perspective. *International Journal of Information Management*, *36*(3), 271-283.

Yang, M., Li, H., & Kim, D. J. (2021). An empirical study on the relationship between real estate price and real estate investment trusts of shadow banking via VAR model: The case of China. *Journal of Global Business and Trade, 17*(2), 49-66.

Zahara, A. N., Rini, E. S., & Sembiring, B. K. F. (2021). The influence of seller reputation and online customer reviews towards purchase decisions through consumer trust from C2C e-commerce platform users in Medan, North Sumatera, Indonesia. *International Journal of Research and Review*, *8*(2), 422-438.

Zhang, H., Xu, F., Leung, H. H., & Cai, L. A. (2016). The influence of destination-country image on prospective tourists' visit intention: Testing three competing models. *Asia Pacific Journal of Tourism Research*, *21*(7), 811-835.

Zhang, M., Liu, Y., Wang, Y., & Zhao, L. (2022). How to retain customers: Understanding the role of trust in live streaming commerce with a socio-technical perspective. *Computers in Human Behavior*, *127*, 107052.

Zhao, Y., Zhao, J., & Wang, X. (2022). A study on consumer's behavioral intention and use behavior based on UTAUT theory: Centered around mobile delivery apps. *Journal of International Trade & Commerce*, *18*(6), 35-48.

Zhong, R., Han, S., & Wang, Z. (2023). Developing personas for live streaming commerce platforms with user survey data. *Universal Access in the Information Society*, 1-17.

ISSN 1946-5130 (Print), ISSN 2470-4733 (Online)
http://dx.doi.org/10.20294/jgbt.2023.19.5.95

The Journal of Global Business and Trade

Journal of Global Business and Trade

https://www.pfw.edu/jgbt

Analyzing Differences in Cruise Tourist Decision: Making Processes Based on Value Perception

Miseong Kim[a], Yeonghye Yoon[b]*

[a]*Tourism Industry Research Center, Kyung Hee University, South Korea*
[b]*Global MICE major, Dongduk Women's University, South Korea*

Received 10 August 2023, Revised 12 September 2023, Accepted 5 October 2023

ABSTRACT

Purpose – The purpose of this study was to analyze differences in the decision-making process of cruise travelers based on value perceptions. The analysis was conducted from the perspective of travelers seeking information online, and pre-decision, purchase decision, and post-sharing were analyzed to draw implications.
Design/Methodology/Approach – The research methodology of this paper is as follows. A survey was conducted among potential travelers who are planning a cruise trip, especially those who are exposed to the digital environment and make pre-trip research and purchase decisions online. After conducting factor analysis for each factor, the relationship between variables was verified through MANOVA. In addition, cluster analysis was used to check for differences between groups and to determine whether there were differences between groups for each variable.
Findings – As a result of the study, we were able to divide the clusters into three groups: low-, medium-, and high-value. For each cluster, we analyzed the difference in preference for digital tourism platforms at different stages of the cruise decision-making process. The results are reported in detail in the main text.
Research Implications – While previous studies have conducted empirical research by incorporating theories on the traveler purchase decision-making process, this study is significant in that it analyzes the differences between groups of digital travelers as they increasingly make purchases online. It is expected to show theoretical and practical implications.

Keywords: cruise, digital traveler, information resources, market segmentation, travel decision making, travel value
JEL Classifications: L83, L86, L95, M31, O33

* *Corresponding Author, E-mail: yhyoon@dongduk.ac.kr*
© 2023 International Academy of Global Business and Trade. All rights reserved.

I. Introduction

The advent of the digital age is heralding a revolutionary shift in the travel paradigm (Pencarelli, 2020). The widespread integration of digital technologies into all phases of travel, from initial planning to immersive experiences to post-trip interactions, represents a radical departure from traditional methods (Arthur & Van Nuenen, 2019; Lee & Kim, 2022). This ubiquitous digital presence has not only created unprecedented convenience and operational efficiencies but has also given rise to a distinct group of travelers, the digital traveler, that uses digital tools to enhance, redefine, and customize trips (Hjalager and Jensen, 2012).

This paradigm shift is particularly evident in cruise travel (Buhalis et al., 2022). Within the cruise tourism sector, a variety of services and businesses are emerging to cater to the burgeoning population of digital travelers. Notable manifestations include the emergence of online booking platforms that streamline the reservation process, as well as the deployment of on-board applications that provide seamless guidance and navigation to enhance the cruise experience (Gibson & Parkman, 2018). The landscape is also enriched by platforms that provide a wealth of information through cruise rating and review sites (Brejla & Gilbert, 2014; Zhang et al., 2015). Nevertheless, it remains striking that there is a lack of scholarly research on the profile of the digital traveler within the cruise tourism domain.

The need to understand and empathize with users cannot be overstated, as it has profound implications for the continued growth and viability of the industry (Zhang & Schmude, 2022). In this context, market segmentation emerges as an instrumental strategy (Dibb, 1998). This approach facilitates a nuanced understanding of the multifaceted digital traveler population, and subsequently enables the development of customized services that are attuned to preferences and expectations. As a result, this tailored approach drives higher levels of customer satisfaction and loyalty.

The overarching goal of our study is to explore the cruise industry in the context of the digital traveler, an area that has been relatively underexplored. More specifically, the study aimed to understand how digital technologies are used in the decision-making process of cruise travelers, and which technologies are preferred based on traveler characteristics. Also, our research hinges on the stratification of the cruise tourism market, with a focus on the intrinsic value that travelers themselves place on tourism experiences. This strategic pivot is rooted in the recognition of value perception as a central driver within the tourism sector. As such, our study is poised to pay dividends by facilitating the formulation of customer-centric services, while simultaneously contributing to the broader expansion of the industry by uncovering novel paradigms and strategies that can be seamlessly integrated into the domain of cruise tourism. There have been many studies on cruise travelers, but there has not been much research on the decision-making process and the use of digital technology in the process, so it was necessary to conduct a study in line with the times.

II. Literature Review

This paper aims to reveal the decision-making factors of digital travelers and investigate travel values that affect these. To reveal this, it is necessary to understand the decision-making process of travelers and understand travel value.

1. Travel Decision Making

There are various theories to explain traveler decision-making. Among these, the theory of planned behavior is based on the theory of reasoned action, which states that specific behavioral intentions are formed by individual attitudes and subjective norms to understand and predict human behavior in the field of social science. It also emphasizes the importance of an individual's ability to control his or her behavior,

and adds the concepts of perceived behavior and sense of control to the theory of reasoned action to provide a theoretical framework (Bosnjak et al., 2020; Fishbein & Ajzen, 2011). Similar to the theory of reasoned action, the theory of planned behavior argues that humans are rational in decision-making because they are rational beings. However, it differs in that it enhances its explanatory power by adding a non-volitional factor, perceived behavioral control (Han et al., 2011).

Attitude, which is defined in the Theory of Planned Behavior as the expectations, beliefs, and evaluations about the outcomes of a particular behavior, is an important psychological variable because positive attitudes can increase behavioral intention (Phillips & Jang, 2008). In addition, in the Theory of Planned Behavior, perceived behavioral control refers to an individual's assessment of his or her ability and conditions to actually perform a particular behavior (Ajzen, 1991).

We also explore the research on the impact of travel value on traveler decision-making. Kim and Matsubara (2008) defined purchase intention as a customer's intention to purchase a particular product or service based on purchase experience, and Cronin and Taylor (1992) argued that satisfaction with a product or service leads to the formation of positive customer attitudes, such as revisit intention and loyalty.

In addition, in the case of the consumer purchase decision-making process, the desire to choose a product proceeds in five stages: problem recognition, product information search, comparison and alternative evaluation, product selection, and post-purchase satisfaction or dissatisfaction behavior., The stages can be moderated by the level of involvement, product type, individual, and environment (Engel & Blackwell, 1995). In most fields of tourism, additional variables have been added to the theory of planned behavior to shed light on the decision-making process of potential tourists (Garay et al., 2018; Goh et al., 2017). As a result, personal values are a key concept for understanding tourists in tourism marketing strategy formulation because they play a broad role in tourist decision-making, and are more stable across time and context than tourism motivations (Beatty et al., 1988; Mehmetoglu et al., 2010; Ye et al., 2017).

2. Travel Value

Consumers perceive value in the consumption process, and different consumption experiences can lead to different consumption values depending on the time, place, and circumstances of consumption (Zeithaml & Bitner, 1996). If consumption value is perceived differently depending on the consumption experience, consumption behavior is also different, so it is necessary to understand consumption value to explain and predict it (Kim & Chang, 2022; Lee, 2021). This is because consumption values are specific enough to provide a comprehensive and integrated view of a consumer's consumption experiences (Kang & Chae, 2011). Consumption value, which is perceived after the consumption process or experience, is organized differently depending on the researcher and the purpose of the study. Sheth et al. (1991) applied five types of consumption value: functional, social, emotional, rare, and situational. Behavioral intention, which is the intention or belief to repurchase or to positively communicate or recommend one's purchase experience to others, is the positive intention and expression of loyal customers, and is the basis for the continuous development of a company (Chi & Qu, 2008; Rhee & Bell, 2002).

Sweeney and Soutar (2001) developed a 19-item perceived value (PERVAL) scale that categorizes value into emotional, social, functional quality/performance, and functional price/price. Sanchez et al. (2006) defined perceived value related to the purchase of travel products into six dimensions, and developed a 24 item GLOBAL scale to measure it. Ponte et al. (2015) found that perceived value and trust determined online purchase intention when purchasing travel products online. Bajs (2015) examined the effects of perceived value on satisfaction and behavioral intention among travelers in Dobrovnik, Croatia. It was found that

destination appearance and emotional experience had the strongest positive effect on the perceived value of travel, and while cost had a negative effect, the effect was weak.

Looking at previous studies on the relationship between consumption value and consumption propensity, Hauseman (2000) and Michon and Chebat (2004) found that consumption value influenced shopping propensity during the shopping process. In Hauseman's (2000) study, it was found that consumption values and consumption disposition significantly affected behavioral intention, which indicates that consumers change behaviors during the shopping process in pursuit of stress relief, escape from routine, and fun. Cronin et al. (2000) found that customer perceived value had a direct and positive effect on future behavioral intention.

Cruise tourism continues to grow mainly in the Americas and Europe, and since 2012, the growth of the cruise tourism market has become more visible as the supply of world-leading cruise lines has expanded to China, Japan, and Korea in Northeast Asia, following the Americas and Europe (CLIA. 2015). It is also a tourism sector that has seen a resurgence after a brief hiatus due to the pandemic (Liu et al., 2022).

If the psychological consumption characteristics are different depending on the consumption experience, the consumption behavior will also appear differently, so it is necessary to identify the consumption value and tendency to explain and predict it (Kang & Chae. 2011).

Online reviews not only answer questions about a product or service, they also provide indirect experiences prior to consumption, giving an overall assessment of the product by previous users (Li et al., 2013). Reviews and ratings from regular consumers that have already experienced a product or service are perceived to be more accurate and honest compared to reviews provided by sellers (Yoo & Gretzel, 2009). As such, online reviews can have a significant impact on the purchase decisions of potential consumers considering purchasing a particular product or service (Sparks et al., 2013).

Studies related to online cruise reviews include Brejla and Gilbert (2014) and Zhang et al. (2015), both of which utilized data from CruiseCritic. Zhang et al. (2015) collected overall satisfaction and satisfaction with each service item rated by reviewers on CruiseCritic on a five-point scale and used regression analysis to identify factors that influenced satisfaction with cruise travel. Meanwhile, Brejla and Gilbert (2014) utilized online review data to study the ongoing service evaluation and bilateral interactions between cruise passengers and crew within the service space of cruises.

3. Digital Traveler

Many travelers today want to be online at all times, meaning before, during, and after a trip (Hjalager & Jensen, 2012). The use of the Internet for commerce or interacting with customers is growing rapidly in the global travel and tourism industry. It has significantly changed the market conditions for organizations operating in the industry (Buhalis & Law, 2008).

The frontrunners of digitizing tourists are generally characterized by the following characteristics: being small in number, able to withstand uncertainties such as financial risks, and having the knowledge to deal with technological solutions. However, not enough effort has been put into identifying segments of mobile service users. In particular, there is still an ongoing debate about segmentation by various modes of travel transportation, or by propensity.

A study related to cruise passenger dissatisfaction experiences is that of Aggett (2011), which is significant because it was the first study to collect and analyze online reviews and categorize passenger complaints into food, policy, systems and operations, and service performance and delivery.

Digital travelers are focused on real-time, place-based information on smart devices during their travels, not just traditional destination-based information or provider information. This means that contextual messaging is important,

personalized and tailored to the information-driven travel patterns of travelers in specific situations. At a time of heightened alertness, the proper packaging and content of messages is critical. There have been studies on social media for information search (Xiang & Gretzel, 2010), motivation to share travel knowledge, specific social media studies, and intention to use social media (Parra-López et al., 2011). Thus far, research on the combination of tourism and ICT has been focused on phenomenological and technological aspects.

Therefore, this paper explores the differences in decision-making based on value perception among digital travelers that have been on a cruise. By dividing these individuals into clusters and checking the differences between each group, this study hopes to derive relevant management and marketing strategies in the future.

4. Market Segmentation

Market segmentation refers to the division of a heterogeneous overall market into mutually exclusive and homogeneous submarkets based on consumer characteristics. Marketers can define consumer characteristics, identify profitable segments, and implement effective marketing strategies in response (Zhang & Schmude, 2022).

In the field of travel and tourism, market segmentation provides important information for building tourism marketing strategies. Dolnicar (2004) defined travel market segmentation as the process of categorizing travel consumers into homogeneous subgroups with similar needs and interests based on demographic, socioeconomic, socio-psychological, and geographic characteristics. In addition to demographic criteria, recent tourism market segmentation studies have attempted to categorize the market based on travel and experience motivations and benefits sought (Molera and Albaladejo, 2007; Poria et al., 2003).

Prior research on travel motivations and market segmentation can be divided into three main categories. First, McIntosh and Goeldner (1995) proposed four motives: physical, cultural, interpersonal, and status and honor motives, in which he argued that tourists do not travel for one motive alone, but rather try to satisfy several motives at the same time. The second is Iso-Ahola and Weissinger's (1987) Escape -Seeking theory, which categorizes tourist motives into those that seek to escape from the everyday environment, and those that seek psychological and intrinsic rewards. Third, travel motivation is divided into push factors, which are motivations to travel to a tourist destination, and pull factors, which represent the attraction of a tourist destination. As such, travel motivation is defined differently by different researchers, but the general view is that it can be complex and diverse, depending on the internal psychological characteristics of tourists, and can vary depending on the cultural, historical, and external environment.

III. Methodology

1. Research Questions

As noted, digital travelers have different characteristics than traditional tourists, meaning that they need to be understood differently. In order to understand this group of tourists in depth, utilizing market segmentation methods is effective. In this study, we used the market segmentation method to understand the phenomenon of digital traveler enjoyment of cruise tourism. In particular, the study believes that tourism value, which is used as the main driver of tourists, is the main factor for market segmentation.

Therefore, the research questions are set as follows.

Q1: Is it possible to market to segment cruise tourists according to the perceived tourism value of digital travelers?

Q2: Does each group segmented by tourism value show differences by travel decision making process?

2. Data Collection and Analysis

This study aimed to understand the cruise tourism behavior of digital travelers and surveyed those that have participated in or intend to participate in cruise tourism. The survey was conducted from September 2nd to October 2nd, 2019, with trained researchers to help respondents complete the survey. The surveyors utilized both a printed paper questionnaire and an online questionnaire, allowing respondents to choose the method that was most convenient, and provided immediate assistance if they had difficulty responding.

The questionnaire consisted of six questions about cruise travel experiences, four questions about preferred information sources for pre-trip planning, eight questions about preferred platforms, six questions about preferred channels for purchasing cruise products, eight questions about preferred platforms for sharing post-trip information, 24 questions about cruise travel values, and five questions about demographic characteristics.

The survey samples were divided into age groups of 20s, 30s, 40s, 50s, and 60s and above to match the age and gender ratio, and a total of 400 copies were collected, with a goal of 40 copies for men and 40 copies for women in each age group. As a result, 410 questionnaires were returned, but through the data cleaning process to exclude insincere responses and responses that were not suitable for statistical analysis, 395 valid samples were finally obtained. Statistical analysis was conducted to present the results of the research questions through frequency analysis, factor analysis, cluster analysis, cross analysis, and analysis of variance.

IV. Results and Discussion

1. Characteristic of the Respondents

The basic demographics of the respondents are shown in Table 1. A total of 395 respondents were analyzed, and although we aimed for a quota sample, more males responded to the survey than females, and respondents were in their 20s, 40s, 30s, and 50s or older. In terms of educational background, university graduates were the most common, and income level was evenly distributed below 60 million won.

Table 1. Demographic Characteristic of the Respondents (n=395)

Variable		N	Percentage
Gender	Male	243	61.5
	Female	152	38.5
Age	20~29	142	35.9
	30~39	86	21.8
	40~49	110	27.8
	50~59	53	13.4
	> 60	4	1.0
Education	High School or below	38	9.6
	College	57	14.4
	University	270	68.4
	Graduate School	30	7.6
Annual Household Income	< 20 million won	148	37.5
	20~40 million won	84	21.3
	40~60 million won	117	29.6
	60~80 million won	29	7.3
	> 80 million won	17	4.3

2. Factor Analysis of Travel Value

The results of the factorization are shown in Table 2. Out of the total 24 questions, 20 questions were used for the analysis, excluding those that did not fit the analysis results and content. As a result, a total of three value factors were derived. First is rare value, which is the perception that cruise travel is special and different from ordinary travel. The second is functional value, which is the perception that cruise travel offers a superior quality of service. Finally, the third value is social value, which is the perception that cruise traveling provides value such as increased social status.

Table 2. Factor Analysis of Travel Value

	Attribute / Factor	Loading	Eigenvalue	Variance Explained(%)	Reliability Alpha
Epistemic Value	Cruising is a memorable experience.	0.837	4.969	24.846	.886
	Cruising is an experience like no other.	0.797			
	Cruising makes me feel like I'm in a new world.	0.745			
	Cruising has unique characteristics that set it apart from regular travel.	0.717			
	Cruising allows me to have a unique experience.	0.709			
	Cruise experiences are priceless.	0.689			
	Cruising offers its own special service.	0.631			
	Cruises can take me to places I can't easily get to with regular travel.	0.461			
Functional Value	Cruising makes me happy.	0.707	3.665	18.324	.862
	Cruising suits my taste.	0.671			
	Cruising is fun.	0.644			
	Cruising is comfortable.	0.640			
	Cruises are usually very well organized.	0.597			
	Cruises are a great value for money.	0.595			
	I can get good service while cruising.	0.577			
	Cruising offers high quality services.	0.576			
Social Value	Cruising changes people's perceptions of me.	0.873	3.401	17.007	.879
	Cruising improves my social status.	0.822			
	Cruising allows me to meet people on a similar social level.	0.794			
	Cruising makes people envious of me.	0.787			

3. Cluster Analysis (Market Segmentation) by Travel Value

For market segmentation, cluster analysis was performed using value recognition. The results are shown in Table 3. The first cluster, with a total of 111 people, has the lowest perceived value of all. We refer to this group as the Low Value Perception Group. The second cluster, with a total of 200 participants, has the highest perceived value. We refer to this group as the High Value Perception Group. Finally, the third group, with 79 members, was found to have a high perception of the epistemic value, and a medium perception of the other two values. This last group is called the moderate value perception group.

Table 3. Cluster Analysis by Travel Value

Construct	Cluster 1 (n=111)	Cluster 2 (n=200)	Cluster 3 (n=79)	F	p-value
Epistemic Value	3.3975(L)	4.0965(H)	4.1913(H)	146.016	0.000
Functional Value	3.2883(L)	4.1344(H)	3.7642(M)	156.551	0.000
Social Value	3.2883(L)	4.1344(H)	3.7642(M)	510.437	0.000

Note: Results of Duncan's and Scheffe's tests shown as 'L<M<H'.

4. Comparison of Clusters

To address Research Question 2, a MANOVA analysis was conducted to determine whether the groups differed by travel decision-making stage.

The results of analyzing the differences in preferred information sources for pre-travel information search are shown in Table 4. The low-value perception group (Cluster 1) generally showed a low preference for all information sources, with only the media showing a moderate preference. The high-value group (Cluster 2) has the highest preference for all sources. Finally, the medium-value group (Cluster 3) has a high preference for online information, family, friends, and acquaintances, a low preference for media and travel agencies, and a medium preference for brochures and public institutions.

Table 4. Comparison of Clusters - Information Resources

Construct	Mean Cluster 1 (n=111)	Cluster 2 (n=200)	Cluster 3 (n=79)	F	p-value
Online Information	3.67(L)	3.98(H)	4.09(H)	8.403	0.000
Friends, Relatives, and Other Acquaintances	3.54(L)	4.01(H)	4.09(H)	13.304	0.000
Brochures	3.20(L)	3.66(H)	3.40(LH)	7.252	0.001
Media	3.29(M)	3.67(H)	2.82(L)	27.252	0.000
Travel Agency	3.23(L)	3.66(H)	3.00(L)	18.434	0.000
Public Organization	3.18(L)	3.52(H)	3.30(LH)	4.528	0.011

Note: Results of Duncan's and Scheffe's MR tests shown as 'L<M<H'.

Next, we analyzed differences in preferred planning platforms during the pre-trip planning phase, as shown in Table 5. The low-value perception group (Cluster 1) had the lowest preference for all platforms. The high-value group (Cluster 2) had the highest preference for all platforms. Finally, the medium-value group (Cluster 3) has a high preference for blogs, cruise line websites, travel review sharing sites, and travel price comparison sites, a low preference for mobile applications, travel agency websites, and social commerce, and an intermediate preference for social media.

Table 5. Comparison of Clusters - Travel Planning

Construct	Mean			F	p-value
	Cluster 1 (n=111)	Cluster 2 (n=200)	Cluster 3 (n=79)		
Blog	3.30(L)	3.60(H)	3.71(H)	5.511	0.004
Mobile Application	3.24(L)	3.63(H)	3.43(L)	7.796	0.000
SNS	3.39(L)	3.70(H)	3.48(LH)	4.406	0.013
Travel Agency Webpage	3.28(L)	3.66(H)	3.34(L)	9.247	0.000
Cruise Company Webpage	3.25(L)	3.62(H)	3.53(H)	7.611	0.001
Social Commerce	3.08(L)	3.53(H)	3.19(L)	12.292	0.000
Travel Review Website	3.24(L)	3.71(H)	3.57(H)	8.916	0.000
Travel Price Comparison Website	3.37(L)	3.65(H)	3.63(H)	4.177	0.016

Note: Results of Duncan's and Scheffe's MR tests shown as 'L<M<H'.

Next, we analyzed the differences in platform preference at the travel purchase stage, as shown in Table 6. The low-value perception group (Cluster 1) generally showed a low preference for all platforms, with only a moderate preference for offline booking with cruise lines. The high-value perception group (Cluster 2) generally has the highest preference for all platforms, with only a moderate preference for the cruise line's online booking system. Finally, the medium-value group (Cluster 3) has a high preference for cruise line online booking systems, a low preference for cruise line offline booking and travel agent offline booking, and a medium preference for travel agent online booking and social commerce.

Table 6. Comparison of Clusters - Purchase

Construct	Mean			F	p-value
	Cluster 1 (n=111)	Cluster 2 (n=200)	Cluster 3 (n=79)		
Cruise Company Online System	3.55(L)	3.83(M)	4.09(H)	10.769	0.000
Cruise Company Offine Reservation	2.95(LH)	3.24(H)	2.78(L)	7.397	0.001
Travel Agency Online Reservation	3.25(L)	3.57(H)	3.32(LH)	5.320	0.005
Travel Agency Offine Reservation	3.00(L)	3.34(H)	2.89(L)	8.401	0.000
Social Commerce Website	3.30(L)	3.61(H)	3.42(LH)	4.654	0.010

Note: Results of Duncan's and Scheffe's MR tests shown as 'L<M<H'.

Next, we analyzed the differences in preferred review posting platforms during the post-trip review sharing phase, as shown in Table 7. The low value perception group (Cluster 1) generally showed a low preference for all platforms, with only a moderate preference for social commerce. The high-value group (Cluster 2) has the highest preference for all platforms. Finally, the medium-value group (Cluster 3) has a high preference for social media, cruise line websites, and travel review sites, a low preference for mobile applications, travel agency websites, social commerce, and travel price comparison sites, and a medium preference for blogs.

Table 7. Comparison of Clusters - WoM (Review Sharing)

Construct	Mean			F	p-value
	Cluster 1 (n=111)	Cluster 2 (n=200)	Cluster 3 (n=79)		
Blog	3.04(L)	3.37(H)	3.09(LH)	4.445	0.012
Mobile Application	2.98(L)	3.37(H)	2.86(L)	10.525	0.000
SNS	3.28(L)	3.78(H)	3.61(H)	8.657	0.000
Travel Agency Webpage	2.89(L)	3.30(H)	2.67(L)	14.726	0.000
Cruise Company Webpage	2.86(L)	3.25(H)	2.70(H)	12.086	0.000
Social Commerce	2.88(M)	3.32(H)	2.48(L)	22.357	0.000
Travel Review Website	2.92(L)	3.40(H)	3.03(H)	9,645	0.000
Travel Price Comparison Website	2.94(L)	3.40(H)	2.65(L)	20.255	0.000

Note: Results of Duncan's and Scheffe's MR tests shown as 'L<M<H'.

Finally, we aimed to investigate the differences in demographic characteristics among groups. A comprehensive presentation of the findings is revealed in Table 8. Notably, no statistically significant disparities emerged in terms of gender distribution, educational attainment, or income levels among the clusters. Predominantly, participant composition in each group skewed toward a female majority, individuals possessing at least a bachelor's degree or higher, and an average income bracket ranging from 40~60 million. However, a notable distinction in demographic profiles surfaced with respect to age. Specifically, Clusters 1 and 2 were more likely to be in their 30s and 40s, and Cluster 3 was in their 20s and 30s.

Table 8. Comparison of Clusters - Demographic Characteristics

Construct	Mean			F	p-value
	Cluster 1 (n=111)	Cluster 2 (n=200)	Cluster 3 (n=79)		
Gender	1.36	1.37	1.48	1.845	0.159
Age	2.37(H)	2.37(H)	1.66(L)	13.653	0.000
Education	2.73	2.69	2.85	1.313	0.270
Annual Household Income	3.19	3.00	2.77	2.110	0.123

Note: Results of Duncan's and Scheffe's MR tests shown as 'L<M<H'.

V. Conclusion

The global economy and industries have been transformed by the COVID-19 pandemic. One study found that industries such as accommodation and food, travel, tourism, recreation, leisure, and cultural activities will be hit harder than others. In countries such as South Korea, Japan, and the EU, where self-employment is high, service sector production has declined, and the impact is expected to be significant. In this situation, there is a great need for research on the recovery of the tourism industry, and it is necessary to study tourism at this time of digital transformation (Yoon & Ko, 2022).

This study was conducted to determine how cruise travelers differ in perceptions of value through market segmentation. In particular, we looked at the characteristics of digital travelers, who have changed the way they search for travel information and make online reservations. We analyzed the behavior of digital cruise travelers by identifying the sources of travel information for pre-trip planning and the platforms used to obtain travel information. We also uncovered how they make final purchases online, and the platforms they use to share experiences after a cruise. We also analyzed the value placed on cruise travel, and the differences in decision-making processes. The results revealed the following implications.

First, we were able to categorize three value perceptions and identify the characteristics of each cluster. The three values were significantly categorized as intrinsic value, functional value, and social value, and we divided these into three clusters to examine influence. The first cluster was higher than the second and third clusters, and the functional value was 1<3<2. Social values were clustered in the order of 3<1<2, and the results of clustering by perception of each value was confirmed through the study.

Second, we analyzed the differences in preference

for digital tourism platforms at each decision-making stage of cruise travel by cluster. The results show that the low-value group has a lower preference for digital platforms, and the high-value group has a higher preference for digital platforms in almost all stages of the process. However, the middle-value group has a wide range of preferred platforms in each stage.

To summarize the differences between the groups, here are some highlights.

The low-value group has a low preference for all platforms, but media is a moderate favorite in the pre-trip information-seeking phase. In the purchase phase, they have a slight preference for booking with an offline cruise line, and in the post-trip review phase, they have a moderate preference for social commerce.

The medium-value group has a high preference for online information, family, friends, and acquaintances, and a low preference for the media as an information source. When it comes to the platforms they use to plan, they have a high preference for blogs, cruise line websites, and travel comparison sites, and a low preference for mobile applications and travel agent websites. When it comes to purchasing products, cruise line online booking systems are preferred, while cruise line and travel agency offline reservations are less preferred. In the post-trip review phase, they were more likely to use social media, cruise line websites, and travel review sites, and less likely to use travel agent websites, social commerce, and travel price comparison sites.

The high-value group shows a high preference for all platforms across the board, but a moderate preference for cruise line online booking systems during the product purchase phase.

We also looked at differences in demographics, and found no differences in gender, education, or income, only age. The mid-value group was younger than the other groups, with more people in their 20s and 30s. This is a group with a high perceived value of rarity, which suggests that younger people are new to cruising and value it highly.

The practical implication is that you can capitalize on the fact that people have different platform preferences based on the value they place on travel. For example, the medium-value group is more likely to use blogs and travel comparison sites for pre-planning, which can be taken into account when promoting and branding. In addition, mobile applications and travel agency websites are less preferred, and research should be conducted to understand the reasons for this and find solutions. Therefore, customized marketing communications are needed to suit various target groups (Patchimnan, et al., 2022). Digital training is needed for travel agents so that they can utilize and promote online platforms, and plan and design online travel information with the mindset of a consumer rather than a provider. In addition, policies should be developed for a curriculum to create a digital travel workforce, especially for existing travel agents to develop digital competencies. Through this study, it is possible to understand which platforms travelers utilize according to decision-making processes and differences in travel values, and applying these findings to practical implications will contribute to the leap forward of the travel industry.

There are a number of implications from this study. It is necessary to apply the findings to practice as there are differences in various travel decisions depending on the perceived value of cruise travel. In recent years, the emergence of digital travelers has led to changes in various decision-making methods, and it is necessary to identify the characteristics of the medium and establish marketing strategies that can lead to the final stage of decision-making, which is purchase. The method of obtaining travel information for advance trip planning has also become more digital, and it is necessary to lay the foundation for online purchases rather than the traditional offline approach. In addition, there are many different platforms on which to find information about cruise travel, and it is important to segment and understand which groups prefer which platforms. It is also important to build such a system by identifying the needs of buyers, as they are increasingly willing to make final purchases

online rather than through analog methods such as travel agencies. In addition, there is an increasing desire to share experiences after a cruise, and it is necessary to identify which platforms are used so that sustainable sales can be achieved through follow-up marketing.

In particular, those who recognize the value of cruise travel have a high preference for digital platforms, so it is necessary to utilize various platforms. In addition, the mid-value group has different platform preferences at each stage, so a more customized marketing strategy is needed to attract the mid-value group as effective customers.

This study is different from previous studies (Del Chiappa et al., 2018; Fan et al., 2015) that have focused on market segmentation based on demographic characteristics. In the case of recent digital cruise travelers, we found that behavior varies according to values rather than demographics. Therefore, it is recommended that customers use the platform differently depending on the values they value. In particular, Cluster 3, which recognizes epistemic value highly and the other two values moderately, is younger than the other groups, with an age range of 20s and 30s. This suggests that cruise travel is still new to this age group, and it is necessary to emphasize the novelty of cruise travel to attract younger people.

However, there are some limitations to this study. Since the study was conducted on potential buyers planning a cruise, it was difficult to identify clear behavioral patterns. In future studies, it is necessary to understand the actual decision-making processes of actual cruise travelers and which platforms are used to book, purchase, and share reviews. Another limitation of this study is the lack of relevant research, so we highlighted a few studies that have addressed digital travelers in the cruise field. Furthermore, further segmentation of online platforms could be used to analyze consumer patterns, as this study focused on the most popular platforms. Future studies should explore a wider range of online purchasing outlets that are actually used by digital travelers. Finally, the study could be further segmented to compare the characteristics of each age group, and the differences in demographics could be analyzed to provide a basis for more targeted marketing strategies. As the number of digital travelers increases, the need for easy-to-use platforms that reflect the needs of these consumers will continue to grow and require more detailed research.

References

Aggett, M. (2011). Cruise passengers' complaints: An analysis of online reviews. In P. Gibson, A. Papathanassis & P. Milde (Eds.) *Cruise sector challenges*. Gabler Verlag. https://doi.org/10.1007/978-3-8349-6871-5_9

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

Arthur, P. L., & Van Nuenen, T. (2019). Travel in the digital age. In N. Das & T. Young (Eds.), *The Cambridge history of travel writing* (pp. 504-518). Cambridge University Press.

Bajs, I. P. (2015). Tourist perceived value, relationship to satisfaction, andbehavioral intentions the example of the Croatian tourist destination Dubrovnik. *Journal of Travel Research*, *54*(1), 122-134. https://doi.org/10.1177/0047287513513158

Bosnjak, M., Ajzen, I., & Schmidt, P. (2020). The theory of planned behavior: Selected recent advanced and applications. *Europe's Journal of Psychology*, *16*(3), 352. https://doi.org/10.5964/ejop.v16i3.3107

Beatty, S., Homer, P., & Kahle, L. (1988). Problem with VALS in international marketing research: An example from an application of the empirical mirror technique. *Advances in Consumer Research*, *15*(1), 375-380.

Brejla, P., & Gilbert, D. (2014). An exploratory use of web content analysis to understand cruise tourism services. *International Journal of Tourism Research*, *16*(2), 157-168. https://doi.org/10.1002/jtr.1910

Buhalis, D., & Law, R. (2008). Progress in information technology and tourism management: 20 years on and 10 years after the Internet - The state of eTourism research. *Tourism Management*, *29*(4), 609-623. https://doi.org/10.1016/j.tourman.2008.01.005

Buhalis, D., Papathanassis, A., & Vafeidou, M. (2022). Smart cruising: Smart technology applications and their diffusion in cruise tourism. *Journal of Hospitality and Tourism Technology*, *13*(4), 626-649. https://doi.org/10.1108/JHTT-05-2021-0155

Chi, C. G., & Qu, H. (2008). Examining the structural relationship of destination image, tourist satisfaction and destination loyalty: An integrated approach. *Tourism Management*, *29*(4), 624-636. https://doi.org/10.1016/j.tourman.2007.06.007

CLIA (2015). *Asia cruise trends: 2016 edition*. 5-25. https://meriteollisuus.teknologiateollisuus.fi/sites/meriteollisuus/files/inline-files/Asia%20Cruise%20Trends%202016.pdf

Cronin, J. J., Jr., & Taylor, S. A. (1992). Measuring service quality: A reexamination and extension. *The Journal of Marketing, 56*(3), 55-68. https://doi.org/10.1177/0022242992056003

Cronin, J. J., Jr., Brady, M. K., & Hult, G. T. M. (2000). Assessing the effects of quality, value and customer satisfaction on consumer behavioral intention in service environments. *Journal of Retailing*, *76*(2), 193-218. https://doi.org/10.1016/S0022-4359(00)00028-2

Del Chiappa, G., Lorenzo-Romero, C., & Gallarza, M. (2018). Host community perceptions of cruise tourism in a homeport: A cluster analysis. *Journal of Destination Marketing & Management*, *7*, 170-181. https://doi.org/10.1016/j.jdmm.2016.08.011

Dibb, S. (1998). Market segmentation: Strategies for success. *Marketing Intelligence & Planning*, *16*(7), 394-406. https://doi.org/10.1108/02634509810244390

Dolnicar, S. (2004). Beyond commonsense segmentation: A systematics of segmentation approaches in tourism, *Journal of Travel Research*, *42*(3), 244-250. https://doi.org/10.1177/0047287503258830

Engel, J. F., & Blackwell, R. D. (1995). *Consumer behavior* (4th ed.). Dryden Press.

Fan, D. X., Qiu, H., Hsu, C. H., & Liu, Z. G. (2015). Comparing motivations and intentions of potential cruise passengers from different demographic groups: The case of China. *Journal of China Tourism Research*, *11*(4), 461-480. https://doi.org/10.1177/00472875010390040

Fishbein, M., & Ajzen, I. (2011). *Predicting and changing behavoir: The reasoned action appoach*. Psychology press.

Garay, L., Font, X., & Corrons, A. (2018). Sustainability-oriented innovation in tourism: An analysis based on the decomposed theory of planned behavior. *Journal of Travel Research*, *58*, 622-636. https://doi.org/10.1177/0047287518771215

Gibson, P., & Parkman, R. (2018). *Cruise operations management: Hospitality perspectives*. Routledge.

Goh, E., Ritchie, B., & Wang, J. (2017). Non-compliance in national parks: An extension of the theory of planned behaviour model with pro-environmental values. *Tourism Management*, *59*, 123-127. https://doi.org/10.1016/j.tourman.2016.07.004

Han, H., Lee, S., & Lee, C. K. (2011). Extending the theory of planned behavior: Visa exemptions and the traveller decision-making process. *Tourism Geographies*, *13*(1), 45-74. https://doi.org/10.1080/14616688.2010.529930

Hauseman, A. (2000). A multi-method investigation of motivation in impulse buying behavior. *Journal of Consumer Research*, *17*, 403-419. https://doi.org/10.1108/07363760010341045

Hjalager, A. M., & Jensen, J. M. (2012). A typology of travelers based on their propensity to go online before, during and after the trip. In M. Fuchs, F. Ricci, F. & L. Cantoni (Eds.). *Information and communication technologies technology in tourism 2012* (pp. 96-107). Springer.

Iso-Ahola S., & Weissinger, E. (1987). Leisure and boredom. *Journal of Social and Clinical Psychology*, *5*,

356-364. https://guilfordjournals.com/doi/abs/10.1521/jscp.1987.5.3.356

Kang, S., & Chae, M. (2011). A study on the perceived value and adoption behavior of the Smartphone Application. *Journal of Internet Electronic Commerce Research*, *11*(4), 187-208.

Kim, J., & Chang, Y. H. (2022). The impact of generation Z's consumption values factors on purchase intention in secondhand goods transaction platforms: Based on the mediated effects of trust. *Journal of International Trade & Commerce, 18*(2), 371-386. http://dx.doi.org/10.16980/jitc.18.2.202204.371

Kim, W. M., & Matsubara, E. (2008). Causal relationship among perceives quality, perceived risk, customer satisfaction, company's trust and repurchase intention about fast food in convenience store: A comparative study between Korea and Japan. *Journal of North-east Asian Cultures*, *14*, 265-294.

Lee, I. (2021). The effects of unmanned store selection factors on revisit intention: Focusing on the mediating effect of perceived value. *Journal of International Trade & Commerce, 17*(6), 389-405. https://doi.org/10.16980/jitc.17.6.202112.389

Lee, S. Y., & Kim, Y. G. (2022). The effects of extended technology-based self-service on passenger satisfaction, airport image, and behavioral intention. *Journal of Global Business and Trade*, *18*(5), 59-76. http://dx.doi.org/10.20294/jgbt.2022.18.5.59

Li, H., Ye, Q., & Law, R. (2013). Determinants of customer satisfaction in the hotel industry: An application of online review analysis. *Asia Pacific Journal of Tourism Research*, *18*(7), 784-802. https://doi.org/10.1080/10941665.2012.708351

Liu, Y., Kim, S., & Hwang, J. H. (2022). A study on the influential factors of Chinese consumer curise destination selection. *Journal of International Trade & Commerce, 18*(1), 219-232. http://dx.doi.org/10.16980/jitc.18.1.202202.219

McIntosh, R. W., & Goeldner, C. R. (1995). *Tourism: Principles, practices, philosophies*. John Wiley and Sons.

Mehmetoglu, M., Hines, K., Graumann, C., & Greibrokk, J. (2010). The relationship between personal values and tourism behaviour: A segmentation approach. *Journal of Vacation Marketing*, *16*(1), 17-27. https://doi.org/10.1177/1356766709356210

Michon, R., & Chebat, J. C. (2004). Cross-cultural mall shopping value and habitats: A comparison between English and French spearking Canadians. *Journal of Business Research, 57*, 883-892. https://doi.org/10.1016/S0148-2963(02)00291-6

Molera, L., & Albaladejo. I. P. (2007). Profiling segments of tourists in rural areas of South-Eastern Spain, *Tourism Management*, *28*(3), 757- 767. https://doi.org/10.1016/j.tourman.2006.05.006

Parra-López, E., Bulchand-Gidumal, J., Gutiérrez-Taño, D., & Díaz-Armas, R. (2011). Intentions to use social media in organizing and taking vacation trips. *Computers in Human Behavior*, *27*(2), 640-654. https://doi.org/10.1016/j.chb.2010.05.022

Patchimnan, M., Phankaew, B., & Inson, C. (2022). Integrated marketing communication exposure, attitude, decision-making process and purchasing behavior: A case study of cricket food products in Thailand. *Journal of Global Business and Trade*, *18*(4), 169-181. http://dx.doi.org/10.20294/jgbt.2022.18.4.169

Pencarelli, T. (2020). The digital revolution in the travel and tourism industry. *Information Technology & Tourism*, *22*(3), 455-476. https://doi.org/10.1007/s40558-019-00160-3

Phillips, W., & Jang, S. (2008). Destination image and tourist attitude; *Tourism Analysis*, *13*(4), 401-411.

Ponte, E. B., Carvajal-Trujillo, E., & Escobar-Rodríguez, T. (2015). Influence of trustand perceived value on the intention to purchase travel online: Integratingthe effects of assurance on trust antecedents. *Tourism Management*, *47*, 286-302. https://doi.org/10.1016/j.tourman.2014.10.009

Poria, Y., Butler, R., & Airey, D. (2003), The core of heritage tourism, *Annals of Tourism Research*, *30*(1), 238-254. https://doi.org/10.1016/S0160-7383(02)00064-6

Rhee, H., & Bell, D. R. (2002). The inter-store mobility of supermarket shoppers. *Journal of Retailing*, *78*(4), 225-237. https://doi.org/10.1016/S0022-4359(02)00099-4

Sanchez, J., Callarisa, L. L. J., Rodriguez, R. M., & Moliner, M. A. (2006). Perceived value of the purchase of a tourism product. *Tourism Management*, *27*(3), 394-409. https://doi.org/10.1016/j.tourman.2004.11.007

Sheth, J. N., Newman B. L., & Gross, B. L. (1991). *Consumption values and market choice: Theory and applications*. Cincinnati Ohio College Division on South-Western Publishing Co.

Sparks, B. A., Perkins, H. E., & Buckley, R. (2013). Online travel reviews as persuasive communication: The effects of content type, source, and certification logos on consumer behavior. *Tourism Management*, *39*, 1-9. https://doi.org/10.1016/j.tourman.2013.03.007

Sweeney, J. C., & Soutar, G. N. (2001). Consumer-perceived value: The development of a multiple item scale. *Journal of Retailing*, *77*(2), 203-220. https://doi.org/10.1016/S0022-4359(01)00041-0

Xiang, Z., & Gretzel, U. (2010). Role of social media in online travel information search. *Tourism Management*, *31*(2), 179-188. http://dx.doi.org/10.1016/j.tourman.2009.02.016

Ye, S., Soutar, G. N., Sneddon, J. N., & Lee, J. A. (2017). Personal values and the theory of planned behaviour: A study of values and holiday trade-offs in young adults. *Tourism Management*, *62*, 107-109. https://doi.org/10.1016/j.tourman.2016.12.023

Yoo, K. H., & Gretzel, U. (2009). Comparison of deceptive and truthful travel reviews. *Information and Communication Technologies in Tourism*, 37-47. https://doi.org/10.1007/978-3-211-93971-0_4

Yoon, S. H., & Ko, J. H. (2022). The impact of COVID-19 on the world economy. *Journal of Global Business and Trade*, *18*(2), 79-98. https://doi.org/10.20294/jgbt.2022.18.2.79

Zhang, Z., Ye, Q., Song, H., & Liu, T. (2015). The structure of customer satisfaction with cruise-line services: An empirical investigation based on online word of mouth. *Current Issues in Tourism*, *18*(5), 450-464. https://doi.org/10.1080/13683500.2013.776020

Zhang, Z., & Schmude, J. (2022). Understanding the travel constraints of potential Chinese tourists visiting Germany: Experience from online travel community members. *Journal of China Tourism Research*, *18*(5), 928-945. https://doi.org/10.1080/19388160.2021.1962472

Zeithaml, V. A., & Biter, M. J. (1996). *Service marketing*. McGraw-Hill.

ISSN 1946-5130 (Print), ISSN 2470-4733 (Online)
http://dx.doi.org/10.20294/jgbt.2023.19.5.111

The Journal of Global Business and Trade

Journal of Global Business and Trade

https://www.pfw.edu/jgbt

An Analysis of the Impact of COVID-19 on Logistics Performance: A Case of the Port of Koper*

Young-Kyou Ha[a]**

[a]*Department of International Trade and Logistics, Chung-Ang University, South Korea*

Received 26 July 2023, Revised 3 September 2023, Accepted 5 October 2023

ABSTRACT

Purpose – This study investigates the influence of the shipping market and cycles on the performance of shipping companies. The turmoil caused by COVID-19 significantly impacted the logistics market. In such a volatile context, conventional wisdom does not always apply, especially for regions neglected in analyses. Therefore, this study examines a crucial yet often overlooked region and provides a new perspective in analyzing the shipping market cycle.

Design/Methodology/Approach – This study uses a panel analysis using economic indicators and the shipping index as independent variables and the performance of shipping companies as the dependent variable. A three-stage panel analysis was undertaken to measure the changes post-COVID. In the first stage, a general panel analysis was conducted, and to explore changes post-COVID, a COVID DUMMY variable was created. Finally, through a panel interaction analysis, the impact of the post-COVID shipping index on the performance of shipping companies was identified.

Findings – The analysis revealed that the shipping market cycle changed after COVID-19, and substantial changes occurred before data could confirm them. Furthermore, economic indicators and the Shanghai Containerized Freight Index impacted the performance of shipping companies that contradicted conventional wisdom.

Research Implications – This study argues that understanding the fundamental principles of the shipping market cycle and the less visible aspects is crucial. It provides academic and practical implications by offering a new understanding of business management and opportunities for extending long-term research topics.

Keywords: logistics, penal analysis, shipping market, transportation
JEL Classifications: F40, N70, N74

* *This research was supported by the 4th Educational Training Program for the Shipping, Port and Logistics from the Ministry of Oceans and Fisheries.*
** *E-mail: tender5k@naver.com*
© 2023 International Academy of Global Business and Trade. All rights reserved.

I. Introduction

COVID-19 significantly impacted the world economy and business management, including the shipping market. During COVID-19, the Shanghai Containerized Freight Index (SCFI), a representative shipping index, soared nearly tenfold before plummeting and returning to pre-COVID levels. This rapid increase in freight rates assisted in the operational improvement of shipping logistics companies and influenced their relationships with shippers. However, as we entered the COVID-19 pandemic, the shipping index plummeted; whether it will operate under the same principles as before has been a major interest and research subject in the shipping market (Kim & Ha, 2021; Stephens et al., 2022; Yun & Cho, 2022).

The shipping index, which is generally influenced by demand and supply in the shipping market, was disrupted by the external factor of COVID-19. During COVID-19, logistics companies' influence in the international trade and logistics market increased and widened to highly profitable sectors. These changes in the shipping market had a short-term positive impact on most logistics companies.

Typically, a rise in the shipping index positively impacts logistics companies. However, it remains uncertain whether the surge in profits of major logistics companies and changes in logistics operations have also positively impacted logistics companies that operate primarily from ports that are not high-revenue main ports. Major routes and the regional hubs connecting major routes in the shipping market are crucial. In situations where it is difficult to predict whether the shipping market cycle will move as it did previously, it is crucial to research aspects that have not been extensively studied.

Hence, this study analyzes the impact of COVID-19 on the performance of logistics companies, focusing on Slovenia's Port of Koper, a regional hub in Eastern Europe, with enough data available for empirical analysis.

Although the Port of Koper is not a major port like Shanghai or Hamburg, it is considered an optimal subject for analysis, having its research value as a major hub in Eastern Europe. In addition, as Asian companies' FDI in Europe is expected to increase due to the reorganization of the global supply chain, this is the optimal target for this study.

For the empirical analysis, we chose the SCFI, a shipping index, and economic indicators that could impact the management of shipping companies as independent variables. Additionally, we selected the container ship lead time from Shanghai to Koper, and the financial performance of logistics companies with the Port of Koper as a primary port of call, as dependent variables.

Based on these variables, this study analyzes the impact of major European countries' economic indicators and the shipping index on logistics companies' performance through a three-stage panel analysis. This research is differentiated from studies centered on freight rates during COVID-19 (Jeon, 2021; Munim & Schramm, 2021) or main ports (Baird & Baird, 2006; Nguyen & Woo, 2022) and has significance in that it serves as a starting point for analyzing drastic freight rate increases due to external factors.

II. Literature Review

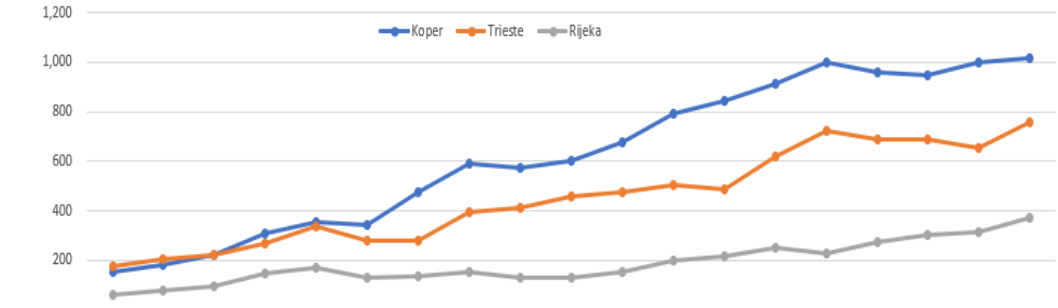
1. Utilization and Importance of the Port of Koper

Located in the Northern Adriatic, the Port of Koper has developed alongside the nearby Port of Venice as a trade port. Despite having a much lower container throughput of 1,017,788 TEUs in 2022 compared to China's Jinzhou Port, a world top 100 container port with 1,830,000 TEUs in 2021, the Port of Koper holds a significance that exceeds any other port. Following the EU accession of Eastern European countries (Czech, Hungary, Slovakia, Slovenia) in May 2004, these nations have become production hubs for global corporations. Consequently, the ports of Slovenia's Koper, Italy's Trieste, and Croatia's Rijeka have emerged as new regional bases (Momirski, 2020;

Ryoo, 2011; Twrdy et al., 2012).

In particular, the Port of Koper has continually increased its investment, setting a long-term target to reach 1,000,000 TEUs by 2020 and 2,000,000 TEUs by 2030. These investments have enhanced the connectivity between land and sea, coinciding with its unique geographical advantages and the growth of its hinterland cities. This led to repeated rapid growth and increased throughput from 153,347 TEUs in 2004 to 1,017,788 TEUs in 2022 (Port of Koper, 2022).

Fig. 1. Changes in Major Port Volume in the Northern Adriatic Sea



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Koper	153	180	219	306	354	343	477	589	571	600	674	791	845	912	998	959	945	998	1,018
Trieste	178	201	221	268	338	277	282	393	411	458	477	501	486	616	725	689	688	652	756
Rijeka	61	76	94	145	169	131	137	151	130	131	150	200	214	250	227	272	304	312	373

Source: Port of Koper (2022).

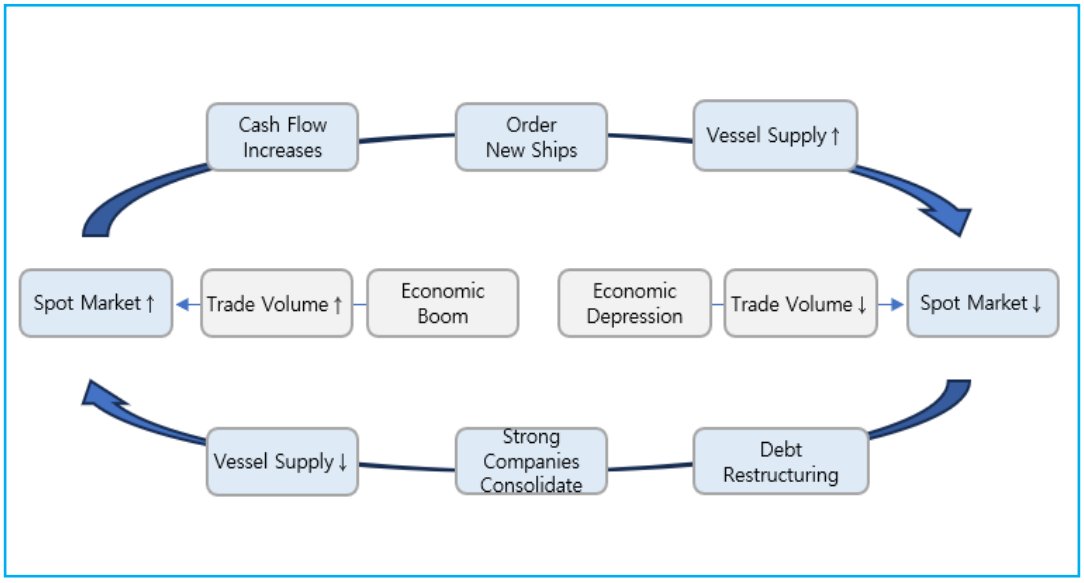
Although it fell short of its target with 945,051 TEUs in 2020, analysts believe it could have exceeded the target if not for COVID-19. Furthermore, recent supply chain competition due to the US-China trade war and efforts for supply chain diversification due to COVID-19 could present new opportunities for the Port of Koper.

2. Characteristics of the Shipping Market and the Impact of COVID-19

The SCFI, which soared to $7,797/TEU (SCFI Europe) in 2022, fell to $763/TEU (SCFI Europe) in the fourth week of June 2023, indicating a temporary recovery of logistics costs and the shipping cycle to pre-COVID levels. Essentially, shipping costs are determined by shipping supply (shipping space) and demand (cargo volume), as explained by Stopford's (2008) shipping market cycle. Stopford (2008) explained that a cycle is formed as the decline in freight rates and the profitability of shipping companies lead to increases and decreases in ships. However, with the increasing influence of external factors such as the bankruptcy of Hanjin Shipping, changes in shipping alliances, and economic recession, corporate management and performance have inevitably been affected, leading to additional studies from new perspectives.

Notably, Kang et al. (2014) and Ha and Woo (2023) claimed that the rise and fall of economic indicators affect the increase and decrease in freight rates, incorporating the COVID-19 situation into Stopford's (2008) shipping market cycle. The combined shipping market cycle resulting from these studies is as follows.

Fig. 2. Shipping Market Cycle



Sources: Reconstructed by the authors referring to Ha and Woo (2023), Kang et al. (2014) and Stopford (2008).

However, the shipping market near coasts and local hubs did not follow the trend proposed by prior studies during COVID-19. This was primarily due to the initial surge in freight costs caused by the imbalance in demand and supply at local ports where data collection was insufficient after the pandemic. The subsequent revelation of this outcome through data occurred only after a time lag. As shipping demand and supply became imbalanced, increases in economic indicators and freight costs no longer guaranteed the performance of logistics companies based on local hubs (Ha, 2022).

Indeed, logistics companies mainly serving local hub ports observed falling profit margins despite rising freight costs and a noticeable increase in lead times. This increase in lead times, a characteristic of a shipping recession, arises when the number of vessels in existing routes is reduced to save fuel costs and develop profitable routes. Furthermore, it is challenging to directly link the rise in the SCFI with the profits of shipping companies that base their operations on local hub ports. The SCFI is primarily based on the main European and US routes.

Researchers have actively tried to overcome these limitations to predict freight costs in the COVID-19 era and shed light on complex factors. Previous research before the pandemic used shipping demand and supply as the main variables (Kang et al., 2014; Munim & Schramm, 2017; Nielsen et al., 2014). However, post-COVID research has used alternative indicators such as GDP, demand index, PPI, inflation index, and shipping company performance metrics like shipping lead time. These studies have made it somewhat feasible to analyze the shipping market's external factors (Bae et al., 2021; Ha & Woo, 2023; Jeon, 2021). On the other hand, studies that use market indexes like the SCFI or the China Containerized Freight Index (CCFI) as single variables for prediction are also actively ongoing (Jeon et al., 2021; Munim, 2022; Munim & Schramm, 2021). Recently, new research perspectives have been associating the shipping index with inflation for forecasting (Carrière-Swallow et al., 2023; Michail et al., 2022).

Table 1. Literature Review

Author	Variables	Method
Nielsen et al. (2014)	SCFI	OLS Regression
Kang et al. (2014)	Oil Price, Vessel Price, Supply and Demand	Panel Analysis
Jeon et al. (2020)	CCFI	ARIMA, SARIMA
Jeon (2021)	SCFI, Supply and Demand, On-time Delivery	System Dynamics
Lee (2021)	Shipping Freight, Supply and Demand, Oil Price	OLS Regression
Bae et al. (2021)	BDI, Supply and Demand, Production Index	Deep Learning
Munim and Schramm (2021)	CCFI	ARIMA
Munim (2022)	CCFI	SARIMA, TBATS
Michail et al.(2022)	Shipping Freight, Inflation Index	VECM
Carrière-Swallow et al. (2023)	Import Price, PPI, Inflation Index	Panel Analysis
Ha and Woo (2023)	GDP, PPI, Demand Index, Invest Index	Panel Analysis

III. Data and Research Model

1. Hypothesis Formulation and Data Collection

This study formulates hypotheses about the post-COVID Asia-Koper route. Numerous studies on this topic have discussed changes in the post-COVID shipping index and market cycle. However, most of these analyses have focused on main routes such as the US and Europe, where the shipping index and shipping company performance have remained relatively stable. As the shipping index increased, many shipping companies experienced improved financial performance and lead times were either maintained or improved. However, for shipping companies operating local and coastal routes, a period was observed where the rise in the shipping index did not lead to financial gains. In some cases, companies faced management difficulties.

This study assumes that the shipping market cycle impacts a company's financial performance and formulated the following hypotheses:

H1: There were changes in the shipping market cycle after COVID-19.

H2: The influencing factors of shipping costs on shipping companies changed after COVID-19.

We selected seven independent variables by referring to previous research on the post-COVID shipping market. The seven independent variables included economic indicators like GDP, demand index, and PPI, which are often mentioned in many studies, and the SCFI, which represents the freight rate. To evaluate the performance of the shipping companies, we selected lead time and financial results as dependent variables.

Table 2. Model Fit Analysis

Variable			Source
Independent Variable	GDP	GDP	OECD Statistics
	Labour Productivity	LPT	
	Invest Forecasting	IFC	
	Demand Forecasting	DFC	
	PPI	PPI	
	Trade In Goods	TIG	
	SCFI	SCF	Shanghai Shipping Exchange
Dependent Variable	Shipping Lead Time		Survey
	Shipping Company Turnover		Survey

The independent variables consist of economic indicators for the 28 quarters before and after COVID-19 (from Q2 2016 to Q1 2023) of the eight main countries (Germany, the Netherlands, Belgium, the UK, France, Spain, Italy, and the rest of the EU) constituting the SCFI, the most reputable shipping index.

2. Research Model

This study performed a three-stage panel analysis to investigate the impact of economic indicators and the shipping index on the performance of shipping companies after COVID-19.

The first analysis is a basic panel analysis conducted with data from 2016 to 2023 with the following formula:

$$Shipping\ Lead\ Time_{it} = \beta_0 + \beta_1(GDP) + \beta_2(LPT) + \beta_3\ (IFC) + \beta_4(DFC) + \beta_5\ (PPI) + \beta_6\ (TIG) + \beta_7\ (SCF) + \mu_{it} \quad (1)$$

$$Shipping\ Company\ Turnover_{it} = \beta_0 + \beta_1(GDP) + \beta_2(LPT) + \beta_3\ (IFC) + \beta_4(DFC) + \beta_5\ (PPI) + \beta_6\ (TIG) + \beta_7\ (SCF) + \mu_{it} \quad (2)$$

Second, to examine changes in the factors influencing performance after COVID-19, we created a COVID-19 dummy variable and analyzed changes in the influencing factors before and after COVID-19. The analysis period was Q2 2016 to Q3 2019 vs. Q4 2019 to Q1 2023.

$$Shipping\ Lead\ Time_{it} = \beta_0 + \beta_1 COVID + \beta_2(GDP) + \beta_3(LPT) + \beta_4(IFC) + \beta_5(DFC) + \beta_6(PPI) + \beta_7(TIG) + \beta_8(SCF) + \mu_{it} \quad (3)$$

$$Shipping\ Company\ Turnover_{it} = \beta_0 + \beta_1 COVID + \beta_2(GDP) + \beta_3(LPT) + \beta_4(IFC) + \beta_5(DFC) + \beta_6(PPI) + \beta_7(TIG) + \beta_8(SCF) + \mu_{it} \quad (4)$$

Finally, a panel interaction term was created and analyzed to examine the impact of the SCFI on shipping performance after COVID-19. In this analysis, the SCFI is the interaction term, and other variables serve as control variables.

$$Shipping\ Lead\ Time_{it} = \beta_0 + \beta_1 COVID + \beta_2(GDP) + \beta_3(LPT) + \beta_4(IFC) + \beta_5(DFC) + \beta_6(PPI) + \beta_7(TIG) + \beta_8(SCF) + \beta_9\, COVID * (SCF) + \mu_{it} \quad (5)$$

$$Shipping\ Company\ Turnover_{it} = \beta_0 + \beta_1 COVID + \beta_2(GDP) + \beta_3(LPT) + \beta_4(IFC) + \beta_5(DFC) + \beta_6(PPI) + \beta_7(TIG) + \beta_8(SCF) + \beta_9\, COVID * (SCF) + \mu_{it} \quad (6)$$

IV. Empirical Analysis

1. Model selection and Descriptive Statistics

This study used panel data constructed on a country-quarter basis. Since this data has both cross-sectional and time-series characteristics, the assumptions about error terms in panel regression analysis could be violated. Therefore, we used a fixed-effects model of the error-component model that can control for heterogeneity in the error term, reducing statistical errors by sequentially performing the F-test, Breusch and Pagan's Lagrangian Multiplier (LM) test, the Likelihood-ratio test, and the Hausman test.

Table 3 shows the results of the F-test, LM test, and Hausman test verification for Model 1 and Model 2. In Model 1, where the dependent variable is the shipping lead time, the F-value was 9.51, with a significant p-value at the 1% significance level. In Model 2, where the dependent variable is the shipping company turnover, the F-value was 1.40, and the p-value was 0.000. These results reject the null hypothesis at the 1% significance level for both Model 1 and Model 2, implying that the fixed-effects model is more efficient than the pooled OLS.

According to Breusch and Pagan's LM test results, Model 1 and Model 2 had p-values of 1.000, indicating that the null hypothesis was accepted. This signifies that the pooled OLS is more efficient than the random-effects model. Subsequently, the Hausman test was conducted to compare the efficiency between the fixed and random-effects models. According to the results in Model 1, where the dependent variable is lead time, chi2 was 147.12, and a significant p-value

was observed at the 1% significance level. In Model 2, where the dependent variable is the shipping company turnover, chi2 was 9.30, and the p-value was 0.000. This means that both Model 1 and Model 2 have more efficient fixed-effects than the random-effects.

Table 3. Model Fit Analysis

	<F Test>		<LM Test>		<Hausman Test>	
	Model1	Model2	Model1	Model2	Model1	Model2
F-Value	9.51	1.40				
Chi2Bar			0.000	0.000		
Chi2					147.12	9.30
P-value	0.000	0.000	1.000	1.000	0.000	0.000
Model	FE	FE	Pooled	Pooled	FE	FE
Model			FE	FE		

This study used panel data from Q2 2016 to Q1 2023. Each quarter includes data for the eight countries, making up balanced panel data. The total sample size is 224 country-years. Table 4 shows the descriptive statistics.

Table 4. Descriptive Statistics

Variable	N	Mean	Std.Dev	Min	Median	Max
GDP	224	4.124444	10.20141	-42.6	3.6	66.9
LPT	224	1.001597	0.025871	0.812	1.002	1.063
IFC	224	2.415197	15.5361	-58.3	1.5	154.9
DFC	224	2.304508	15.62037	-64.2	1.8	160.5
PPI	224	107.701	10.33842	92.9	104.4	157
TIG	224	0.480634	6.123427	-29.1	0	35.4
SCF	224	7.113445	0.7507395	6.035916	6.844815	8.937875
Shipping Lead Time	224	27.66667	3.264361	26	26	38
Shipping Company Turnover	224	9.593629	0.1973295	8.928243	9.62192	9.921278

2. Panel Analysis

2.1. First Stage of Panel Analysis

The first stage of panel analysis involves evaluating the data from 2016 to 2023. In the results of this analysis, principles of the shipping market cycle based on demand and supply, as proposed by Kang et al. (2014) and Stopford (2008) were observed through GDP, investment forecasting, and PPI. GDP had a significant positive impact on shipping company turnover at a significance level of 10%. Investment forecasting had a significant negative impact of 0.021 on shipping lead time and a significant positive impact of 0.002 on shipping company turnover at a significance level of 5%. Moreover, PPI had a significant positive impact on shipping company turnover at a 1% significance level.

Stopford (2008) claimed that an increase in cash flow leads to an excess supply of vessels due to investments by shipping companies, which in turn depresses the spot market. Therefore, increased investment results in a temporary decrease in shipping lead time due to increased vessel supply. This aligns with the logic that an increase in major countries' GDP and productivity (PPI) could increase freight volume, thereby contributing to shipping company turnover. These results allow for an analysis of the general aspects of the traditional shipping market cycle. However, they are insufficient for considering the exceptional circumstances presented by COVID-19. It was particularly challenging to find correlations between economic indicators and shipping index and business performance, the subject of this research. Therefore, in the second stage of the analysis, we create a COVID-19 dummy variable to examine changes in the relationships between variables before and after the pandemic.

Table 5. Empirical Analysis

Variable		Shipping Lead Time	Shipping Company Turnover
GDP	GDP	0.035 (1.860)	0.004* (2.355)
Labour Productivity	LPT	3.185 (0.882)	2.940** (3.421)
Invest Forecasting	IFC	-0.021** (-2.103)	0.002** (2.635)
Demand Forecasting	DFC	0.007 (0.909)	-0.000 (-0.498)
PPI	PPI	0.214 (20.303)	0.006*** (5.856)
Trade In Goods	TIG	-0.029 (-1.373)	-0.002 (-0.955)
SCFI	SCF	1.364 (10.533)	-0.023 (-3.748)
N		224	224
R-sq		0.842	0.285

Note: ***p<0.01, **p<0.05, *p<0.1.

2.2. Second Stage of Panel Analysis

In the second stage of panel analysis, we compared the performance of the 14 quarters before (Q2 2016 to Q3 2019) and after (Q4 2019 to Q1 2023) the pandemic. The analysis revealed that traditional cycle correlations could be found in PPI with investment forecasting and shipping company turnover as dependent variables, though their influence was weaker. However, different results were observed in PPI with demand forecasting and shipping lead time as dependent variables. Demand forecasting had a significant negative impact of 0.001 on shipping company turnover at a 10% significance level. On the other hand, PPI had a significant positive impact of 0.207 on shipping lead time at a 5% significance level. Demand forecasting and PPI refer to production or shipping volume. In other words, although the shipping volume increased, the shipping company's profitability decreased or lead time increased, which means that the shipping company's performance deteriorated.

The results for SCFI showed a strong opposite trend from the traditional shipping market cycle. SCFI had a significant positive impact of 1.274 on shipping lead time and a significant negative impact of 0.084 on shipping company turnover, both at a 1% significance level. This suggests the emergence of a paradox with an increase in delay and deterioration in profits despite an upswing in the spot market.

Table 6. Empirical Analysis

Variable		Shipping Lead Time	Shipping Company Turnover
COVID Dummy	CVD	1.148*** (3.337)	-0.308*** (-5.977)
GDP	GDP	0.023 (0.928)	0.001 (0.655)
Labour Productivity	LPT	1.958 (0.382)	1.650 (1.833)
Invest Forecasting	IFC	-0.022* (-1.835)	-0.000 (-0.249)
Demand Forecasting	DFC	0.007 (0.413)	-0.001* (-2.106)
PPI	PPI	0.207*** (15.720)	0.012** (5.599)
Trade In Goods	TIG	-0.009 (-0.339)	0.004 (1.783)
SCFI	SCF	1.274*** (7.408)	-0.084*** (-6.890)
N		224	224
R-sq		0.884	0.507

Note: ***p<0.01, **p<0.05, *p<0.1.

2.3. Third Stage of Panel Analysis

In the shipping market cycle, the shipping index is one of the most important factors influencing a shipping company's operations. Therefore, in the third stage of panel analysis, an interaction term was generated between the independent variable, SCFI, and the COVID-19 dummy variable to assess the impact of SCFI on a shipping company's performance during the pandemic. The analysis revealed that SCFI had the same impact as in the second stage of panel analysis. Under the COVID-19 pandemic, SCFI had a significant positive impact of 1.665 on shipping lead time at a 10% significance level and a significant negative impact of 0.193 on shipping company turnover at a 1% significance level.

Table 7. Empirical Analysis

Variable		Shipping Lead Time	Shipping Company Turnover
COVID Dummy	CVD	-10.053 (-1.528)	0.989*** (6.304)
SCFI	SCF	-0.341 (-0.354)	0.271*** (13.424)
COVID Dummy * SCFI	CDS	1.665* (1.705)	-0.193*** (-9.165)
GDP	GDP	0.018 (0.758)	0.001 (0.875)
Labour Productivity	LPT	1.577 (0.309)	0.031 (0.974)
Invest Forecasting	IFC	-0.022* (-1.879)	-0.000 (-0.153)
Demand Forecasting	DFC	0.010 (0.559)	-0.002* (-2.399)
PPI	PPI	0.208*** (15.853)	0.012*** (5.586)
Trade In Goods	TIG	-0.006 (-0.211)	0.004 (1.591)
N		224	224
R-sq		0.886	0.513

Note: ***p<0.01, **p<0.05, *p<0.1.

V. Conclusions

1. Summary of the Results

This study effectively analyzes key regional hubs in the disintegrating and increasingly chaotic shipping market cycle. However, this analysis was difficult to conduct using traditional research approaches. The findings of this study are significant as they advance the primary areas of study on the shipping market cycle. Understanding these results creates the potential for new perspectives in analyzing the shipping market cycle. The conclusions of this study are as follows.

First, the shipping market cycle experienced significant changes due to the COVID-19 pandemic, with notable shifts in the Asia-Koper route. Usually, when the shipping index rises, the vessel supply increases, reducing the shipping lead time and boosting the profitability of shipping companies. However, the performance in the Asia-Koper route following the pandemic showed a trend opposite to traditional theory. This can be attributed to several factors, including decreased cargo volume due to COVID-19, delays caused by port congestion or closures, departures of joint venture partners, and strategies like slow steaming or blank sailing for economic navigation (Ben, 2009; Woo, 2014; Ha, 2022).

Second, changes in shipping costs also affected the performance of shipping companies. Port congestion and closures due to the pandemic temporarily reduced vessel supply and caused transportation delays. This worsened the profitability of shipping companies and exacerbated the transportation situation in unprofitable routes, as vessel supply had to be redirected from them to profitable routes. Notable responses from shipping companies to improve profitability under these circumstances included slow steaming and blank sailing, which in turn further reduced vessel supply and caused additional transportation delays, creating a vicious cycle.

However, it would be unreasonable to determine, based on this analysis, that the SCFI fluctuations during the pandemic are inversely proportional to the profitability of shipping companies. Generally, the SCFI is proportional to a shipping company's profitability. The analysis also showed that these two indicators moved in proportion over a long period, and the sharp decrease in shipping company profitability immediately after the COVID-19 outbreak led to such results.

2. Implications and Limitations

This study argues that understanding the fundamental principles of the shipping market cycle and the less visible aspects is crucial. It takes several quarters for data within the shipping market cycle to emerge. The study is significant because it emphasizes the importance of researching these unseen areas and offers topics for subsequent studies. It also suggests the reasons for the deterioration of shipping company performance, such as port congestion, slow steaming, and blank sailing. Each of these causes could serve as a potential research topic. Finally, Eastern Europe is a region that many Asian companies are considering to be an FDI hub, given the rapid changes and restructuring of global supply chains. The analysis of Eastern Europe's shipping market in this study can provide policy implications for companies considering European FDI. Thus, this study provides academic and practical implications by offering a new understanding of business management and opportunities for extending long-term research topics.

The limitations of this study are as follows. Additional analysis is required regarding shipping company turnover. Historically, the economy, shipping index, and shipping company turnover have demonstrated a moderate and prolonged proportional relationship. However, there were short periods of drastic fluctuations in both the shipping index and shipping company turnover. During these periods, despite the rise in the SCFI, certain sectors exhibited significant negative impacts on profitability. Shipping companies

naturally faced challenges in some regions due to operational difficulties, city lockdowns, and port congestion, even during the rise in the shipping index. However, based on this, it is unreasonable to claim that the SCFI and profitability were inversely proportional. Therefore, additional research is required on the financial status and profit structure of individual shipping companies during COVID-19. This is expected to constitute another meaningful study in shipping market research.

References

Bae, S. H., Lee, G. W., & Park, K. S. (2021). A baltic dry index prediction using deep learning models. *Journal of Korea Trade, 25*(4), 17-36. https://doi.org/10.35611/jkt.2021.25.4.17

Baird, A. J., & Baird, A. (2006). Optimizing the container transshipment hub location in northern Europe. *Journal of Transport Geography*, 14, 95-213. https://doi.org/10.1016/j.jtrangeo.2004.12.004

Ben, N. D. (2009). *Impact of high fuel costs on the shipping industry and the world trade, Cardiff university conference: The globalization and its implications for shipping in the 21st century.* Cardiff University.

Carrière-Swallow. Y., Deb. P., Fureceri. D., & Jiménez. D. (2023). Shipping costs and inflation. *Journal of International Money and Finance*, *130*, 1-36. https://doi.org/10.1016/j.jimonfin.2022.102771

Ha, Y. K. (2022). A study on the effect of economic indicators on container freight rates. *Korea Trade Review*, *47*(1), 13-24.

Ha, Y. K., & Woo, S. H. (2023). Causes and prospects of SCFI Fluctuations during the COVID Period. *Journal of International Trade & Commerce*, *19*(2), 161-174.

Jeon, J. W. (2021). Shanghai containerized freight index prediction considering the COVID-19. *Journal of Shipping and Logistics*, *37*(30), 517-536.

Jeon, J. W., Duru, O., & Yeo, G. T. (2020). Modelling cyclic container freight index using system dynamics. *Maritime Policy & Management*, *47*(3), 287-303. https://doi.org/10.1080/03088839.2019.1708984

Kang, H. W., Kim, W. H., & Lee, Y. S. (2014). An empirical analysis on the determinants of the liner freight rate. *Korea Trade Review*, *29*(5), 46-65.

Kim, Y. J., & Ha, B. C. (2021). An analysis on the forward and backward industrial linkage structure of Korean maritime transportation industry. *Journal of International Trade & Commerce*, *17*(3), 509-528.

Lee, S. Y. (2021). Analysis of factors affecting the determination of freight rates for container ships in the global shipping market. *Journal of International Trade & Commerce, 17*(5), 631-643.

Michail, N., Melas, K. D., & Cleanthous, L. (2022). The relationship between shipping freight rates and inflation in the Euro area. *International Economics*, *172*, 40-49. https://dx.doi.org/10.2139/ssrn.4012154

Momirski, L. A. (2000). The resilience of the port cities of Trieste, Rijeka, and Koper. *Journal of Urban History*, *47*(2), 293-316. https://doi.org/10.1177/0096144220926600

Munim, Z. H. (2022). State-space TBATS model for container freight rate forecasting with improved accuracy. *Maritime Transport Research*, *3*, 1-14. https://doi.org/10.1016/j.martra.2022.100057

Munim, Z. H., & Schramm, H. J. (2017). Forecasting container shipping freight rates for the far East-northern Europe trade lane. *Maritime Economics & Logistics*, *19*, 106-125. https://doi.org/10.1057/s41278-016-0051-7

Munim, Z. H., & Schramm, H. J. (2021). Forecasting container freight rate for major trade route: A comparison of artificial neural networks and conventional models. *Maritime Economics & Logistics*, *23*, 310-327. https://doi.org/10.1057/s41278-020-00156-5

Nguyen, P. N., & Woo, S. H. (2022). Port connectivity and competition among container ports in Southeast Asia based on social network analysis and TOPSIS. *Maritime Policy & Management, 49*(6), 779-796. https://doi.org/10.1080/03088839.2021.1908637

Niesen, P., Jiang, L., Rytter, N. G. M., & Chen, G. (2014). An investigation of forecast horizon and observation fit's influence on an econometric rate forecast model in the liner shipping industry. *Maritime Policy & Management*, *41*(7), 667-682. https://doi.org/10.1080/03088839.2014.960499

Port of Koper (2022). *Annual and sustainability report.* https://www.luka-kp.si/en/investors/annual-reports/

Ryoo, J. H. (2011). Samsung electronics' foreign market entry strategy: The case of lcd business in Eastern Europe. *Korea Business Review, 15*(3), 71-111.

Stopford, M. (2008). *Maritime economics* (3rd ed.). Routledge.

Stephens, A. R., Robb, C. A., & Kang, M. H. (2022). A comparative study of Korean and U.S. firms amid COVID-19 supply chain disruptions: The role of relational capital for improving ambidextrous innovation and firm performance. *Journal of Global Business and Trade*, *18*(5), 77-100.

Twrdy, E., Trupac, I., & Kolenc, J. (2012). Container boom in the port of Koper. *Traffic & Transportation*, *24*(2), 169-175. https://doi.org/10.7307/ptt.v24i2.289

Woo, J. K. (2014). The effects of slow steaming on the liners' operating strategy. *Journal of Korean Navigation and Port Reserch*, *38*(6), 567-575.

Yun, H. S., & Cho, S. S. (2022). The effect of vessel employment types on the cash flow volatility of shipping companies. *Journal of International Trade & Commerce*, *18*(5), 159-174.

ISSN 1946-5130 (Print), ISSN 2470-4733 (Online)
http://dx.doi.org/10.20294/jgbt.2023.19.5.125

The Journal of Global Business and Trade

Journal of Global Business and Trade

https://www.pfw.edu/jgbt

A Study on the Digital Trade Transaction Paradigm of Middle-Aged and Senior Citizens in Korea: The Mediating Effect of E-commerce Usage Level

Hyuk Kwon[a]*

[a]*School of Liberal Arts for Students Growth, Joongbu University, South Korea*

Received 11 July 2023, Revised 15 August 2023, Accepted 5 October 2023

ABSTRACT

Purpose – The paradigm of digital transactions is gradually changing as the elderly surfers are attracting attention as a new consumption group, but there is a lack of research on the relationship between digital transformation awareness, digital economic activity, and the mediating effect of e-commerce usage level among the elderly in Korea. The purpose of this study is to predict the change in the digital paradigm of the Middle-Aged and elderly in Korea, and to consider what efforts should be made by individuals, companies, and governments in the digital age.

Design/Methodology/Approach – A total of 2,300 questionnaire data from 547 individuals in their 50s, 957 in their 60s, and 796 in their 70s and above were collected from September to December of 2020 and analyzed using SPSS 29.0, and a mediation effect analysis was conducted using Process Macro Model 4 to test the mediating effect of e-commerce usage level.

Findings – First, it was analyzed that digital transformation awareness, social capital, and digital self-efficacy all have a positive effect on e-commerce usage level and life satisfaction. Second, social capital has no significant effect on digital economic activities. Third, e-commerce usage level plays a mediating role when digital transformation awareness and social capital affect life satisfaction.

Research Implications – The practical implications of this study are that digital transformation awareness, social capital, and digital self-efficacy can be further enhanced by increasing the level of e-commerce use by the elderly in real life, which will increase their digital economic activity and life satisfaction.

Keywords: digital economic activity, digital trade, digital transformation awareness, e-commerce, life satisfaction
JEL Classifications: E10, F40, F44, L81, L86

* *E-mail: khjb0830@joongbu.ac.kr*
© 2023 International Academy of Global Business and Trade. All rights reserved.

I. Introduction

Due to environmental changes such as COVID-19 and the digital transition, there has been an increase in O2O sales through e-commerce. Consequently, the Korean government has stated that it should expand e-commerce export support policies, primarily for small and medium-sized enterprises (Choi, 2022; Kim & Choi, 2021). Additionally, industries related to digital technology are rapidly growing recently (Han, 2021). However, it has been noticed that the digital divide for the elderly, a marginalized group, is leading to digital inequality due to individual digital information gaps. This is because the information gap is not just a matter of convenience but can lead to economic and social inequality. This is why it is constantly pointed out that measures to resolve the information gap are necessary are rapidly progressing. In particular, the damage caused by the information gap is becoming more pronounced as the transition to a non-face-to-face, digital society is accelerating after COVID-19. Currently, Japan, Germany, Italy, South Korea, Spain, and Poland are among countries with severe aging in the world, and in Germany, the purchasing power of seniors is steadily increasing due to stable old-age pensions, and smart seniors proficient in operating IT devices are attracting attention as an important consumer group that can easily purchase expensive products based on their relatively strong economic power, and make good use of online marketplaces such as Amazon, Real, and Conrad (KOTRA, 2021).

Although the elderly are generally considered to be digitally vulnerable, even among the same group, there are differences in income and digital attitudes, more and more elderly are using online shopping malls such as Amazon, and the number of users of direct overseas purchases is increasing. Therefore, the paradigm of digital trade transactions is changing as silver surfers are emerging as a new buying group in countries with rapidly aging populations. In particular, as the level of e-commerce usage increases globally, countries that are about to enter, or are already in the process of aging, are analyzing the barriers to e-commerce usage by the elderly, as well as their motivations and behavioral characteristics. Spain is a country with an aging population that is more substantial than Korea, and the Spanish government is currently taking measures to cope with advanced old age, such as implementing health measures for the elderly, establishing the National Agency for the Elderly as an independent department within the government ministry for support, and proposing a welfare corporation for the vulnerable. According to a study on the use of e-commerce by the elderly in Spain, 11 types of user characteristics were observed in a survey of 405 elderly people between the ages of 60 and 70 that use e-commerce to shop, and it was analyzed that elderly people well-versed in digital technology are more likely to purchase online, but have low trust in product quality due to the nature of online transactions where they cannot see, touch, and buy products in person. Elderly not well versed in digital technology have low levels of e-commerce use due to various barriers (Mónica et al., 2022).

Meanwhile, Malaysia, which has recently begun to age, is expected to become an aging society in 2022, and the use of e-commerce by the elderly is expected to gradually increase, so the Malaysian government is making efforts to increase the ICT capabilities of the elderly by developing an e-commerce platform customized for the elderly. In particular, focus group interviews were conducted to identify factors that should be prioritized when using e-commerce for the elderly. It was found that online cybersecurity awareness training should be conducted first (Tan et al., 2021). Despite this paradigm shift in the level of e-commerce platform usage among the elderly, there is a lack of research on the mediating role of e-commerce usage on digital competencies, such as digital transformation awareness, social capital, and digital self-efficacy in influencing digital economic activity and life satisfaction among the Korean elderly. The purpose of this study is to analyze the relationship

between the digital characteristics and digital performance of elderly Koreans to predict changes in the digital paradigm, and to consider the efforts to be made by individuals, companies, and governments in the digital age.

II. Literature Review

1. Digital Transformation Awareness, Social Capital, Digital Self-Efficacy, and E-Commerce Usage Level

Similarly, population aging is a global trend, and is the inevitable result of a demographic transition to longevity and small families. Consensus is being formed that a system for a smart elderly care industry must be established (Huang & Hong, 2022). The recent development of the Fourth Industrial Revolution has accelerated digital transformation and raised expectations for growth through digital technologies. However, it is necessary to recognize that the application of new technologies is a change factor that triggers both new opportunities and crises in society. These innovations can also have serious side effects, such as enhancing existing risks in our society, or creating new ones. Examples include poor information security, data monopolization, lack of government legislation, lack of social consensus on digital technologies, and digital inequality for vulnerable populations. This is why individuals, businesses, and governments need to weigh the benefits and risks of digital technologies. The subjective perception of the riskiness of a given situation is generally defined as the psychology of feeling more at risk when an event feels uncontrollable, or its cause is unknown (Kim, 1994). As such, how individuals, businesses, and governments perceive digital transformation will be important. Meanwhile, social capital refers to a set of social assets, such as shared institutions, norms, networks, and trust, that enable people to cooperate, with social trust at the core of social capital. Specifically, it includes family members and professionals, such as having someone to feel comfortable talking to about intimate, personal matters, and having someone who can help solve different problems (Van Deursen et al., 2014). Self-efficacy can be defined as a person's level of confidence and attitude when faced with new skills on digital devices. When analyzing how digital social capital and digital self-efficacy affect the level of e-commerce utilization, it was found that the digital social capital of the young, middle-aged, and elderly did not significantly affect the level of e-commerce utilization, while the digital self-efficacy of young, middle-aged, and elderly people significantly affected the level of e-commerce utilization (Kwon, 2022). In addition, the higher the digital self-efficacy, the higher the level of e-commerce utilization. However, among social capital, family has no significant effect on e-commerce utilization (Ko, 2021). Although previous studies have shown that higher digital self-efficacy positively affects the level of e-commerce utilization, there are differences in social capital by class, and there is still a lack of research on the relationship between digital transformation awareness and e-commerce utilization. On the other hand, the higher the level of e-commerce usage across all ages in Korea, the better the digital economic activity and life satisfaction. In general, the more people that use e-commerce, the more they will search for information that helps increase income and acquire knowledge. In addition, it is believed that this result is due to the fact that marketing activities necessary for employment, job change, and start-up are possible through the Internet (Kwon, 2023). Therefore, this study synthesized the previous literature review to understand how digital transformation awareness, social capital, and digital self-efficacy affect the level of e-commerce use among the elderly, and set the following research hypotheses to find how the level of e-commerce use among the elderly affects digital economic activities and life satisfaction.

H1a: Middle-aged & elderly perceptions of digital transition will have a positive (+) influence on the E-Commerce Usage Level.

H1b: Middle-aged & elderly social capital will have a positive (+) influence on the E-Commerce Usage Level.

H1c: Middle-aged & elderly digital self-efficacy will have a positive (+) influence on the E-Commerce Usage Level.

H2a: Middle-aged & elderly levels of e-commerce usage will have a positive (+) influence on digital economic activities.

H2b: Middle-aged & elderly levels of e-commerce usage will have a positive (+) influence on life satisfaction.

2. Mediating Effects of Digital Competence on Digital Economic Activity, Life Satisfaction, and E-Commerce Usage Levels

Upon understanding the impact of COVID-19 on the global economy, it has been analyzed that the income of the service industry has generally decreased, and the GDP of all countries has contracted (Yoon & Ko, 2022). Korea has realized the importance of digital transformation awareness through the COVID-19 pandemic. Through digital technology, the process of collecting and analyzing information on confirmed cases has been automated, and the medical treatment system has been digitized by applying AI technology to improve efficiency. If individuals are unable to utilize digital technology, they will not only be inconvenienced in their daily lives but may also be put at a disadvantage. As the pace of digital transformation accelerates, there is a need to be more vigilant and risk-aware. Risk perception can be categorized into social, psychological, and physical risks, as well as risks from epidemics and natural disasters (Peter & Tarpey, 1975), and efforts should be made to improve digital capabilities so that none are excluded and all can benefit. In addition, the quality of digital literacy should be improved, including critical thinking skills to search for reliable information, communication skills to communicate respectfully online, and civil society skills to volunteer and engage in digital economy activities. A recent study analyzed how digital social capital and digital literacy affect digital economic activity among South Koreans, and it was found that digital social capital had no significant effect on digital economic activity, but higher digital literacy had a positive effect on digital economic activity. It can be interpreted that higher attitudes toward adapting to new digital technologies and products have a significant impact on entrepreneurial activities as well as increased income through the Internet. The higher the digital social capital and usage attitudes, the better the life satisfaction. Therefore, it is necessary for the government to expand education on how to use digital devices, individuals be willing to actively learn digital technologies, and for companies to improve technical skills on personal information security (Kwon, 2023). A study of all ages in South Korea also found that a higher level of digital social capital positively affected life satisfaction (Jun, 2020). As the digital economy is being integrated into everyday life, shopping, education, health, employment, and start-ups are being linked to digital economic activities, and digital transformation is gaining attention as an important factor affecting life satisfaction. As the digital transformation will continue to accelerate in the future, companies need to invest in solutions and adapt organizational culture, and individuals need to increase digital social capital, digital self-efficacy, and change perceptions of digital transformation. Therefore, it is believed that the level of digital economic activity and life satisfaction will increase when the government, companies, and individuals work together. In addition, recent studies on e-commerce-related mediating effects have observed the relationship between perceived consumer value or risk perception in the relationship between service quality and price sensitivity to e-commerce (Shim & Kim, 2020). In other words, there are only studies that have provided meaningful

implications for companies by identifying factors that affect the price sensitivity that consumers feel when using e-commerce, but there are no studies on the mediating role of the level of e-commerce usage on the relationship between digital transformation awareness, social capital, digital self-efficacy, and digital economic activity and life satisfaction. Therefore, this study synthesized previous literature to identify how digital transformation awareness, social capital, and digital self-efficacy affect digital economic activity and life satisfaction among the elderly. Additionally, how to identify the mediating role of e-commerce usage level in the relationship between digital transformation awareness, social capital, and digital self-efficacy and digital economic activity and life satisfaction among the elderly was examined, and the following research hypotheses were set.

H3a: Middle-aged & elderly perceptions of the digital transition will have a positive (+) influence on digital economic activities.
H3b: Middle -aged & elderly social capital will have a positive (+) influence on digital economic activities.
H3c: Middle -aged & elderly digital self-efficacy will have a positive (+) influence on digital economic activities.

H4a: Middle -aged & elderly's perception of digital transition will have a positive (+) influence on life satisfaction.
H4b: Middle -aged & elderly social capital will have a positive (+) influence on life satisfaction.
H4c: Middle -aged & elderly digital self-efficacy will have a positive (+) influence on life satisfaction.

H5a: The level of e-commerce usage will mediate the influence of elderly perceptions of the digital transition on digital economic activities.
H5b: The level of e-commerce usage will mediate the influence of elderly social capital on digital economic activities.
H5c: The level of e-commerce usage will mediate the influence of elderly digital self-efficacy on digital economic activities.

H6a: The level of e-commerce usage will mediate the influence of middle-aged & elderly perceptions of the digital transition on life satisfaction.
H6b: The level of e-commerce usage will mediate the influence of middle-aged & elderly social capital on life satisfaction.
H6c: The level of e-commerce usage will mediate the influence of middle-aged & elderly digital self-efficacy on life satisfaction.

III. Methodology

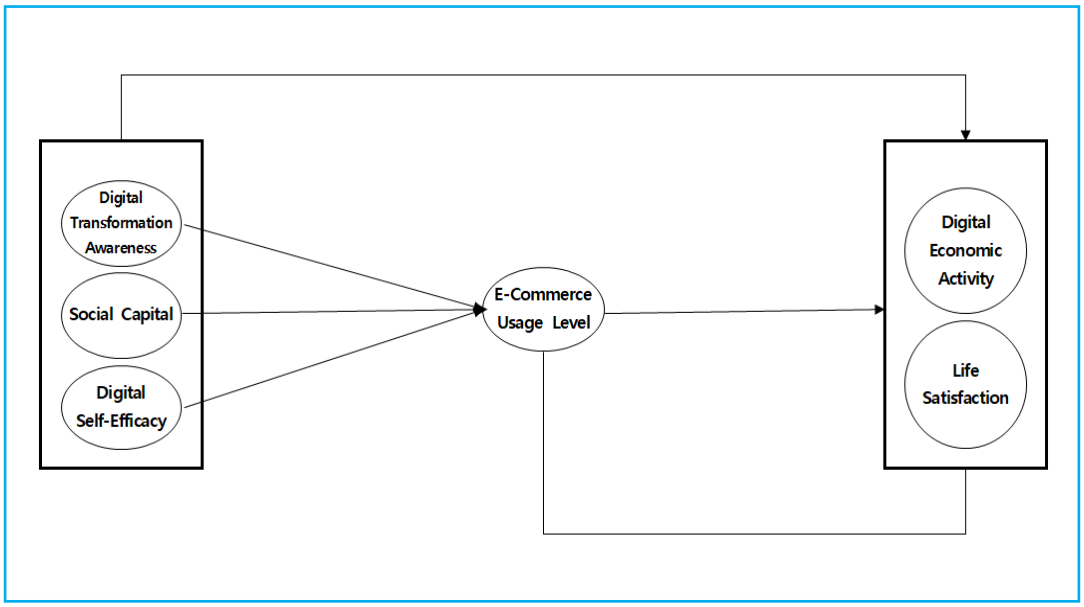
1. Research Model

For this study, digital transformation awareness, social capital, and digital self-efficacy were set as independent variables, and digital economic activity and life satisfaction were set as dependent variables. In addition, the level of e-commerce usage was set as a parameter to analyze the related literature, and the following research model was set, as shown in Fig. 1.

2. Operational Definition

First, the independent variables, digital transformation awareness with five questions, social capital with five questions, and digital self-efficacy with four questions, were defined operationally to test the research model. Second, the dependent variable, digital economic activity, consists of four questions, and life satisfaction had four questions. Third, the parameter, e-commerce usage level, consisted of three questions. Specifically, digital transformation awareness consisted of the perception of whether digital technology has become more important

Fig. 1. Research Model



in life, the worry that lack of digital skills will make daily life difficult in the future, the degree of awareness of the digital transformation, and the impact of the digital transformation on life. Social capital consisted of whether or not people can help solve my problems, whether or not I have people I can ask for advice, whether or not I feel comfortable talking to them about personal matters, and whether or not I have people I can entrust with important tasks. Digital self-efficacy was measured as confidence in learning and using digital devices, the ability to quickly figure out how to use new digital devices, and the intention to use digital devices. Digital economic activities consisted of whether or not the respondent has ever used the Internet to find a job or change jobs, whether or not the respondent has ever used the Internet to perform marketing activities to help start a business, search for information to help increase income, or make direct purchases abroad. Life satisfaction was composed of satisfaction with current life, happiness, and so on, and e-commerce usage level was composed of shopping, booking, and reservations on Naver Shopping, Coupang, and Auction, as well as internet banking, securities trading, transfer, remittance, and various life information services to identify the level of usage of e-commerce services or financial transaction services.

3. Data Collection and Analysis Method

This study was conducted by the Korea Agency for the Advancement of Intelligence and Information Society and by Kantar Korea to understand the extent to which Koreans are bridging the digital information gap. From September to December of 2020, a total of 2,300 survey data from 547 individuals in their 50s, 957 in their 60s, and 796 in their 70s and older were collected and analyzed via SPSS 29.0 . In addition, to verify the mediating effect of e-commerce usage level on digital transformation awareness, social capital, and digital self-efficacy on digital economic activity and life satisfaction, the analysis was conducted using SPSS's Process Macro Model 4.

IV. Research Results

1. Demographic Characteristics

Among the demographic characteristics of the study sample, gender showed a response rate with 1,072 males (46.6%) and 1,228 females (53.4%). In terms of age, 547 respondents were in their 50s (23.8%), 957 respondents were in their 60s (41.6%), and 796 respondents were in their 70s or older (34.6%). 1,183 respondents were high school graduates (51.5%), and the detailed demographic characteristics are shown in Table 1.

Table 1. Demographic Characteristics

Division	Item	Frequency(n)	Proportion(%)
Gender	Male	1,080	49.1
	Female	1,120	50.9
Age	Fifties	547	23.8
	Sixties	957	41.6
	Over seventy	796	34.6
Education Level	Elementary graduate and below	321	14.0
	Middle school graduate	474	20.6
	High school graduate	1,183	51.5
	College graduate or higher	321	14.0
Occupation	Agriculture/fisheries	71	3.1
	Service/sales jobs	548	23.8
	Production-related jobs	402	17.5
	Professional management/office jobs	157	6.8
	Housewife	755	32.8
	Unemployed/others	366	15.9

2. Research Model Test

An exploratory factor analysis was conducted to test the research model designed in this study, and as a result, the validity of digital transformation awareness, social capital, digital self-efficacy, e-commerce usage level, digital economic activity, and life satisfaction were all secured. Reliability was analyzed at .854 for digital transformation awareness, .963 for social capital, .992 for digital self-efficacy, .840 for e-commerce usage level, .791 for digital economic activity, and .949 for life satisfaction, all of which are above the acceptable standard values, and the detailed results are shown in Table 2.

Table 2. Factor and Reliability Analysis

Factor	Item						Cronbach's α	Accumulated (%)
	1	2	3	4	5	6		
Digital Transformation Awareness	.673	.068	.072	.098	.136	.088	.854	12.773
	.499	.047	.488	.127	-.061	.095		
	.549	.026	.226	.125	.011	-.012		
	.600	.098	.347	.029	.084	.196		
	.749	-.007	-.018	-.015	.036	-.041		
Social Capital	.077	.686	.098	.139	.032	.029	.963	25.240
	.035	.683	.020	.074	.155	.042		
	-.036	.677	.015	.064	.058	.048		
	.038	.714	.066	.144	-.005	.028		
	.007	.679	.112	.100	-.016	.066		
Digital Self-Efficacy	.096	.167	.836	.121	.130	.008	.922	36.412
	.092	.216	.793	.105	.173	.113		
	.068	.195	.823	.043	.075	.106		
	.088	.132	.700	.138	.173	.062		
E-Commerce Usage Level	-.068	.066	.037	.802	.078	.130	.840	46.187
	.274	.028	.069	.724	.067	.050		
	.194	.249	.100	.797	.087	.005		
Digital Economic Activity	.098	.070	.012	.045	.884	.066	.791	54.007
	.068	.070	.023	.026	.906	.073		
	.072	.021	.045	.110	.885	.022		
	.088	.042	.042	.123	.867	.028		
Life Satisfaction	.036	.199	.095	-.038	.053	.765	.949	61.782
	.037	.167	.105	.008	.118	.723		
	.051	.092	.127	.126	.044	.696		
	.033	.083	.186	.123	.063	.681		
KMO and Bartlett test of sphericity test	KMO						.875	
	Chi-square						20510.150	
	df(p)						325	
	Significance Probability						.000	

3. Correlation Analysis

Pearson correlation analysis was conducted to analyze the interrelatedness of the variables. As a result, it was confirmed that there is a significant correlation between the independent variables of digital transformation awareness, social capital, and digital self-efficacy, and a significant correlation between digital transformation awareness, social capital, and digital self-efficacy and e-commerce usage level, digital economic activity, and life satisfaction, and the detailed analysis results as follows in Table 3.

Table 3. Correlation Analysis Results

Division	Average	Standard Deviation	Digital Transformation Awareness	Social Capital	Digital Self-Efficacy	E-Commerce Usage Level	Digital Economic Activity	Life Satisfaction
Digital Transformation Awareness	14.88	3.43	1					
Social Capital	14.46	2.49	.205**	1				
Digital Self-Efficacy	8.71	2.83	.474**	.271**	1			
E-Commerce Usage Level	7.18	2.47	.259**	.198**	.425**	1		
Digital Economic Activity	5.30	2.43	.160**	.089**	.221**	.275**	1	
Life Satisfaction	12.67	2.57	.280**	.339**	.203**	.203**	.139**	1

Note: **The correlation coefficient is significant at the 0.01 level (two-tailed).

4. Hypothesis Verification Results

As a result of analyzing how digital transformation awareness, social capital, and digital self-efficacy affect the level of e-commerce usage among the elderly, it was analyzed that digital transformation awareness, social capital, and digital self-efficacy have a positive (+) effect on the level of e-commerce usage, and Hypothesis 1-1, Hypothesis 1-2, and Hypothesis 1-3 were adopted.

After analyzing the influence of e-commerce usage level on the digital economic activity and life satisfaction of the elderly, it was analyzed that e-commerce usage level has a positive (+) influence on digital economic activity and life satisfaction, so Hypothesis 2-1 and Hypothesis 2-2 were accepted.

Table 4. Digital Transformation Awareness, Social Capital, Digital Self-Efficacy, and E-Commerce Usage level

Model	Standardized Regression Coefficient		Standardized Coefficients	t	p	95.0% confidence interval for B		Collinearity Statistic	
	B	SE	β			Supremum	Infimum	tolerance	VIF
(constant)	1.462	0.379		3.859	0.000	0.719	2.205		
A	0.075	0.018	0.094	4.213	0.000	0.040	0.110	0.827	1.209
B	0.103	0.022	0.096	4.576	0.000	0.059	0.147	0.937	1.067
C	0.334	0.021	0.364	16.103	0.000	0.293	0.375	0.804	1.244

A: Digital Transformation Awareness, B: Social Capital, C: Digital Self-Efficacy

-subordination variable: E-Commerce Usage Level(D)

Table 5. E-Commerce Usage Level and Digital Economic Activity and Life Satisfaction

Model	Standardized Regression Coefficient		Standardized Coefficients	t	p	95.0% confidence interval for B		Collinearity Statistic	
	B	SE	β			Supremum	Infimum	tolerance	VIF
(Constant)	3.359	0.162		20.699	0.000	3.041	3.678		
A	0.271	0.021	0.275	12.661	0.000	0.229	0.313	1.000	1.000
A: E-Commerce Usage Level, subordination variable: Digital Economic Activity(E)									
(Constant)	11.345	0.171		66.294	0.000	11.009	11.681		
B	0.206	0.023	0.203	9.144	0.000	0.162	0.250	1.000	1.000
A: E-Commerce Usage Level, subordination variable: Life Satisfaction(F)									

After analyzing how digital transformation awareness, social capital, and digital self-efficacy affect the digital economic activities of the elderly, Hypothesis 3-1 and Hypothesis 3-3 were adopted because it was analyzed that digital transformation awareness and digital self-efficacy had a positive (+) effect on digital economic activities. Hypothesis 3-2 was rejected because the social capital of the elderly did not have a positive (+) effect on digital economic activities.

Table 6. Digital Transformation Awareness, Social Capital, Digital Self-Efficacy, and Digital Economic Activity

Model	Standardized Regression Coefficient		Standardized Coefficients	t	p	95.0% confidence interval for B		Collinearity Statistic	
	B	SE	β			Supremum	Infimum	tolerance	VIF
(constant)	2.337	0.404		5.782	0.000	1.545	3.130		
A	0.064	0.019	0.081	3.355	0.001	0.026	0.101	0.827	1.209
B	0.034	0.024	0.032	1.418	0.156	-0.013	0.081	0.937	1.067
C	0.163	0.022	0.180	7.351	0.000	0.119	0.206	0.804	1.244

A: Digital Transformation Awareness, B: Social Capital, C: Digital Self-Efficacy

-subordination variable: Digital Economic Activity(E)

After analyzing how digital transformation awareness, social capital, and digital self-efficacy affect life satisfaction among the elderly, it was analyzed that digital transformation awareness, social capital, and digital self-efficacy have a positive effect on life satisfaction, so Hypothesis 4-1, Hypothesis 4-2, and Hypothesis 4-3 were accepted.

Table 7. Digital Transformation Awareness, Social Capital, Digital Self-Efficacy, and Life Satisfaction

Model	Standardized Regression Coefficient		Standardized Coefficients	t	p	95.0% confidence interval for B		Collinearity Statistic	
	B	SE	β			Supremum	Infimum	tolerance	VIF
(constant)	5.727	0.316		18.121	0.000	5.107	6.347		
A	0.065	0.016	0.086	4.137	0.000	0.034	0.095	0.769	1.300
B	0.246	0.020	0.238	12.468	0.000	0.207	0.285	0.919	1.088
C	0.278	0.019	0.307	14.472	0.000	0.240	0.316	0.744	1.344

A: Digital Transformation Awareness, B: Social Capital, C: Digital Self-Efficacy

-subordination variable: Life Satisfaction(F)

Bootstrapping was conducted to verify the statistical significance of the mediating role of e-commerce usage level on digital transformation awareness, social capital, and digital self-efficacy in influencing digital economic activities. First, we identified the mediating effect of e-commerce usage level on the digital transformation awareness on digital economic activities, the number of resampled samples was 5,000, and the mediation coefficient was .0509. As shown in Table 8, the lower and upper limits of the confidence interval of the mediation coefficient were .0402 and .0624, respectively, and the mediation effect was analyzed as statistically significant because the interval did not contain zero. Second, the mediation effect of e-commerce usage level on social capital's impact on digital economic activities was found to be .0562. The lower and upper limits of the confidence interval of the mediation coefficient were .0422 and .0719, respectively, and the mediation effect was found to be statistically significant because the interval does not contain zero. Third, the mediation effect of e-commerce usage level on digital self-efficacy was found to be .0849. The lower and upper limits of the confidence interval of the mediation coefficient were .0672 and .1040, respectively, and the mediation effect was analyzed to be statistically significant because the interval did not contain zero.

Table 8. Mediation Effect of E-Commerce Usage Level I

Route	Effect	se(Boot)	t	p	LLCI(Boot)	ULCI(Boot)	Effects
A1 → E1	.1258	.0175	7.18	.0000	.0915	.1601	T/E
A1 → E1	.0749	.0176	4.25	.0000	.0404	.1093	D/E
A1→ D1→ E1	.0509	.0057	-	-	.0402	.0624	I/E
B1 → E1	.0939	.0238	3.94	.0001	.0472	.1405	T/E
B1 → E1	.0377	.0234	1.61	.0173	-.0082	.0836	D/E
B1→D1 → E1	.0562	.0076	-	-	.0422	.0719	I/E
C1 → E1	.1996	.0199	10.02	.0000	.1606	.2387	T/E
C1 → E1	.1147	.0215	5.32	.0000	.0725	.1570	D/E
C1→D1 → E1	.0849	.0094	-	-	.0672	.1040	I/E

Bootstrapping was conducted to verify the statistical significance of the mediating role of e-commerce usage level on life satisfaction between digital transformation awareness, social capital, and digital self-efficacy. First, the mediating effect of e-commerce usage level on the effect of digital transformation awareness on life satisfaction was identified, the number of re-sampled samples was 5,000, and the mediation coefficient was .0306. As shown in Table 9, the lower and upper limits of the confidence interval of the mediation coefficient were .0207 and .0411, respectively, and the mediation effect was found to be statistically significant because the interval did not contain zero. Second, the mediation effect of e-commerce usage level on life satisfaction of social capital was.0315. The lower and upper limits of the confidence interval of the mediation

coefficient were .0211 and .0435, respectively, and the mediation effect was analyzed as statistically significant because the interval does not contain zero. Third, the mediation effect of e-commerce usage level on digital self-efficacy on life satisfaction was.0136, and the lower and upper limits of the confidence interval of the mediation effect coefficient were -.0038 and .0304, respectively, and the mediation effect was found to be statistically insignificant because the interval does not contain zero.

Table 9. Mediation Effect of E-Commerce Usage Level II

Route	Effect	se(Boot)	t	p	LLCI(Boot)	ULCI(Boot)	Effects
A1 → F1	.2100	.0177	11.83	.0000	.1752	.2447	T/E
A1 → F1	.1794	.0182	9.87	.0000	.1438	.2150	D/E
A1→D1 → F1	.0306	.0053	-	-	.0207	.0411	I/E
B1 → F1	.3462	.0234	14.77	.0000	.3003	.3922	T/E
B1 → F1	.3147	.0236	13.30	.0000	.2683	.3611	D/E
B1→D1 → F1	.0315	.0058	-	-	.0211	.0435	I/E
C1 → F1	.3836	.0193	19.90	.0000	.3458	.4214	T/E
C1 → F1	.3701	.0213	17.38	.0000	.3283	.4118	D/E
C1→D1 → F1	.0136	.0088	-	-	-.0038	.0304	I/E

V. Conclusion

As the digital transformation accelerates around the world with the development of the Fourth Industrial Revolution, expectations for growth through digital technologies are growing. However, it is necessary to recognize that the application of new technologies is a change factor that triggers both new opportunities and crises in society. These innovations can also have serious side effects, reinforcing existing risks in society or creating new ones. For individuals, a digital information gap may appear, and for enterprises, this could lead to digital innovation or a failure in digital transformation (Jung et al., 2022). Recently, it has been pointed out that the digital information gap is leading to the marginalization of the elderly, and it is constantly pointed out that measures to close the information gap are necessary because the information gap is not just a matter of convenience, it can lead to economic and social inequality. However, it should be noted that in the case of Germany, which has a severe aging population, the purchasing power of seniors is steadily increasing due to stable old-age pensions, and smart seniors proficient in operating IT devices are attracting attention as an important consumer group that can easily purchase expensive products based on relatively strong economic power, making good use of online marketplaces such as Amazon, Real, and Conrad (KOTRA, 2021). Although the paradigm of digital trade is gradually changing with the emergence of the middle-aged and elderly as a new consumer group in digital trade transactions, there is a lack of research on the mediating role of

e-commerce usage level on digital competencies such as digital transformation awareness, social capital, and digital self-efficacy in influencing digital economic activity and the life satisfaction of the Korean middle-aged and elderly. This study aimed to analyze the relationship between the digital characteristics and digital performance of the middle-aged and elderly in Korea to predict changes in the digital paradigm, and to consider the efforts to be made by individuals, companies, and governments in the era of digital transformation. The main findings of this study are as follows. First, it was analyzed that digital transformation awareness, social capital, and digital self-efficacy had a positive (+) effect on the level of e-commerce usage among the middle-aged & elderly. It can be interpreted that the more the middle-aged & elderly perceive the digital transformation to be a new opportunity, the higher the level of e-commerce use, as digital technology is becoming more important and the digital transformation brings many changes to economic activities. In addition, it has been shown that seniors that are good at using digital technology are more likely to use Internet purchases and online shopping, but have low trust in product quality due to the nature of online transactions where they cannot see, touch, and buy products in person. Seniors that are not good at using digital technology have low levels of e-commerce use due to various barriers (Mónica et al., 2022). Governments and local governments will need to develop e-commerce tailored to the middle-aged & elderly, establish various human resource support processes, and build the confidence of the elderly in using and adapting to digital devices. Second, e-commerce usage level, digital transformation awareness, and digital self-efficacy had a positive (+) effect on digital economic activity, while social capital had no significant effect on digital economic activity. Malaysia, which has recently begun to age, is expected to become an aging society in 2022, and e-commerce usage among the elderly is gradually increasing, Malaysian government authorities are making efforts to increase the ICT capabilities of the elderly by developing e-commerce platforms tailored to them (Tan et al., 2021). Therefore, it is necessary to increase the level of e-commerce usage among the elderly, increase digital transformation awareness and digital self-efficacy, and propose that digital learning centers be expanded and operated for specific elderly groups that are not adapted to the digital environment. Further, digital device experience zones where the elderly can practice own should be operated in areas where the elderly are concentrated. In addition, as the types of monetary transaction fraud for the elderly, who are digitally vulnerable, are diversifying and the number of damage cases is increasing, specific countermeasures should be taken, such as establishing guidelines on the types of digital damage cases and countermeasures. Third, the level of e-commerce usage, digital transformation awareness, social capital, and digital self-efficacy were all analyzed to have a positive (+) effect on life satisfaction. As the digital economy has been integrated into everyday life, shopping, education, health, employment, and entrepreneurship have been linked to digital economic activities, and digital transformation is gaining attention as an important factor affecting life satisfaction. As the digital transformation will continue to accelerate in the future, companies need to invest in solutions and adapt organizational culture, and individuals need to increase digital social capital, digital self-efficacy, and change perceptions of the digital transformation. Therefore, it is believed that the combined efforts of the government, companies, and individuals will increase the level of digital economic activity and improve life satisfaction. Fourth, we found that the level of e-commerce usage plays a mediating role when digital transformation awareness, social capital, and digital self-efficacy affect digital economic activity. Next, the level of e-commerce usage was analyzed to mediate the effect of digital transformation awareness, social capital, and digital self-efficacy on life satisfaction, but the level of e-commerce usage was not analyzed to mediate the effect of digital self-efficacy on life

satisfaction. The practical implication of this study is that if we can go beyond the perception and understanding of digital transformation awareness, social capital, and digital self-efficacy and concretize them, as well as increase the level of e-commerce use by the elderly in real life, we can further increase digital economic activity and life satisfaction. However, this study has a number of value limitations in that it is an initial study on the e-commerce paradigm of the elderly in Korea, and only identified the level of awareness and capability of digital transformation awareness, social capital, and digital self-efficacy. As a follow-up study, it would be more reliable to conduct a comparative study by categorizing the elderly in the age groups of the 50s, 60s, 70s, and above.

References

Choi, S. B. (2022). The O2O commerce situation and research of consumers' purchasing pattern in O2O commerce in Korea. *Journal of International Trade & Commerce*, *18*(1), 453-471. http://dx.doi.org/10.16980/jitc.18.1.202202.453

Han, K. J. (2021). An estimation of the qualitative trade competitiveness of Korea relative to China in IT industries. *Journal of International Trade & Commerce*, *17*(1), 369-388. http://dx.doi.org/10.16980/jitc.17.1.202102.369

Huang, C., & Hong, S. H. (2022). SEM based study on the influencing factors of the integration of China's smart elderly care industry chain. *Journal of Global Business and Trade*, *18*(4), 107-122. http://dx.doi.org/10.20294/jgbt.2022.18.4.107

Jun, D. S. (2020). The impact of online and offline social capital on life satisfaction. *Journal of Korean Association For Regional Information Society*, *23*(2), 1-30.

Jung, J. S., Liu, H. F., & Han, J. (2022). The effect of self-efficacy of small business start-ups in Korea and China on startup performance: Focusing on the mediating effect of startup intention and the moderating effect of digital transformation. *Journal of Global Business and Trade*, *18*(6), 1-18. http://dx.doi.org/10.20294/jgbt.2022.18.6.1

Kim, W. (1994). Fear control and danger control: A test of the extended parallel process model (EPPM). *Communication Monographs*, *61*(2), 113-134. http://dx.doi.org/10.1080/03637759409376328

Kim, Y. S., & Choi, J. W. (2021). An empirical study on the performance of the government's e-commerce export support programs. *Journal of International Trade & Commerce*, *17*(3), 167-188. http://dx.doi.org/10.16980/jitc.17.3.202106.167

Ko, J. H. (2021). A study on factors affecting the qualitative use of information by the elderly: Focusing on the use of digital supporters. *Korean Public Management Review*, *35*(3), 23-46. http://dx.doi.org/10.24210/kapm.2021.35.3.002

KOTRA (2021, June 25). Germany, aim for the 'Silver surfer'. *Korea Trade News*. https://www.weeklytrade.co.kr/news/view.html?section=1&category=136&item=&no=74064

Kwon, H. (2022). Analysis of factors affecting digital information competency and e-commerce utilization level: Focusing on young people, middle aged, senior citizen. *The e-Business Studies*, *23(*6), 41-57.

Kwon, H. (2023). The effect of e-commerce use level, social capital, usage attitude on digital utilization performance. *International Commerce and Information Review*, *25*(1), 3-22.

Mónica, V. A., Marilé, P. J., & Carlos, Q. G. (2022). E-commerce, social media and social inclusion: A typology of users over 60 years of age in Spain. *Communication & Society, 35*(3), 141-154. http://dx.doi.org/10.15581/003.35.3.141-154

Paton, D., Smith, L., & Johnston, D. (2005). When good intentions turns bad: Promoting natural hazard

preparedness. *Australian Journal of Emergency Management*, *20*(1), 25-30.

Peter, J. P., & Tarpey, L. X. (1975). A comparative analysis of three consumer decision strategies. *Journal of Consumer Research, 2*(1), 29-37.

Shim, J. H., & Kim, J. H. (2020). A study on the mediating effect of perceived value and risk perception of e-commerce in COVID-19. *International Commerce and Information Review, 22*(3), 307-323. http://dx.doi.org/10.15798/kaici.2020.22.3.307

Tan, S. L., Vergara, R. G., Khan, N., & Khan, S. (2021). Senior citizen activity centre e-commerce and cybersecurity: The way ahead to IR 4.0. *F1000 Research, 10*, 1-11.

Van Deursen, A. J. A. M., Van Dijk, J. A. G. M., & Ten Klooster, P. M. (2014). Increasing inequalities in what we do online: A longitudinal cross sectional analysis of internet activities among the Dutch population (2010 to 2013) over gender, age, education. *Telematics and Informatics, 32*(2), 259-272. http://dx.doi.org/10.1016/j.tele.2014.09.003

Yoon, S. H., & Ko, J. H. (2022). The impact of COVID-19 on the world economy. *Journal of Global Business and Trade, 18*(2), 79-98. http://dx.doi.org/10.20294/jgbt.2022.18.2.79

The Journal of Global Business and Trade

ISSN 1946-5130 (Print), ISSN 2470-4733 (Online)
http://dx.doi.org/10.20294/jgbt.2023.19.5.141

Journal of Global Business and Trade

https://www.pfw.edu/jgbt

Determinants of Switching Behavior of New Energy Vehicles in China: Evidence from Subjective Norms

Jingwen Wu[a], Menghua Li[b], Sok-Tae Kim[c]*

[abc]*Department of International Trade, Dongguk University, South Korea*

Received 7 August 2023, Revised 15 September 2023, Accepted 5 October 2023

ABSTRACT

Purpose – This study investigates the determinants of the switching behavior of new energy vehicles in China. With the help of the Theory of Planned Behavior (TPB) and technology acceptance model (TAM), the moderating effect of subjective norms is discussed.

Design/Methodology/Approach – We develop and test conceptual models using data collected from 240 respondents in China. Then, SPSS 25.0, AMOS 21.0, PROCESS v3.3, and SmartPLS 4.0.9.2 were used for empirical tests.

Findings – The results show that perceived risk has a significant negative impact on switching intention, while perceived value and perceived ease of use have a significant positive impact on switching intention. Switching intention has a significant positive impact on user switching behavior. In addition, social identity has a positive correlation effect on attitude toward switching. Moreover, subjective norms have a moderating effect on the relationship between perceived risk, social identity, perceived value, perceived ease of use, and switching intention.

Research Implications – The theoretical significance of this study lies in the technology acceptance model (TAM), theory of planned behavior (TPB), and the theory of perceived risk, perceived value, and social identity are introduced into the model to expand the model. Its practical significance is to provide feasible suggestions for the new energy automobile industry to meet user expectations, playing a guiding and reference role for the subsequent rise of renewable energy cars, and promoting the outlawing of fuel-powered autos and the sustainable development of renewable energy vehicles.

Keywords: moderating effect of subjective norms, new energy vehicle, switching behavior
JEL Classifications: M30, M31, O30

* *Corresponding Author, Email address: ted7@dongguk.edu*
© 2023 International Academy of Global Business and Trade. All rights reserved.

I. Introduction

In recent years, greenhouse gas (GHG) emissions are to blame for severe worldwide changes in the climate, as well as the melting of the icecaps, and this is receiving more and more attention (Yong et al., 2015). Driven by the urgent need to mitigate climate change, reducing carbon emissions has become a major environmental challenge faced by the global economy (Irfan & Ahmad, 2021), and more importantly, transportation alone makes up 25% of the world's total greenhouse gas production (Bonsu, 2020). Based on this, the European Commission (2011) set a target to cut transportation-related greenhouse gas emissions by 60% by 2050 (Peters & Dütschke, 2014). At the same time, electric vehicles may change the various aspects of transportation, including cost, maintenance, and driving habits. Electric vehicles are also receiving higher attention in the economic sector based on economic and high-performance advantages compared to gasoline vehicles (Crabtree, 2019). A "green" vehicle is defined as one kinder to the environment than a conventional internal combustion engine powered by petroleum, including HEVs, Plug ln, EVs, and any other non-traditional vehicles (Situ, 2009). Therefore, new energy vehicles (NEVs) are being gradually promoted as an energy-efficient transportation innovation, and they are considered a successful means of implementing an environmentally friendly, low-carbon system of transportation (Hohenberger et al., 2016; Holland et al., 2016; Luna et al., 2020; Zhou et al., 2013).

Since 2009, China has been the world's number-one country in terms of vehicle sales (Ou et al., 2019), and the global economy, energy market, and greenhouse gas production are all affected by the growth of the Chinese renewable energy vehicle market (Huo et al., 2012). China has adopted a variety of laws that encourage the development of alternative energy cars since 2010. The development of vehicles powered by alternative energy was identified as a key subject for the national future growth plan in 2016, after being listed as a strategically important sector in 2012, and new energy vehicles are a significant sector identified in China's Industry 2025 agenda (Li et al., 2018). Meanwhile, governments have also put in place several successful policies to encourage the growth of electric automobiles. India pursues NEMMP (National Electric Mobility Mission Plan) and FAME (Faster Adoption and Manufacture of EVs), which are expected to achieve a 100% new energy vehicle transition by 2030. A number of countries, including France, Norway, and Denmark, have put in place financial incentive programs that have lowered the price at which electric vehicles are purchased (Robison & Nath, 2010). However, China is currently experiencing a "hot policy" but "cold market" conundrum concerning electric automobiles (Li et al., 2016), In China, there will be 13.1 million new energy cars by the end of 2022, making up just 4.10% of the country's automobiles (Chinese Battery industry, 2023). This phenomenon is not unique to the Chinese market (Li et al., 2016); in several industrialized nations, including the United States, new energy vehicles accounted for 7%, 9% in Korea, and in Japan, only 2% (Wallstreetcn, 2022).

The theory of planned behavior and the model of technology acceptance have been flourishing in different research fields since introduction. Davis first proposed the technology acceptance model in 1989. Explaining the process of the user acceptance of information technology from the aspects of Perceived Usefulness, Perceived Ease of Use, Attitude, and Behavior Intention (Davis, 1989), the technology acceptance model holds that system use is determined by behavioral intention, which is jointly determined by the attitude toward using and perceived usefulness (Davis et al., 1989). This theory has gradually become the mainstream theoretical model in the field of information technology to study user information system acceptance. Proposed by Ajzen in 1991, planned action theory is the successor to the rational action theory, and it includes five main factors: attitude, subjective norms, perceived behavior control, behavior intention, and behavior.

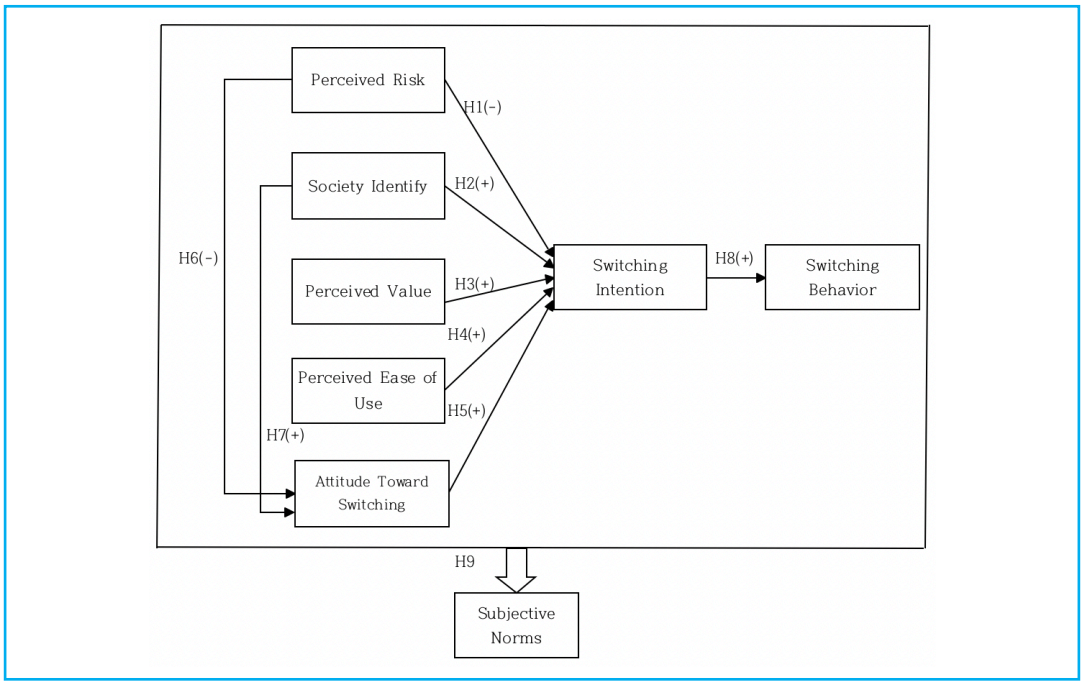
Planned action theory holds that human behavior is not voluntary, but controlled, and that human behavior is the result of deliberate planning. Any factor that may influence behavior is the expression of behavioral intention that indirectly influences behavior (Ajzen, 1991). Based on this, the study will make empirical analysis with the help of planned behavior theory (TPB) and the technology acceptance model (TAM).

The majority of current research focuses on how policies affect customer acceptance of alternative fuel vehicles, and only a few studies have been conducted on customer switching behavior to alternative fuel vehicles. Although empirical studies on driving the consumer acceptance of new energy products have begun (Menon et al, 1999; Oliver & Rosen, 2010), a comprehensive framework of influence factors and empirical validation for new energy cars and the alternative to fuel vehicles still need to be refined (Petschnig et al., 2014). China is the fastest-growing country in terms of alternative fuel vehicle users (Wu et al., 2018), and in 2022, China again became the leader (IEA, 2023). This study will examine consumer willingness to buy new energy vehicles, using the Chinese market as the primary market. Consumers are the main recipients of government policies (Krupa et al., 2014), and consumers have a major role in determining whether or not new energy vehicles are widely accepted (Rezvani et al., 2015). Therefore, studying the determinants of switching behavior to new energy vehicles will help government departments, car operators, manufacturers, and other relevant enterprises and departments to formulate relevant policies and market operation strategies on the promotion of electric cars to accelerate the process of switching fuel vehicles to new energy vehicles.

II. Literature Review

The research model of this study is as follows.

Fig. 1. Research Model



1. Effect of Perceived Risk on Switching Intention

Perceived risk (PR) refers to the perceived unpredictable nature of the result when a novel technology or service is adopted (Bauer, 1964; Nicolaou & McKnight, 2006). Perceived risk is strongly subjective and can influence an individual's final decision if such behavior is perceived as risky. In Joo and Hwang's (2021) study, perceived risk was subdivided into financial risk, privacy risk, time risk, performance , and psychological risk. Many researchers currently correlate perceived risk with the psychological activities of consumers during the purchase process (Chen et al., 2023). Choi and Ji (2015) suggested that the more risks perceived by individuals, the more they tend to reduce purchase intention. Several prior studies have shown that consumer personal risk perceptions can negatively affect the acceptance of adopting novel technologies (Bearth & Siegrist, 2016; Jing et al., 2019). PR usually affects decision-making connected to the change, postponement, or purchase orders cancellation by consumers. Furthermore, it has a large impact on whether or not customers intend to purchase an electric car (Kamal et al., 2020). This study is conducted on electric cars and consumer perceptions of risk in terms of the reliability and performance of alternative fuel vehicles (Featherman et al., 2021). Vafaei-Zadeh et al. (2022) demonstrated that perceived risk adversely affected the desire to buy new energy vehicles in a study conducted for the Malaysian market. It has also been shown in studies related to purchase intention for NEVs that multiple dimensions of perceived risk have an adverse influence on vehicle purchase intention (Featherman et al., 2021; Wang et al., 2018). Concerns about performance safety, operational difficulty, convenience, and some other factors will influence customer choice of new energy vehicles. Thus, the hypothesis is as follows:

H1: Perceived risk has a negative effect on switching intention.

2. Effect of Social Identity on Switching Intention

Turner et al. (1979) proposed social identity theory, in which people define the concept of self through their association with social groups or organizations. Generally, consumers will be attracted to products or brands that incorporate the characteristics of their social identity (Forehand et al., 2002; Smith et al., 1956). Social identity theory suggests that individuals prefer to align individually with the values and beliefs of the group when a particular social identity is significant (Fielding et al., 2008). Therefore, the degree to which individuals identify with different social groups may have an impact on their actions (Bagozzi & Dholakia, 2006). Fielding et al. (2008) discovered that the subjective norms of those that strongly identified with the group were linked positively with intention. Based on research on electric car adoption, there is a growing perception consumers are more likely to adopt electric vehicles if doing so positively influences their social status (Noppers et al., 2014). The hypothesis below embodies this concept.

H2: Social identity positively affects switching intention.

3. Effect of Perceived Value on Switching Intention

Comprehensive consumer evaluation of product effectiveness is based on weighing pros and cons, defined as the perceived value (Zeithaml, 1988). After the proposed customer's perceived value, significant research has been conducted on the dimensional measurement (Sweeney & Soutar, 2001). Parasuraman and Grewal (2000) split perceived value into functional value, price factor, and service value. Sheth et al. (1991) divided perceived value into five types: functional value, cognitive value, conditional value, affective value, and social value. Lee (2021) research validates the central role of perceived value. Therefore, perceived

value is applied in this paper to investigate the impact of perceived value on purchase-switching willingness. Purchase intentions are significantly influenced by perceived value (Xiong & Li, 2023), and strong perceived value for new energy vehicles will actively promote intention to purchase (Chen et al., 2019). Switching behavior is also confirmed to be influenced by perceived value (Gale & Wood, 1994), while Frank et al. (2012) indicated that repurchase intention is influenced by perceived value. Consumers may be more resistant to adopting new technologies when they find the new technology's perceived value to be low (Kim & Kankanhalli, 2009), and conversely, people are more willing to adopt innovative technology if the perceived value is high (Hsieh, 2015). In an empirical investigation, Lin et al. (2021) found a favorable correlation among perceived value and switching intention. Therefore, the theory below is be established.

H3: Perceived value will positively affect switching intention.

4. Effect of Perceived Ease of Use on Switching Intention

The TAM model is an essential model for assessing consumer acceptance of new technologies (Adu-Gyamfi et al., 2022). The TAM model proposed by Davis et al. (1989) consists of five main factors: attitude, perceived ease of use, perceived usefulness, behavioral intention, and actual behavior. In the TAM model, perceived ease of use is a prerequisite for consumer intention to accept new technology (Venkatesh & Davis, 2000). Perceived ease of use refers to the degree to which consumers perceive a new technology to be simple and uncomplicated (Wang & Dong, 2016). Tran and Kim (2022) used perceived factors (perceived ease of use, perceived usefulness) as the basic theory to build a comprehensive research framework. TAM modeling has been extensively used to study consumer intentions to use electric vehicles. Buckley et al. (2018) suggested that perceived ease of use may have an impact on consumer intention to adopt new technologies, but in a study by Jing et al. (2021), it was proposed that there was no correlation between perceived ease of use and the intention of use electric vehicles. Ngoc et al. (2023) confirmed that perceived ease of use affected the intention to use an electric cargo vehicle. If consumers recognize the ease of use of new energy vehicles, then they may increase intention to use. This led to the following hypotheses.

H4: Perceived ease of use has a positive effect on switching intention.

5. Effect of Attitude toward Switching-on-Switching Intention

Attitude is a favorable or unfavorable assessment of an individual in response to a behavior (Jiang et al., 2019). Switching attitudes and intentions can significantly affect each other (Ajzen et al., 2019). Armitage and Conner (2001) believed that the key prerequisite for the formation of behavioral intention was attitude. An association between views about adopting a certain technology and the desire to use it has been shown in earlier studies (Liu et al., 2018; Park and Ohm, 2014). The connection among attitudes and intentions has been studied by numerous researchers, and it has been demonstrated that attitudes have a favorable impact on intentions (Palau-Saumell et al., 2021; Tong & Hwang, 2021). Attitudes have a positive impact on the decision-making process (Patchimnan et al., 2022). Based on the technology acceptance model, a person's attitude about a product or service positively affects whether they plan to use it. (Davis, 1989). Adu-Gyamfi et al. (2022) suggested that consumer intentions to adopt new technologies emerges when they are assessed as useful, and a significant positive correlation between attitude and intention for using new technology has been confirmed. Wang et al. (2018) also confirmed that the attitudes toward using electric vehicles will positively influence the desire to use electric vehicles. A study by Jaiswal et al. (2021) pointed out that the adoption of electric cars is affected by attitudes in the Indian market.

Therefore, the hypothesis below was developed.

H5: Attitude toward switching positively affects switching intention.

6. Effect of Perceived Risk on Attitude toward Switching

Prior research has shown a substantial inverse link between consumer attitudes regarding the adoption of cutting-edge technology and perceived risk (Bearth & Siegrist. 2016). According to study findings by Yin et al. (2022) on variables affecting the desire to buy family electric cars, perceived risk has an adverse effect on the mindset toward turning off potential customers. According to Ngoc et al. (2023), perceived risk has a detrimental effect on attitudes, and this finding was also supported by earlier research (Jing et al., 2021; Marriott & Williams, 2018). In this study, perceived risk refers to how consumers perceive possible hazards associated with adopting new energy vehicles. According to prior research, consumers may be reluctant to drive new energy vehicles if they perceive a greater danger of using new energy vehicles. Consequently, the hypothesis below was determined.

H6: Perceived risk negatively affects attitude toward switching intention.

7. Effect of Social Identity on Attitude toward Switching

Self-image congruency theory posits that consumers may hold positive attitudes toward a new product or technology when they perceive the image of this good to be consistent with their image (Sirgy, 1982). A primary reason for matching product image with self-image is that consumers have expectations of expressing when identity or social status to others through products (Schuitema et al., 2013). Whitmarsh & O'Neill (2010) referred to a specific kind of social identity as pro-environmental identity, which means the social public's recognition of the pro-environment (Cook et al., 2002). Operating costs and emotional perceptions are the economic benefits perceived by users of new energy vehicles; this means that the public believes that using green vehicles with alternative fuel is better for the environment compared to fuel cars. The adoption of electric automobiles improves positive image and social prestige due to face-consciousness and pro-environmental behavior, so social identity positively impacts the Attitude toward switching (Chen et al., 2023; Jing et al., 2021). In addition, Bartle and Bellucci (2014) studied the correlation between social identity and individual attitudes within the context of political parties and partisan relations. Therefore, the hypothesis below was developed.

H7: Social identity positively affects attitude toward switching intention.

8. Effect of Switching Intention on Switching Behavior

In recent years, the relationship between switching intention and switching behavior has received extensive attention and research (Lin & Wang, 2017). Behavioral intent is a direct determinant of actual behavior (Chen & Chao, 2011). Recent research has emphasized the importance of intention versus actual behavior (Wirtz et al., 2014). Intentions have been shown to significantly influence actual behavior in a subset of prior studies (Davis, 1989; Venkatesh et al., 2022). Hino (2017) also explained the relationship between switching intention and actual switching behavior in his study. The Theory of Planned Behavior proposed by Ajzen (1991) explains the relationship between intentions and actual behaviors. Lin and Wang (2017) also proved the positive effect of switching intention on actual switching behavior, with a significant path in the results. Therefore, this study proposes the following hypotheses.

H8: Switching intention has a positive effect on switching behavior.

9. Modulated Variables

Subjective norms are defined as social pressure to engage in a perceived behavior based on normative beliefs or the perceptions of others (Ajzen, 2005; Ajzen & Fishbein, 1975). It usually refers to "personal perceptions" influenced by others (Bhattacherjee, 2000). In most cases, consumer decisions are influenced by group opinions and advice, but information based on different requirements can be biased (Hasbullah et al., 2016). Subjective norms have been shown to considerably affect the dependent variable in a subset of related studies (Plouffe et al., 2001; Igbaria et al., 1997). Cheung et al. (2002) also demonstrated that subjective norms have a greater influence on the behavioral intentions of women to use new technologies. The environmental performance and innovativeness of new energy vehicles are considered to be in line with the values of society, and at the same time, consumers will make purchasing decisions based on the purchasing advice of family members as well as friends, so subjective norms as a moderating variable will have a positive impact on willingness to purchase (Wang & Dong, 2016). Therefore, the following hypothesis was formulated for this study.

H9: The Subjective norms have a moderating effect on the model.

Based on previous research, the questionnaire of this study is composed as below.

Table 1. Questionnaire Composition

Construct		Item	Related Studies
Perceived Risk	1	I am concerned that the technology of new energy vehicle products is immature, and there are still defects or flaws.	Wu et al. (2017) Bauer (1960) Jacoby and Kaplan (1972) Peter et al. (1975)
	2	I am concerned that the performance of the new energy vehicle is not consistent with the information from merchants.	
	3	I am concerned about financial losses due to inadequate facilities, such as charging, maintenance, and repair facilities.	
	4	I am worried that there are potential battery safety problems in new energy vehicles, and I did not find them in time when I purchased.	
	5	I am worried that the performance of new energy vehicles will not meet my expectations.	
Social Identify	1	Using new energy vehicles provides me with the perception of affiliation.	Chiu et al. (2006) Jiang et al. (2022)
	2	Using new energy vehicles provides me with a sense of intimacy.	
	3	Being a part of the new energy vehicle family makes me proud.	
Subjective Norms	1	People important to me think that I should switch to new energy vehicles as soon as possible.	Ajzen (2006) Yoon (2011) Bobek and Hatfield (2003)
	2	People expect me to switch to new energy vehicles as soon as possible.	
	3	Most people from whom I value opinions support the switch to new energy vehicles as soon as possible.	

Perceived Value	1	All things considered, new energy vehicles are a good deal.	Sweeney and Soutar (2001) Cocosila and Trabelsi (2016) Nimako and Ntim (2013)
	2	I believe new energy cars are incredibly cost-effective and economical.	
	3	In general, using new energy cars gives me more value for my money.	
	4	I do think that I get more benefits than the value I spent on new energy vehicles.	
Attitude toward Switching	1	I think new energy cars are satisfactory.	Nimako and Ntim (2013) Bansal et al. (2005) Morgan and Dev (1994)
	2	I am interested in new energy cars.	
	3	I think new energy cars are very good.	
	4	In general, I have an optimistic attitude toward new energy vehicles.	
	5	For me, it was a good decision to switch from gasoline vehicles to new energy vehicles.	
Perceived Ease of Use	1	For me, using new energy vehicles is relatively easy.	Davis (1989) Cakmak et al. (2011)
	2	Learning how to use new energy vehicles is easy for me.	
	3	I will find that new energy vehicles are very easy to use.	
	4	The operation of new energy vehicles is relatively simple compared with fuel vehicles.	
Switching Intention	1	Do you plan to move to a better new energy car in the upcoming year?	Chang et al. (2014) Hsieh et al. (2012) Chang et al. (2017) Bölen (2020)
	2	In the next two years, how probable is it that you'll move from a fuel-powered car to one energy-powered?	
	3	To satisfy my consumption requirements, I'll move from fuel-powered to new-energy automobiles.	
	4	To satisfy my future transportation needs, I intend to move from fuel-powered vehicles to new energy.	
	5	I plan to primarily use a new energy vehicle soon.	
	6	I will try to use new energy vehicles as much as possible.	
Switching Behavior	1	I have recently increased the frequency of use of new energy vehicles.	Hsieh et al. (2012) Nimako and Winneba (2012)
	2	I have reduced the use of fuel vehicles and increased the number of new energy vehicles.	
	3	I am already using new energy vehicles.	
	4	I hope to use new energy vehicles frequently in the future.	
	5	I will continue to use new energy vehicles in the future.	

III. Empirical Analysis

1. Research Data

The questionnaire was published on the online platform Credamo (www.credamo.com) using a seven-point Likert scale, and data were collected for one week from July 10, 2023. A total of 274 samples were accepted, 34 invalid samples were excluded, and 240 valid samples remained, which led to an effective rate of 87.59%.

In this study, a questionnaire survey was conducted among Chinese adults over 18 (family unit). The results showed that among the 240 valid samples, males account for 37.1% of total respondents, and 62.9% were female. 2.5% of the interviewees were aged 18-20, 34.2% were aged 21-30, 57.1% were aged 31-40, 4.2% were aged 41-50, and 2.1% were over 51 years old. In terms of occupation, 174 respondents (72.5%) were company employees, 7.9% were students, 8.3% were civil servants, 8.3% held other occupations, and 2.9% were self-employed. In addition, based on the amount of cars driven by the respondents, 32.5% said their families owned one fuel vehicle, 13.3% owned one new energy vehicle, and 1.7% owned two fuel vehicles. In addition, households with one fuel vehicle and one new energy vehicle accounted for 51.2% of the total, while households with neither of the above accounted for only 0.8% of the total sample size.

Table 2. Demographic Characteristics

Variable	Category	Frequency (N=240)	Ratio (%)
Gender	Male	89	37.10%
	Female	151	62.90%
Age	18~20	6	2.50%
	21~30	82	34.20%
	31~40	137	57.10%
	41~50	10	4.20%
	over 51	5	2.10%
Occupation	Student	19	7.90%
	Civil Servant	20	8.30%
	Self-Employed	7	2.90%
	Company Employee	174	72.50%
	Other	20	8.30%
Assumptions Average Annual Gross Revenue	RMB 100,000 and below	22	9.20%
	RMB 110,000~200,000	63	26.30%
	RMB 210,000~300,000	81	33.80%
	RMB 310,000~500,000	57	23.80%
	RMB 510,000 and above	17	7.10%

Highest Education	High school or below	4	1.70%
	3-year college	21	8.80%
	4-year college	150	62.50%
	Master and above	65	27.10%
Address	First-tier city	63	26.30%
	Second-tier city	104	43.30%
	Third-tier city	50	20.80%
	Fourth-tier city	16	6.70%
	Fifth-tier city	7	2.90%
Average Monthly Mileage	1000 km and below	75	31.30%
	1001 km~2000 km	83	34.60%
	2001 km~3000 km	57	23.80%
	3001 km and above	25	10.40%
Total Number of Household Cars	None	1	0.40%
	1 fuel car	78	32.50%
	1 energy car	32	13.30%
	2 fuel car	4	1.70%
	1 fuel car, 1 energy car	123	51.20%
	2 energy car	0	0.00%
	None of the above	2	0.80%

2. Reliability Test

Reliability is scale reliability or consistency, also known as reliability or a consistency test. In this study, the internal consistency reliability test was conducted using Cronbach's Alpha coefficient. SPSS 25.0 was used for testing, and the data processing results displayed that the survey's Cronbach's Alpha coefficient was 0.861. According to Nunally and Bernstein (1994) on Cronbach's Alpha coefficient (>0.7), the questionnaire can be judged to be highly reliable.

Table 3. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.861	0.891	35

3. Correlation Coefficient Test

This is shown in the following table. All measurement factors were significantly associated with switching behavior. Among these, there is a substantial negative link among perceived risk and switching behavior, while there is a substantial positive connection between society identify, perceived value, perceived ease of use, subjective norms, attitude toward switching, switching intention, and switching behavior.

Table 4. Correlation Analysis

	M	SD	PR	ID	SN	PV	PEOU	ATT	SI	SB
PR	3.158	1.683	1							
ID	5.121	1.363	-.351**	1						
SN	5.385	1.251	-.431**	.475**	1					
PV	5.668	0.968	-.374**	.569**	.481**	1				
PEOU	5.885	0.701	-.310**	.412**	.344**	.499**	1			
ATT	5.913	0.714	-.170**	.171**	.191**	.360**	.258**	1		
SI	5.600	1.171	-.414**	.430**	.479**	.593**	.475**	.231**	1	
SB	5.523	1.325	-.411**	.479**	.545**	.551**	.432**	.271**	.509**	1

Notes 1. The correlation is significant (two-tailed) at the 0.01 level.
2. ***P<0.001; **P<0.01; *P<0.05.

4. Validity Analysis

To a large extent, the validity description scale can accurately express its expected meaning, which is mainly applied to calculate the validity of indicators. The sample data in this case have a KMO value of 0.916, and the Bartlett sphericity test proved statistically significant at the level of P=0.000, meaning that the data can be used for factor analysis.

Table 5. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.916
Bartlett's Test of Sphericity	Approx. Chi-Square	5989.641
	df	595.000
	Sig.	0.000

The analysis method was used for factor extraction, and the outputs pointed out that all factor extraction values were higher than 0.5. The factor rotation was further carried out by the principal component analysis method, and the iteration was convergent six times. A total of eight factors with eigenvalues higher than 1 were extracted, and the cumulative interpretive variance was 73.512%.

Table 6. Common Factor Variance and Total Variance Explanation

Item	Extract	Sum of the Squares of Rotating Loads		
		Total	Percent Variance	Accumulation (%)
PR1	0.867			
PR2	0.763			
PR3	0.835	4.575	13.072	13.072
PR4	0.849			
PR5	0.833			
ID1	0.836			
ID2	0.854	4.392	12.55	25.621
ID3	0.831			
SN1	0.844			
SN2	0.788	3.734	10.668	36.289
SN3	0.799			
PV1	0.739			
PV2	0.762	3.058	8.736	45.026
PV3	0.617			
PV4	0.746			

PEOU1	0.647	2.59	7.400	52.426
PEOU2	0.628			
PEOU3	0.552			
PEOU4	0.513			
ATT1	0.649	2.503	7.153	59.578
ATT2	0.526			
ATT3	0.588			
ATT4	0.556			
ATT5	0.672			
SI1	0.668	2.44	6.97	66.549
SI2	0.785			
SI3	0.765			
SI4	0.748			
SI5	0.833			
SI6	0.822			
SB1	0.815	2.437	6.963	73.512
SB2	0.805			
SB3	0.805			
SB4	0.689			
SB5	0.700			

A total of eight components were extracted from the rotated component matrix, and the attribution of factor components is shown in Table 7. Each item's factor load was higher than 0.5, pointing out that the measure had strong validity (Kaiser, 1974).

Table 7. Component Matrix after Rotation

	Item							
Item	1	2	3	4	5	6	7	8
SI5	0.85							
SI6	0.832							
SI2	0.808							
SI4	0.774							
SI3	0.763							
SI1	0.603							
PR4		0.886						
PR1		0.882						
PR5		0.865						
PR3		0.853						
PR2		0.82						
SB1			0.82					
SB3			0.815					
SB2			0.799					
SB5			0.713					
SB4			0.649					
ATT5				0.792				
ATT1				0.788				
ATT3				0.725				
ATT4				0.719				
ATT2				0.688				
PV2					0.719			
PV1					0.712			
PV4					0.704			
PV3					0.629			
ID2						0.827		
ID3						0.813		
ID1						0.796		
PEOU2							0.724	
PEOU1							0.72	
PEOU3							0.675	
PEOU4							0.614	
SN1								0.801
SN3								0.78
SN2								0.771

To further confirm the reliability of the scale, the standard load for each factor, the extracted mean-variance (AVE), the comprehensive reliability (CR), and the correlation coefficients among all factors were calculated. The CR-value of each factor is higher than 0.7, showing that the measure has high internal consistency (Chin, 1998). AVE is the explanatory power of variance to calculate potential variables (measured variables). The higher the AVE value, the greater the reliability and convergence validity of the survey, with the ideal AVE value higher than 0.5 (Fornell & Larcker, 1981). However, the value ranges from 0.36 to 0.5, which is an acceptable range. Based on this, the AVE value of every single factor in this study is more than 0.4, demonstrating that this survey's convergence validity is great (Bagozzi & Yi, 1998).

Table 8. Convergent Validity Analysis

Construct	Items	Estimate	AVE	CR
Perceived Risk	PR1	0.914	0.7765	0.9455
	PR2	0.823		
	PR3	0.893		
	PR4	0.900		
	PR5	0.873		
Society Identify	ID1	0.878	0.7571	0.9034
	ID2	0.884		
	ID3	0.848		
Subjective Norms	SN1	0.875	0.7197	0.885
	SN2	0.814		
	SN3	0.855		
Perceived Value	PV1	0.801	0.6129	0.8632
	PV2	0.803		
	PV3	0.702		
	PV4	0.820		
Perceived Ease of Use	PEOU1	0.688	0.4174	0.7407
	PEOU2	0.674		
	PEOU3	0.604		
	PEOU4	0.614		
Attitude Toward Switching	ATT1	0.734	0.4739	0.8177
	ATT2	0.630		
	ATT3	0.663		
	ATT4	0.664		
	ATT5	0.744		

Switching Intention	SI1	0.695	0.6894	0.9298
	SI2	0.861		
	SI3	0.834		
	SI4	0.814		
	SI5	0.880		
	SI6	0.883		
Switching Behavior	SB1	0.869	0.6798	0.9136
	SB2	0.876		
	SB3	0.851		
	SB4	0.748		
	SB5	0.770		

5. Hypothesis Testing and Model Fitting

Model fit is shown in Table 9. RMSEA is least affected by sample size (Hu & Bentler, 1995). An RMSEA-value among 0.0 and 0.05 means a very tight fit, a fit value lower than 0.08 can be considered reasonable, and a fit value higher than 0.08 can be considered poor (Browne & Cudeck, 1993). The RMSEA index value in this study is 0.051, which belongs to the reasonable fitting range. All model fit indexes were up to the standard, and the model fit was good.

Table 9. Model Fit

Fit Index	Recommended Value	Fit Result
CMIN	-	859.268
DF	-	532
CMIN/DF	<3	1.615
RMSEA	<0.08	0.051
GFI	>0.80	0.833
AGFI	>0.80	0.803
PGFI	>0.05	0.704
NFI	>0.80	0.864
RFI	>0.80	0.848
IFI	>0.90	0.943
TLI	>0.90	0.936
CFI	>0.90	0.943

The absence of a high correlation between each factor of a potential feature is considered discriminative validity. In other words, items measured at one level should not have high loads or overload at other levels (Hair et al., 2014). It can be demonstrated that the scale's discriminative validity is strong if the square roots of the AVE values for all variables are higher than the correlation coefficient between factors (Fornell & Larcker, 1981). The differential validity of this study is displayed in Table 10. A substantial connection existed in perceived risk, society identify, perceived value, perceived ease of use, subjective norms, attitude toward switching, switching intention, and switching behavior (P<0.01). The diagonal was the square root of the AVE-value, whereas other values were correlation coefficients.

Table 10. Discriminant Validity Analysis

	SB	PU	SN	SI	ATT	PV	ID	PR
SB	0.824							
PU	0.521***	0.646						
SN	0.601***	0.416***	0.848					
SI	0.536***	0.552***	0.495***	0.830				
ATT	0.304***	0.335***	0.223***	0.26***	0.688			
PV	0.609***	0.619***	0.549***	0.634***	0.426***	0.783		
ID	0.516***	0.493***	0.525***	0.455***	0.197**	0.642***	0.870	
PR	-0.431***	-0.365***	-0.472***	-0.425***	-0.185**	-0.408***	-0.388***	0.881

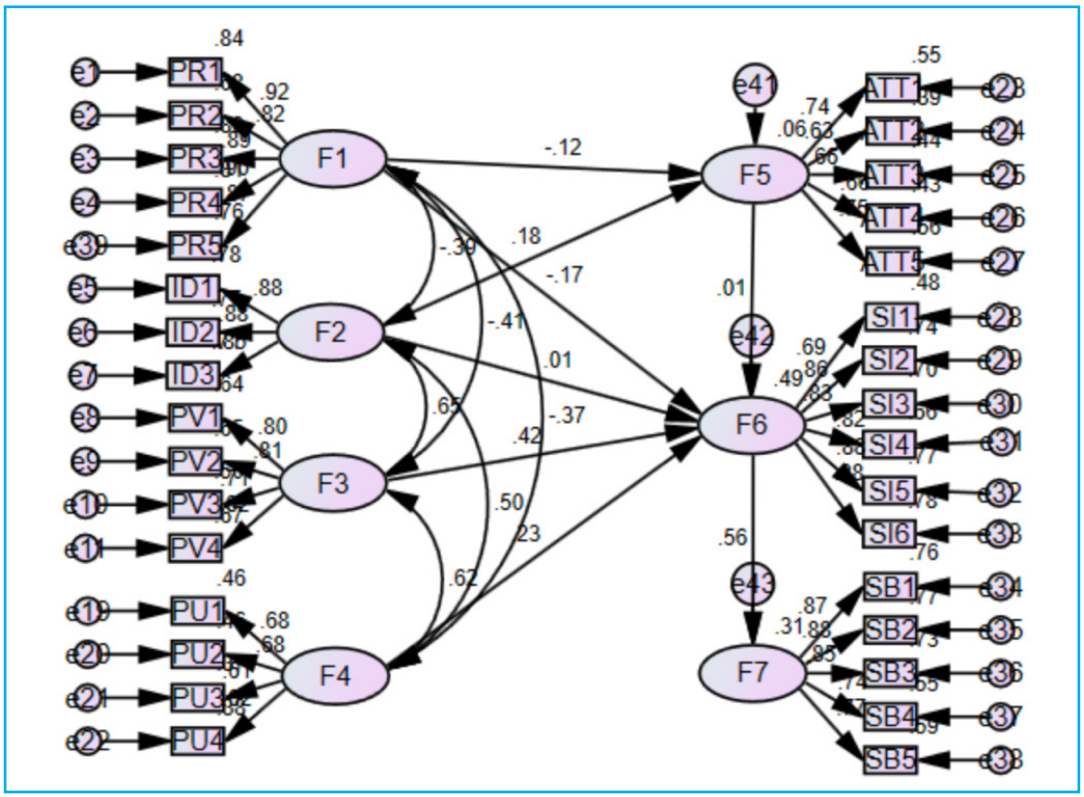
Notes: 1. The diagonal is the square root of the AVE value.
2. ***p<0.001; **p<0.01; *p<0.05.

In this study, AMOS 21.0 and SmartPLS 4.0.9.2 were adopted to verify the hypotheses. The test outputs of this model are displayed below (Table 11). The test outputs demonstrate that among all hypotheses, Hypothesis H2 with a P-value of 0.854, H5 with a P-value of 0.930, and H6 with P-value of 0.130 greater than 0.05 reject the null hypothesis, while the other hypotheses with P-values less than 0.05 are supported. In addition, using SmartPLS 4.0.9.2, it was calculated that the adjusted R-squared is 0.400. This means that the explanatory variance of switching behavior is 40%, which is high, demonstrating that the model can more accurately capture the entire switching behavior process of consumers.

Table 11. Hypothesis Testing

	Plan			Estimate	S.E.	C.R.	P	Result
H1	SI	←	PR	-0.098	0.036	-2.73	0.006	Supported
H2	SI	←	ID	0.011	0.059	0.184	0.854	Not Supported
H3	SI	←	PV	0.471	0.113	4.152	0.000	Supported
H4	SI	←	PEOU	0.385	0.149	2.575	0.010	Supported
H5	SI	←	ATT	0.008	0.086	0.088	0.930	Not Supported
H6	ATT	←	PR	-0.05	0.033	-1.515	0.130	Not Supported
H7	ATT	←	ID	0.096	0.044	2.167	0.030	Supported
H8	SB	←	SI	0.738	0.097	7.647	0.000	Supported

Fig. 2. Structural Equation



6. Moderator Variable Test

Hayes Process Macro-Model 1 was used to conduct the adjustment effect test. In this process, to determine whether W has an adjustment effect, X and W should first be determined to have an effect on Y respectively, and then determine whether the product of XW has significant statistical significance on the effect value of Y. When the lower and upper limits of the 95% confidence interval do not contain 0 in the range, it can be considered to have a moderating mediation effect (Hayes, 2013). The results are shown in Table 12.

Table 12. Variable Moderator Effect (Subjective Norms)

Path				β	SE	T	P	95% CI		Result
								Lower	Upper	
H9-1	SI	←	PR	0.1629	0.0307	5.3131	0.0000	0.1025	0.2233	Supported
H9-2	SI	←	ID	-0.1711	0.0265	-6.4679	0.0000	-0.2232	-0.1190	Supported
H9-3	SI	←	PV	-0.2275	0.0317	-7.1753	0.0000	-0.2899	-0.1650	Supported
H9-4	SI	←	PEOU	-0.1182	0.0485	-2.4339	0.0157	-0.2138	-0.0225	Supported
H9-5	SI	←	ATT	-0.0397	0.0578	-0.6872	0.4926	-0.1536	0.0742	Not Supported
H9-6	ATT	←	PR	0.0161	0.0228	0.7046	0.4817	-0.0288	0.0610	Not Supported
H9-7	ATT	←	ID	0.0039	0.0202	0.1947	0.8458	-0.0359	0.0437	Not Supported
H9-8	SB	←	SI	-0.0570	0.0336	-1.6940	0.0916	-0.1233	0.0093	Not Supported

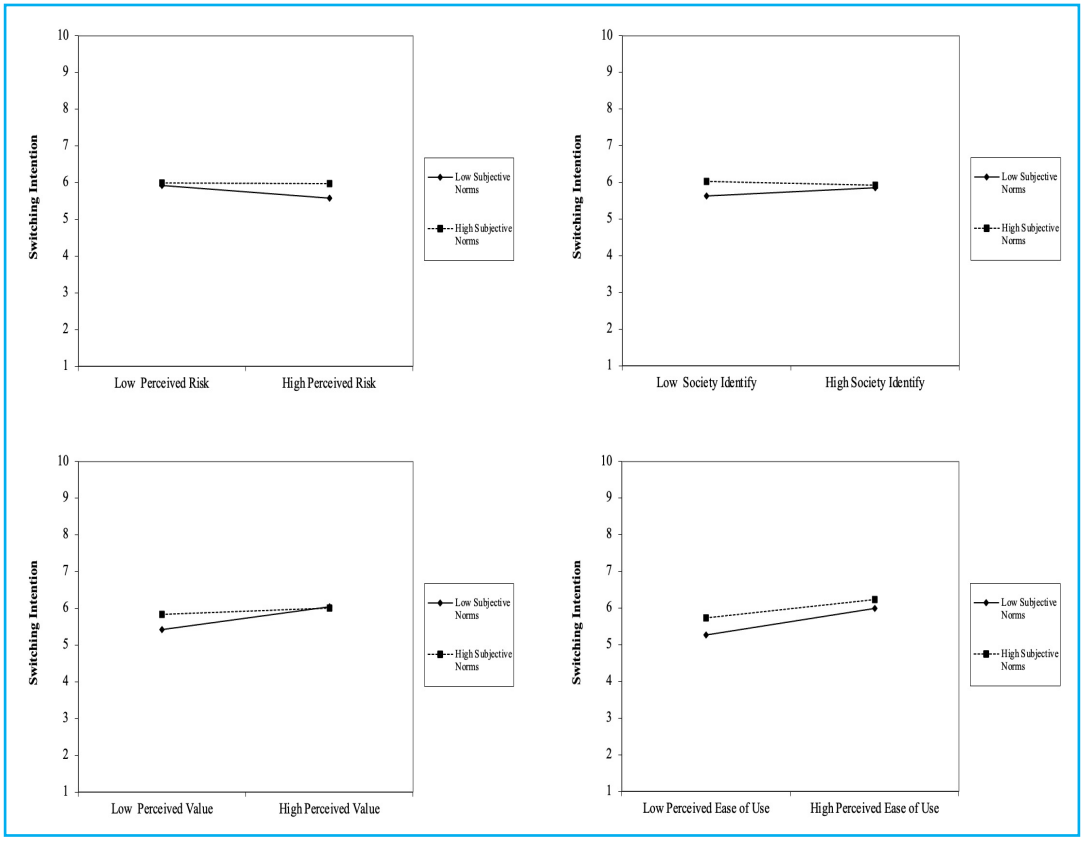
Notes 1. Bootstrapping = 5000.
2. ***p<0.001, **p<0.01, *p<0.05.

Perceived risk * subjective norm on switching intention leads to β=0.1629, P=0.000<0.05, and a 95% CI (0.1025, 0.2233), which means the product of perceived risk and subjective norm has a positive correlation with switching intention. The result of β=-0.1711, P=0.000<0.05, and a 95% CI (-0.2232, -0.1190) from social identity * subjective norm on switching intention indicates the product of social identity and subjective norm has a negative correlation with switching intention. Perceived value * subjective norm on conversion intention leads to β=-0.2275, P=0.000<0.05, and a 95% CI (-0.2899, -0.1650), meaning the product of perceived value and subjective norm has a negative correlation with switching intention. Perceived ease of use * subjective norm on switching intention produces β=-0.1182, P=0.0157<0.05, and a 95% CI (-0.2138, -0.0225), so the product of perceived ease of use and subjective norm has a negative correlation with switching intention. Pathways with moderating effects were visualized to confirm the results, as shown in Fig. 3. It can

be shown that subjective norms can positively regulate the relationship between perceived risk and switching intention, and negatively regulate the relationship between social identity, perceived value, perceived ease of use, and switching intention. Therefore, Hypothesis 9 is supported.

In addition, Subjective norms had no moderating effect on the relationship between perceived risk (P=0.4817>0.05), social identity (P=0.8458>0.05), and attitude toward switching. Meanwhile, there was no moderating effect between attitude toward switching (P=0.1536>0.05) and switching intention. Also, there was no moderating effect between switching intention (P=0.0916>0.05) and switching behavior.

Fig. 3. Visualization of Moderating Effect



IV. Conclusions and Suggestions

This study took Chinese adults over 18 (family unit) as the research object to analyze the effects of perceived risk, social identity, perceived value, perceived ease of use, attitude toward switching, and switching intention on switching behavior, along with influence of perceived risk and social identity on attitude toward switching. According to the empirical analysis results, in addition to social identification (T=0.184, P=0.854), attitude toward switching (T=0.088, P=0.930) on switching intention and perceived risk (T= -1.515, P=0.130) on attitude toward switching were rejected, different

from the research results of Ngoc et al. (2023) that perceived risk negatively impacts attitude change, this study found that perceived risk does not significantly impact attitude change. Perceived risk (T=-2.73, P=0.854, P=0.854), P=0.006) had a significant negative impact on switching intention, and perceived value (T=4.152, P=0.00) and perceived ease of use (T=2.575, P=0.010) had a significant positive impact on switching intention. Switching intention (T=7.647, P=0.00) has a significant positive impact on switching behavior; in addition, social identity (T=2.167, P=0.030) has a positive correlation with attitude toward switching. Moreover, subjective norms have a moderating effect on the relationship between perceived risk, social identity, perceived value, perceived ease of use, and switching intention.

The higher the risk users perceive, the lower the willingness to convert. As a result, appropriate actions must be taken to lower the level of perceived danger. In a study on the risk assessment of self-serving electrical car service failure, Zhang et al. (2022) identified that service breakdowns linked to driving security, incident managing, and significant property losses correspond to the high-risk category. These include the provision of defective electric vehicles, lack of safety markings, insufficient auto insurance, insufficient safety gear, and issues with deposit refunds. In particular, the core device of new energy vehicles, the battery, has been criticized. Whether it is the endless battery explosion news in recent years, battery life problems, or high insurance premiums, people are discouraged from new energy vehicles. Therefore, according to earlier research and the findings of this research, the relevant government departments, automobile enterprises, manufacturers and operators, and insurance companies should improve the technical shortcomings and provide more reliable service guarantees for existing problems to reduce user losses, so as to enhance user conversion willingness by reducing user perceived risk.

High perceived value can effectively increase user willingness to switch (Ghazali et al., 2020). With the progress and development of society, cars have become one of the necessities of daily life. COVID-19 led to stagnation or a contraction in the GDP of all countries (Yoon & Ko, 2022). However, global vehicle sales in 2022 were 67.2 million units, and compared with 66.7 million vehicles in 2021, there was still a slight increase (Statista, 2023). With it comes the depletion of oil resources, global warming, and rising oil prices, which makes the users of oil vehicles miserable. Studies have shown that new energy vehicles offer more intuitive benefits than fuel vehicles (Egbue & Long, 2012). For example, carbon reduction and the promotion of sustainable power (Lopes et al., 2014) are some of the benefits. Therefore, strengthening public awareness is also one of the main advantages of new energy vehicles, such as expanding environmental protection, energy saving, reducing air pollution, reducing costs, reducing carbon emissions, promoting renewable energy, and other aspects of publicity. In addition, new energy vehicle companies, manufacturers, and operators can organize related brand fans activities through online and offline information sharing so that users can intuitively feel the value brought by new energy vehicles. Through various activities, users are indirectly encouraged to exchange and disseminate information to achieve the dissemination effect.

Consumer adoption of electric vehicles is largely driven by perceived ease of use. This is consistent with the findings of Jaiswal et al. (2022). As demonstrated by Rose et al. (2006), the determinants of perceived ease of use are self-efficacy, technical discomfort, perceived risk, and personal feeling (Rose et al., 2006). This is consistent with the results of this study. In particular, the current mileage of new energy vehicles cannot meet long-distance needs, and is more suitable for urban transportation. The frequent charging requirement and long charging time during long-distance driving greatly reduce the intuitive benefits of new energy vehicles. Therefore, car manufacturers, government departments, and related enterprises should provide better solutions to the current mileage problem and improve the shortcomings of existing

technologies, Bringing more intuitive self-efficacy to users and reducing technical discomfort.

Just as in Chen et al. (2023) and Jing et al. (2021), due to awareness and environmental behavior, the use of electric automobiles improves positive image and social reputation, so social recognition has a favorable influence on attitude change. This study also obtained the same results as Chen et al. (2023) and Jing et al. (2021). Therefore, strengthening the user's social awareness and environmental protection behavior can improve the user's conversion attitude. At the same time, the management department, marketing department, and strategy department of automobile enterprises can improve the favorable social impression for the automobile enterprises and products by donating large-scale international activities and actively organizing public activities, including but not limited to changing the public's inherent stereotype of automobile enterprises and products from the aspects of brand image, corporate image, social image, marketing methods, and strategic forms. Strengthening the public's social recognition of new energy vehicles will enhance the conversion attitude.

More importantly, switching intention significantly positively affects switching behavior, which is consistent with Lin and Wang (2017). Service failures and extreme outcomes have been shown to lead to behavior shifts and customer churn (Keaveney, 1995; Bolton et al., 2006). Managers should pay attention to actual switching behaviors (Wirtz et al., 2014). Based on the results of this study, the corresponding marketing operation strategies on perceived risk, perceived value, perceived ease of use, and society identify should be formulated to enhance user conversion willingness and complete the transformation from intention to behavior.

This study provides evidence for the adjustment of subjective norms, showing that subjective norms strengthen the relationship between perceived risk, social identity, perceived value, perceived ease of use, and willingness to switch. Therefore, the focus of government departments, car operators, manufacturers, and other relevant enterprises and departments on subjective norms is, through the use of brand spokespeople in real social communities and virtual Internet channels to obtain social recognition, to create an atmosphere of appreciation, and thus enhance user intention to switch.

The theoretical significance of this study lies in the technology acceptance model (TAM), the theory of planned behavior (TPB), and the theory of perceived risk, perceived value, and social identity introduced into the model to expand it. Its practical significance is to provide feasible suggestions for the new energy automobile industry to meet user expectations, playing a guide and reference role for the subsequent rise of renewable energy cars, and promoting the decline of fuel-powered autos and the sustainable development of renewable energy vehicles.

Although this study has produced results, there are still limitations that need to be further improved and studied in subsequent studies. First, the research objects were only Chinese users, and the data was only collected in China. Therefore, to further validate and enhance the findings of the research, it is essential to bring out a global survey and comparative study in the future. Secondly, from the perspective of the sample structure, female users (62.9% of all respondents) and employees (72.5% of all respondents) were more willing to participate in this study, which directly resulted in a higher percentage of women and employees in the sample. Therefore, efforts should be made to mitigate this problem and reduce the imbalance in the proportion of users throughout the data collection phase of future relevant studies. Finally, the model needs to be extended further. According to the existing previous research theory, this study proposed relevant variable factors to study the conversion behavior of car users. However, the variable factors proposed in this research model were limited. In future research, we can enrich the existing model by adding independent variables such as initial trust, psychological inertia, and social expectancy, and adding moderating factors such as gender, age, and purchasing experience.

References

Adu-Gyamfi, G., Song, H., Obuobi, B., Nketiah, E., Wang, H., & Cudjoe, D. (2022). Who will adopt? Investigating the adoption intention for battery swap technology for electric vehicles. *Renewable and Sustainable Energy Reviews, 156*, 111979.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211.

Ajzen, I. (2005). *Attitudes, personality and behaviour.* McGraw-hill education.

Ajzen, I. (2006). *Constructing a TpB questionnaire: Conceptual and methodological considerations.* http://people.umass.edu/aizen/tpb.html

Ajzen, I., & Fishbein, M. (1975). A bayesian analysis of attribution processes. *Psychological bulletin, 82*(2), 261.

Ajzen, I., Fishbein, M., Lohmann, S., & Albarracín, D. (2019). The influence of attitudes on behavior. In D. Albarracín, & B. T. Johnson (Eds.), *The handbook of attitudes, volume 1: Basic principles* (2nd ed., pp. 197-255), Routledge.

Armitage, C. J., & Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology, 40*(4), 471-499.

Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science, 16*, 74-94.

Bagozzi, R. P., & Dholakia, U. M. (2006). Antecedents and purchase consequences of customer participation in small group brand communities. *International Journal of Research in Marketing, 23*(1), 45-61.

Bansal, H. S., Taylor, S. F., & St. James, Y. (2005). "Migrating" to new service providers: Toward a unifying framework of consumers' switching behaviors. *Journal of the Academy of Marketing Science, 33*(1), 96-115.

Bartle, J., & Bellucci, P. (2014). Introduction: Partisanship, social identity and individual attitudes. In *Political parties and partisanship* (pp. 1-25). Routledge.

Bauer, R. A. (1960). Consumer behavior as risk-taking, dynamic marketing for changing world. *American Marketing Association*, 389-398.

Bauer, R. A. (1964). The obstinate audience: The influence process from the point of view of social communication. *American Psychologist, 19*(5), 319.

Bearth, A., & Siegrist, M. (2016). Are risk or benefit perceptions more important for public acceptance of innovative food technologies: A meta-analysis. *Trends in Food Science & Technology, 49*, 14-23.

Bhattacherjee, A. (2000). Acceptance of e-commerce services: The case of electronic brokerages. *IEEE Transactions on Systems, Man, and Cybernetics, Part A: Systems and Humans, 30*(4), 411-420.

Bobek, D. D., & Hatfield, R. C. (2003). An investigation of the theory of planned behavior and the role of moral obligation in tax compliance. *Behavioral Research in Accounting, 15*(1), 13-38.

Bölen, M. C. (2020). From traditional wristwatch to smartwatch: Understanding the relationship between innovation attributes, switching costs and consumers' switching intention. *Technology in Society, 63*, 101439.

Bolton, R. N., Lemon, K. N., & Bramlett, M. D. (2006). The effect of service experiences over time on a supplier's retention of business customers. *Management Science, 52*(12), 1811-1823.

Bonsu, N. O. (2020). Towards a circular and low-carbon economy: Insights from the transitioning to electric vehicles and net zero economy. *Journal of Cleaner Production, 256*, 120659.

Browne, M. W., & Cudeck. R. (1993), Alternative ways of assessing model fit. In K. A. Bollen & J. S. Long (Eds.), *Testing structural equation models* (pp. 136-162), Sage.

Buckley, L., Kaye, S. A., & Pradhan, A. K. (2018). Psychosocial factors associated with intended use of automated vehicles: A simulated driving study. *Accident Analysis & Prevention, 115*, 202-208.

Cakmak, A. F., Benk, S., & Budak, T. (2011). The acceptance of tax office automation system (VEDOP) by employees: Factorial validation of Turkish adapted Technology Acceptance Model (TAM). *International Journal of Economics and Finance, 3*(6), 107-116.

Chang, H. H., Wong, K. H., & Li, S. Y. (2017). Applying push-pull-mooring to investigate channel switching behaviors: M-shopping self-efficacy and switching costs as moderators. *Electronic Commerce Research and Applications, 24*, 50-67.

Chang, I. C., Liu, C. C., & Chen, K. (2014). The push, pull and mooring effects in virtual migration for social networking sites. *Information Systems Journal, 24*(4), 323-346.

Chen, C. F., & Chao, W. H. (2011). Habitual or reasoned? Using the theory of planned behavior, technology acceptance model, and habit to examine switching intentions toward public transit. *Transportation Research Part F: Traffic Psychology and Behaviour, 14*(2), 128-137.

Chen, K., Ren, C., Gu, R., & Zhang, P. (2019). Exploring purchase intentions of new energy vehicles: From the perspective of frugality and the concept of "mianzi". *Journal of Cleaner Production, 230*, 700-708.

Chen, L., Liu, X., & Jing, P. (2023). Do unprecedented gasoline prices affect the consumer switching to new energy vehicles? An integrated social cognitive theory model. *Sustainability, 15*(10), 8030.

Cheung, C. M., Lee, M. K., & Chen, Z. (2002, January). Using the internet as a learning medium: An exploration of gender difference in the adoption of FaBWeb. In Proceedings of the 35th Annual Hawaii International Conference on System Sciences, IEEE, 475-483.

Chin, W. W. (1998). The partial least squares approach to structural equation modeling. *Modern Methods for Business Research, 295*(2), 295-336.

Chinese Battery industry. (2023, May 04). *March 2023 China battery market report (China's battery market demand).* http://www.cbipress.com/index/index/views/id/47

Chiu, C. M., Hsu, M. H., & Wang, E. T. (2006). Understanding knowledge sharing in virtual communities: An integration of social capital and social cognitive theories. *Decision Support Systems, 42*(3), 1872-1888.

Choi, J. K., & Ji, Y. G. (2015). Investigating the importance of trust on adopting an autonomous vehicle. *International Journal of Human-Computer Interaction, 31*(10), 692-702.

Cocosila, M., & Trabelsi, H. (2016). An integrated value-risk investigation of contactless mobile payments adoption. *Electronic Commerce Research and Applications, 20*, 159-170.

Cook, A. J., Kerr, G. N., & Moore, K. (2002). Attitudes and intentions towards purchasing GM food. *Journal of Economic Psychology, 23*(5), 557-572.

Crabtree, G. (2019). The coming electric vehicle transformation. *Science, 366*(6464), 422-424.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 319-340.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35*(8), 982-1003.

Egbue, O., & Long, S. (2012). Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. *Energy Policy, 48*, 717-729.

Featherman, M., Jia, S. J., Califf, C. B., & Hajli, N. (2021). The impact of new technologies on consumers beliefs: Reducing the perceived risks of electric vehicle adoption. *Technological Forecasting and Social Change, 169*, 120847.

Fielding, K. S., McDonald, R., & Louis, W. R. (2008). Theory of planned behaviour, identity and intentions to engage in environmental activism. *Journal of Environmental Psychology, 28*(4), 318-326.

Forehand, M. R., Deshpandé, R., & Reed II, A. (2002). Identity salience and the influence of differential activation of the social self-schema on advertising response. *Journal of Applied Psychology, 87*(6), 1086.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39-50.

Frank, K. J., Rosenblatt, K. M., Westedt, U., Hölig, P., Rosenberg, J., & Mägerlein, M. et al. (2012). Amorphous solid dispersion enhances permeation of poorly soluble ABT-102: True supersaturation vs. apparent solubility enhancement. *International Journal of Pharmaceutics, 437*(1-2), 288-293.

Gale, B., & Wood, R. C. (1994). *Managing customer value: Creating quality and service that customers can see.* Simon and Schuster.

Ghazali, E. M., Ngiam, E. Y. L., & Mutum, D. S. (2020). Elucidating the drivers of residential mobility and housing choice behaviour in a suburban township via push–pull–mooring framework. *Journal of Housing and the Built Environment, 35*, 633-659.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014), *Multivariate data analysis*, Pearson Education Limited, Essex.

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach.* The Guilford Press.

Hasbullah, N. A., Osman, A., Abdullah, S., Salahuddin, S. N., Ramlee, N. F., & Soha, H. M. (2016). The relationship of attitude, subjective norm and website usability on consumer intention to purchase online: An evidence of Malaysian youth. *Procedia Economics and Finance, 35*, 493-502.

Hino, H. (2017). Does switching-intention result in a change in behaviour? Exploring the actual behavioural shopping patterns of switching-intended customers. *British Food Journal, 119*(12), 2903-2917.

Hohenberger, C., Spörrle, M., & Welpe, I. M. (2016). How and why do men and women differ in their willingness to use automated cars? The influence of emotions across different age groups. *Transportation Research Part A: Policy and Practice, 94*, 374-385.

Holland, S. P., Mansur, E. T., Muller, N. Z., & Yates, A. J. (2016). Are there environmental benefits from driving electric vehicles? The importance of local factors. *American Economic Review, 106*(12), 3700-3729.

Hsieh, J. K., Hsieh, Y. C., Chiu, H. C., & Feng, Y. C. (2012). Post-adoption switching behavior for online service substitutes: A perspective of the push–pull–mooring framework. *Computers in Human Behavior, 28*(5), 1912-1920.

Hsieh, P. J. (2015). Healthcare professionals' use of health clouds: Integrating technology acceptance and status quo bias perspectives. *International Journal of Medical Informatics, 84*(7), 512-523.

Hu, L. T., & Bentler, P. M. (1995). Evaluating model fit. In R. H. Hoyle (ed.), *Structural equation modeling: Concepts, issues and applications* (pp. 76-99). Sage.

Huo, H., Zhang, Q., He, K., Yao, Z., & Wang, M. (2012). Vehicle-use intensity in China: Current status and future trend. *Energy Policy, 43*, 6-16.

IEA (2023). *Global EV outlook 2023.* https://www.iea.org/reports/global-ev-outlook-2023

Igbaria, M., Zinatelli, N., Cragg, P., & Cavaye, A. L. M. (1997). Personal C computing acceptance factors in small firms: A structural equation model. *MIS Quarterly, 21*(3), 279-305.

Irfan, M., & Ahmad, M. (2021). Relating consumers' information and willingness to buy electric vehicles: Does personality matter?. *Transportation Research Part D: Transport and Environment, 100*, 103049.

Jacoby, J. & Kaplan, L. B. (1972), The components of perceived risk. *Proceedings of the Annual Conference of the Association for Consumer Research, 10*, 382-393

Jaiswal, D., Kant, R., Singh, P. K., & Yadav, R. (2022). Investigating the role of electric vehicle knowledge in consumer adoption: Evidence from an emerging market. *Benchmarking: An International Journal, 29*(3), 1027-1045.

Jaiswal, D., Kaushal, V., Kant, R., & Singh, P. K. (2021). Consumer adoption intention for electric vehicles: Insights and evidence from Indian sustainable transportation. *Technological Forecasting and Social Change, 173*, 121089.

Jiang, S., Jotikasthira, N., & Pu, R. (2022). Toward sustainable consumption behavior in online education industry: The role of consumer value and social identity. *Frontiers in Psychology, 13*, 865149.

Jiang, Z., Li, W., Ma, C., Ma, L., Zhang, B., Lu, K., & Li, W. (2019). Joint operation of renewable energy and battery switch station considering the benefits of different subjects. *Applied Sciences, 9*(8), 1679.

Jing, P., Du, L., Chen, Y., Shi, Y., Zhan, F., & Xie, J. (2021). Factors that influence parents' intentions of using autonomous vehicles to transport children to and from school. *Accident Analysis & Prevention, 152*, 105991.

Jing, P., Huang, H., Ran, B., Zhan, F., & Shi, Y. (2019). Exploring the factors affecting mode choice Intention of autonomous vehicle based on an extended theory of planned behavior: A case study in China. *Sustainability, 11*(4), 1155.

Joo, K. H., & Hwang, J. S. (2021). Understanding perceived risks in the context of drone food delivery services: Focusing on the difference analysis before and after the outbreak of COVID-19. *Journal of International Trade & Commerce*, *17*(4), 391-405,

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika, 39*(1), 31-36.

Kamal, S. A., Shafiq, M., & Kakria, P. (2020). Investigating acceptance of telemedicine services through an extended technology acceptance model (TAM). *Technology in Society, 60*, 101212.

Keaveney, S. M. (1995). Customer switching behavior in service industries: An exploratory study. *Journal of Marketing, 59*(2), 71-82.

Kim, H. W., & Kankanhalli, A. (2009). Investigating user resistance to information systems implementation: A status quo bias perspective. *MIS Quarterly*, 567-582.

Krupa, J. S., Rizzo, D. M., Eppstein, M. J., Lanute, D. B., Gaalema, D. E., & Lakkaraju, K. et al. (2014). Analysis of a consumer survey on plug-in hybrid electric vehicles. *Transportation Research Part A: Policy and Practice, 64*, 14-31.

Lee, I. G. (2021). The effects of unmanned store selection factors on revisit intention: Focusing on the mediating effect of perceived value. *Journal of International Trade & Commerce*, *17*(6), 389-405.

Li, W., Long, R., & Chen, H. (2016). Consumers' evaluation of national new energy vehicle policy in China: An analysis based on a four paradigm model. *Energy Policy, 99*, 33-41.

Li, Y., Zhang, Q., Liu, B., McLellan, B., Gao, Y., & Tang, Y. (2018). Substitution effect of new-energy vehicle credit program and corporate average fuel consumption regulation for green-car subsidy. *Energy, 152*, 223-236.

Lin, C., Lai, X., & Yu, C. (2021). Switching intent of disruptive green products: The roles of comparative economic value and green trust. *Frontiers in Energy Research, 9*, 764581.

Lin, C. N., & Wang, H. Y. (2017). Understanding users' switching intentions and switching behavior on social networking sites. *Aslib Journal of Information Management, 69*(2), 201-214.

Liu, Y., Hong, Z., Zhu, J., Yan, J., Qi, J., & Liu, P. (2018). Promoting green residential buildings: Residents' environmental attitude, subjective knowledge, and social trust matter. *Energy Policy, 112*, 152-161.

Lopes, M. M., Moura, F., & Martinez, L. M. (2014). A rule-based approach for determining the plausible universe of electric vehicle buyers in the Lisbon Metropolitan Area. *Transportation Research Part A: Policy and Practice, 59*, 22-36.

Luna, T. F., Uriona-Maldonado, M., Silva, M. E., & Vaz, C. R. (2020). The influence of e-carsharing schemes on electric vehicle adoption and carbon emissions: An emerging economy study. *Transportation Research Part D: Transport and Environment, 79*, 102226.

Marriott, H. R., & Williams, M. D. (2018). Exploring consumers perceived risk and trust for mobile shopping: A theoretical framework and empirical study. *Journal of Retailing and Consumer Services, 42*, 133-146.

Menon, A., Menon, A., Chowdhury, J., & Jankovich, J. (1999). Evolving paradigm for environmental sensitivity in marketing programs: A synthesis of theory and practice. *Journal of Marketing Theory*

and Practice, 7(2), 1-15.

Morgan, M. S., & Dev, C. S. (1994). An empirical study of brand switching for a retail service. *Journal of Retailing, 70*(3), 267-282.

Ngoc, A. M., Nishiuchi, H., & Nhu, N. T. (2023). Determinants of carriers' intentions to use electric cargo vehicles in last-mile delivery by extending the technology acceptance model: A case study of Vietnam. *The International Journal of Logistics Management, 34*(1), 210-235.

Nicolaou, A. I., & McKnight, D. H. (2006). Perceived information quality in data exchanges: Effects on risk, trust, and intention to use. *Information Systems Research, 17*(4), 332-351.

Nimako, S. G., & Ntim, B. A. (2013). Construct specification and misspecification within the application of push-pull-mooring theory of switching behaviour. *Journal of Business and Management Sciences, 1*(5), 83-95.

Nimako, S. G., & Winneba, K. G. (2012). Consumer switching behaviour: A theoretical review and research agenda. *Research Journal of Social Science and Management, 2*(3), 74-85.

Noppers, E. H., Keizer, K., Bolderdijk, J. W., & Steg, L. (2014). The adoption of sustainable innovations: Driven by symbolic and environmental motives. *Global Environmental Change, 25*, 52-62.

Nunally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). McGraw- Hill, 261-262.

Oliver, J. D., & Rosen, D. E. (2010). Applying the environmental propensity framework: A segmented approach to hybrid electric vehicle marketing strategies. *Journal of Marketing Theory and Practice, 18*(4), 377-393.

Ou, S., Hao, X., Lin, Z., Wang, H., Bouchard, J., & He, X. et al. (2019). Light-duty plug-in electric vehicles in China: An overview on the market and its comparisons to the United States. *Renewable and Sustainable Energy Reviews, 112*, 747-761.

Patchimnan, M., Phankaew, B., & Inson, C. (2022). Integrated marketing communication exposure, attitude, decision-making process and purchasing behavior. *Journal of Global Business and Trade*, *18*(4), 169-181.

Palau-Saumell, R., Matute, J., Derqui, B., & Meyer, J. H. (2021). The impact of the perceived risk of COVID-19 on consumers' attitude and behavior toward locally produced food. *British Food Journal, 123*(13), 281-301.

Parasuraman, A., & Grewal, D. (2000). The impact of technology on the quality-value-loyalty chain: A research agenda. *Journal of the Academy of Marketing Science, 28*(1), 168-174.

Park, E., & Ohm, J. Y. (2014). Factors influencing the public intention to use renewable energy technologies in South Korea: Effects of the Fukushima nuclear accident. *Energy Policy, 65*, 198-211.

Peter, J. P., & Tarpey, L. X., Sr. (1975). A comparative analysis of three consumer decision strategies. *Journal of Consumer Research, 2*(1), 29-37.

Peters, A., & Dütschke, E. (2014). How do consumers perceive electric vehicles? A comparison of German consumer groups. *Journal of Environmental Policy & Planning, 16*(3), 359-377.

Petschnig, M., Heidenreich, S., & Spieth, P. (2014). Innovative alternatives take action: Investigating determinants of alternative fuel vehicle adoption. *Transportation Research Part A: Policy and Practice, 61*, 68-83.

Plouffe, C. R., Vandenbosch, M., & Hulland, J. (2001). Intermediating technologies and multi-group adoption: A comparison of consumer and merchant adoption intentions toward a new electronic payment system. *Journal of Product Innovation Management, 18*(2), 65-81.

Rezvani, Z., Jansson, J., & Bodin, J. (2015). Advances in consumer electric vehicle adoption research: A review and research agenda. *Transportation Research Part D: Transport and Environment, 34*, 122-136.

Robison, R. A. V., & Nath, C. (2010). *Electric vehicles* (Postnote No. 365). Houses of Parliament: Parliamentary Office of Science & Technology. https://researchbriefings.files.parliament.uk/documents/POST-PN-365/POST-PN-365.pdf

Rose, J., & Fogarty, G. J. (2006, July 10-13). Determinants of perceived usefulness and perceived ease of use in the technology acceptance model: Senior consumers' adoption of self-service banking technologies. In Proceedings of the 2nd Biennial Conference of the Academy of World Business, Marketing and Management Development: Business Across Borders in the 21st Century, Paris, France, 2(10), 122-129. https://research.usq.edu.au/item/9xyx6/determinants-of-perceived-usefulness-and-perceived-ease-of-use-in-the-technology-acceptance-model-senior-consumers-adoption-of-self-service-banking-technologies

Schuitema, G., Anable, J., Skippon, S., & Kinnear, N. (2013). The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles. *Transportation Research Part A: Policy and Practice, 48*, 39-49.

Sheth, J. N., Newman, B. I., & Gross, B. L. (1991). Why we buy what we buy: A theory of consumption values. *Journal of Business Research, 22*(2), 159-170.

Sirgy, M. J. (1982). Self-concept in consumer behavior: A critical review. *Journal of Consumer Research, 9*(3), 287-300.

Situ, L. (2009, May). Electric vehicle development: The past, present & future. *2009 3rd International Conference on Power Electronics Systems and Applications* (PESA), 1-3.

Smith, M. B., Bruner, J. S., & White, R. W. (1956). *Opinions and personality*. John Wiley & Sons.

Sweeney, J. C., & Soutar, G. N. (2001). Consumer perceived value: The development of a multiple item scale. *Journal of Retailing, 77*(2), 203-220.

Statista (2023, Aug 29). *Number of cars sold worldwide from 2010 to 2022, with a 2023 forecast.* https://www.statista.com/statistics/200002/international-car-sales-since-1990/

Tong, Z. H., & Hwang, J. S. (2021). The effects of multi-dimensions of brand globalness on quality, prestige, attitude, and purchase intention of sportswear brand: Focusing on Chinese consumers. *Journal of International Trade & Commerce*, *17*(1), 489-516.

Tran, H. T., & Kim, M. S. (2022). A study on personal traits, social influences and, the flow experience of video conference service users. *Journal of Global Business and Trade*, *18*(3), 17-40.

Turner, J. C., Brown, R. J., & Tajfel, H. (1979). Social comparison and group interest in ingroup favouritism. *European Journal of Social Psychology, 9*(2), 187-204.

Vafaei-Zadeh, A., Wong, T. K., Hanifah, H., Teoh, A. P., & Nawaser, K. (2022). Modelling electric vehicle purchase intention among generation Y consumers in Malaysia. *Research in Transportation Business & Management, 43*, 100784.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science, 46*(2), 186-204.

Venkatesh, V., Speier, C., & Morris, M. G. (2002). User acceptance enablers in individual decision making about technology: Toward an integrated model. *Decision Sciences, 33*(2), 297-316.

Wallstreetcn (2022, July 31). *China accounts for 59% of the world's new energy vehicles in the first half of 2022*. https://wallstreetcn.com/articles/3666277

Wang, S., Wang, J., Li, J., Wang, J., & Liang, L. (2018). Policy implications for promoting the adoption of electric vehicles: Do consumer's knowledge, perceived risk and financial incentive policy matter?. *Transportation Research Part A: Policy and Practice, 117*, 58-69.

Wang, Z., & Dong, X. (2016). Determinants and policy implications of residents' new energy vehicle purchases: The evidence from China. *Natural Hazards, 82*, 155-173.

Whitmarsh, L., & O'Neill, S. (2010). Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviours. *Journal of Environmental Psychology, 30*(3), 305-314.

Wirtz, J., Xiao, P., Chiang, J., & Malhotra, N. (2014). Contrasting the drivers of switching intent and

switching behavior in contractual service settings. *Journal of Retailing, 90*(4), 463-480.

Wu, J., Yang, Z., Hu, X., Wang, H., & Huang, J. (2018). Exploring driving forces of sustainable development of China's new energy vehicle industry: An analysis from the perspective of an innovation ecosystem. *Sustainability, 10*(12), 4827.

Wu, K., Vassileva, J., & Zhao, Y. (2017). Understanding users' intention to switch personal cloud storage services: Evidence from the Chinese market. *Computers in Human Behavior, 68*, 300-314.

Xiong, Y., & Li, Y. (2023). Analysing the evolution of new energy vehicle consumption market: A "leading" and "following" consumers' perspective. *Research in Transportation Business & Management*, 100944.

Yin, Y. R., Li, Y., & Zhang, Y. (2022). Influencing factor analysis of household electric vehicle purchase intention of HaiNan Free Trade Port under the background of low-carbon lifestyle. *Energy Reports, 8*, 569-579.

Yong, J. Y., Ramachandaramurthy, V. K., Tan, K. M., & Mithulananthan, N. (2015). A review on the state-of-the-art technologies of electric vehicle, its impacts and prospects. *Renewable and Sustainable Energy Reviews, 49*, 365-385.

Yoon, C. (2011). Theory of planned behavior and ethics theory in digital piracy: An integrated model. *Journal of Business Ethics, 100*, 405-417.

Yoon, S. H., & Ko, J. H. (2022). The impact of COVID-19 on the world economy. *Journal of Global Business and Trade*, *18*(2), 79-98.

Zeithaml, V. A. (1988). Consumer perceptions of price, quality, and value: A means-end model and synthesis of evidence. *Journal of Marketing, 52*(3), 2-22.

Zhang, D., Li, Y., Li, Y., & Shen, Z. (2022). Service failure risk assessment and service improvement of self-service electric vehicle. *Sustainability, 14*(7), 3723.

Zhou, G., Ou, X., & Zhang, X. (2013). Development of electric vehicles use in China: A study from the perspective of life-cycle energy consumption and greenhouse gas emissions. *Energy Policy, 59*, 875-884.

The Journal of Global Business and Trade

ISSN 1946-5130 (Print), ISSN 2470-4733 (Online)
http://dx.doi.org/10.20294/jgbt.2023.19.5.171

Journal of Global Business and Trade

https://www.pfw.edu/jgbt

Current Status and Policy Direction of the Age-Friendly Industry in Korea*

So-Jin Kim[a]**

[a]*Department of Social welfare, Joongbu University, South Korea*

Received 23 August 2022, Revised 3 September 2023, Accepted 5 October 2023

ABSTRACT

Purpose – The purpose of this study is to explore and analyze the current status of Korea's age-friendly industry (AFI), which is attracting attention as a solution to various social and economic problems caused by aging, and to find policy directions for the future.

Design/Methodology/Approach – In order to understand the current status of the age-friendly industry in Korea, this study first investigated and analyzed nine industrial sectors classified by the government. It also looked at the current four major policies fostering this industry. Finally, based on the results of analysis, this study suggests future policy directions.

Findings – Korea's age-friendly industry did not fully consider the characteristics and needs of the elderly, and neglected many fields other than care services. In addition, it was still difficult for consumers to access this industry, and practical experts were not effectly nurtured.

Research Implications – Based on the results of the analysis, this study identified the problems of the current age-friendly industry in Korea. and suggested the following four policy directions: (1) a broader analysis of the characteristics and needs of the elderly, (2) the expansion of customized consulting for the diversification and quality improvement of age-friendly industrial products, (3) active private participation to increase accessibility to consumers and expansion of promotion centered on residential areas in the region, and (4) the introduction of a more practical expert training system through non-degree programs.

Keywords: age, age-friendly industry, age-friendly product, fostering age-friendly industry, silver industry
JEL Classifications: P42, L52, L67, L70, L80

** This paper was supported by Joongbu University Research & Development Fund, in 2022.*
*** Email: sojinkim@joongbu.ac.kr*
© 2023 International Academy of Global Business and Trade. All rights reserved.

I. Introduction

One of the major issues in Korean is the aging of the population. Korea became an aged society as the proportion of the elderly (over 65 years of age) reached 14.3% of the total population in 2018, and it is expected to be a super-aged society with over 20% in 2025, reaching 46.7% in 2070 (Statistics Korea, 2021). The problem of aging is not simply caused by a numerical increase in the number of the elderly. The bigger problem is the speed of aging.[1] In the case of Korea, the aging of the population is progressing very rapidly, so countermeasures against this problem were inevitably insufficient. As a result, it is expected to face various problems, such as the problem of supporting the elderly, a shortage of labor, and reduced consumption and savings.

Due to the rapidly aging population, Korean society is in a position to solve not only problems related to life stability in old age but also economic problems caused by the decrease in the working population. The age-friendly industry (AFI) is being proposed as the best measure to solve these two problems similtaneously in this situation (Kim, 2006). An AFI refers to an industry that provides goods or services according to the principle of market competition for the maintenance and promotion of mental and physical health, improvement of convenience, and promotion of safety for the elderly (Presidential Committee on Ageing Society and Population Policy, 2006). The demand for this age-friendly industrial market is expected to increase significantly as the number of elderly with a high educational level and financial ability increases. Although the elderly are still considered the objects of support or beneficiaries, it is expected that they will be recognized as contributors to revitalize the economy in the future (Cho, 2014). In addition, given that aging is a global trend, the importance of the AFI market is likely to be further strengthened. This is because, as the so-called baby boomers, those born after World War II and the largest group in the population structure, gradually enter the elderly population, the aging-friendly industry will play an important role not only in the domestic market but also in the overseas export market. As a result, the aging population, which has been only regarded as a threat, is now being viewed as an opportunity. In addition, the AFI is evaluated as a field with very high potential for future development.

In South Korea, the age-friendly industry has witnessed significant growth, paralleling the retirement phase of the baby boomer cohort. Data projections indicated that the market capitalization of the AFI tailored to the elderly demographic was poised to surge from KRW 27,381 billion in 2012 to KRW 77,801 billion in 2020, reflecting a compound annual growth rate (CAGR) of 16.61% (Moon, 2019). Recognizing its potential, the Korean government has strategically earmarked the AFI as a pivotal industry for future expansion, subsequently enacting the Senior-friendly Industry Promotion Act in the mid-2000s to cultivate a conducive ecosystem. Notwithstanding these initiatives, substantive support, particularly in terms of services and training for the AFI, remains conspicuously inadequate (Cho, 2016). Compounding these challenges is the discernible lack of in-depth knowledge indispensable for effective policy-making and industrial augmentation. As underscored by Park (2017), existing research on the age-friendly industry is often constrained in its analytical breadth and depth. To secure a sustained development of future age-friendly sectors, there exists a pressing requirement for extensive and nuanced academic exploration in this sphere. Presently, both the magnitude and research methodologies employed in this domain are not well delineated. Consequently, this study seeks to assess the prevailing landscape of age-friendly industries in South Korea and delineate prospective strategies.

1. It took Korea 18 years to transition from an aging society to an aged society, compared to 115 years for France, 85 years for Sweden, 75 years for the United States, 45 years for the United Kingdom, and 26 years for Japan.

II. Meaning of Age-Friendly Industry

'Age-friendly' refers to considering the preferences of the elderly as the top priority. This is a concept based on the convenience and stability of the elderly that if the elderly experience convenience, everyone does (Presidential Advisory Committee on Ageing and Future Society, 2005). The term 'AFI' has been used continuously in related laws and policies since the Presidential Advisory Committee on Ageing and Future Society, formerly the Presidential Committee on Ageing Society and Population Policy, decided on the name in 2005. Specifically, in Article 2 of Chapter 1 of the Senior-friendly Industry Promotion Act, AFI is defined as an industry to meet the demand caused by biological aging and the deterioration of the social and economic capabilities of the elderly, and a business that researches, develops, manufactures, builds, provides, distributes, or sells products or services of which the elderly are the main consumers (Shim, 2019). The Senior-friendly Industry Promotion Act was enacted in December 2006 and implemented in 2007 as the importance of the AFI was recognized (Section 2 of Article 2 of the same Act). This Act specified major content on human resource training, R&D promotion, standardization, and human resource training, including the AFI development plan (Jeong, 2017).

AFI is attracting attention as an industry with high developmental potential in the future. This is because the quantitative increase in the elderly population can directly lead to an increase in demand for the AFI. In particular, as the number of elderly consumers with high financial resource increases, the demand for health care and other various quality-of-life related products and services will also increase significantly. In fact, the number of national pension recipients, which was 24.5% in 2006, has been increasing rapidly since 2008, and is expected to increase rapidly to 51.5% in 2030 and 68.2% in 2050. In addition, the participation rate of the elderly population in economic activities is steadily increasing. As a result, the number of elderly with high income through earned income, pensions, and financial assets is increasing, which is gradually emerging as a new consumer group.

On the other hand, although they have lived longer, the disabled life expectancy of the elderly due to disease is also increasing. Moreover, as the family ability to support the elderly weakens, the number of elderly living alone is increasing. Accordingly, it is expected that the demand for goods, services, housing facilities, and so on that can promote convenience in life, especially for the elderly living alone, will greatly increase.

III. Current Status and Prospects of the AFI

The Korea Health Industry Development Institute (KHIDI) divides AFIs into the following nine types: the care industry, which produces and operates care services for the elderly; the pharmaceutical industry related to geriatric diseases; the food industry with nutrition considering the physical characteristics of the elderly; the cosmetic industry that satisfies the aesthetic needs for youth from various aging phenomena; the medical device industry that induces pleasant old age and social activities; the product industry for the convenience of the elderly; the financial industry that maintains a stable flow of old-age income; the residential industry that renovates existing residential houses to be age-friendly, or provides house for the elderly; and the leisure industry for hobbies, entertainment, and health. Each industry has strategic items, and Table 1 summarizes the content.

In Korean, AFI is showing remarkable growth with the implementation of long-term care insurance for the elderly in 2008. In fact, the market size of AFI for the elderly was expected to increase from KRW 27,381 billion in 2012 to KRW 77,801 billion in 2020, showing a 16.61% compound annual growth rate (CAGR) (Moon, 2019). A detailed look at the current status and prospects by sector of the AFI is as follows.

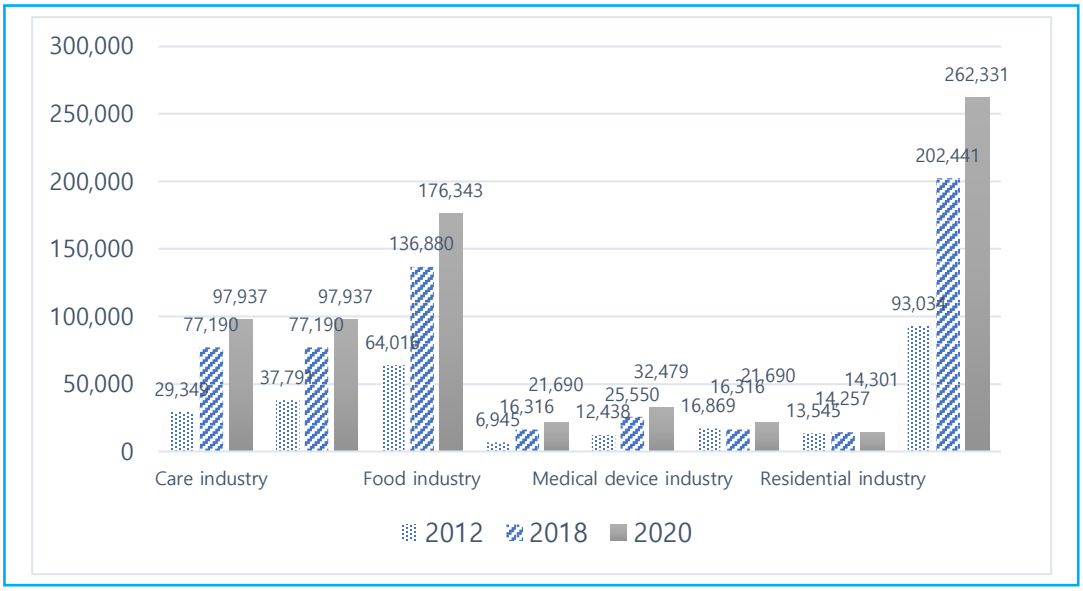
Table 1. AFI Fields

Industrial Sector	Strategic Items
Care Industry	Disease counseling, health examination service, visiting care service, management service
Pharmaceutical Industry	Dementia drugs, diabetes drugs, hypertension drugs, anti-pyretic analgesic anti-inflammatory drugs, tumor drugs
Food Industry	Tofu, traditional fermented food, health functional food, food for special medical use
Cosmetic Industry	Anti-aging, body odor prevention, improving skin dryness and itchiness
Medical Device Industry	Dental implant, dental milling device, dental ceramic material, artificial lens, hearing aid, dental computed tomography X-ray device, combination stimulator, joint therapy device
Product Industry	Personal medical supplies, functional deterioration prevention products, leisure products
Financial Industry	Pension saving, retirement pension
Residential Industry	Home renovation
Leisure Industry	Sports facility operation, cultural and entertainment center, senior-friendly recreation complex

Source: KHIDI (2012).

Fig. 1. Market Size and Prospects of AFI

(100 million Won)



Source: Moon (2019).

1. Care Industry

The care industry refers to a service industry that provides care or treatment for patients with physical and mental disabilities in a comfortable place. Care services, which are the foundation of the care industry, include home care and institutional care. Home care refers to the provision of care and daily life support services by directly visiting the homes of users in need of services. Institutional care is a service that is responsible for overall (health) care or the management for the elderly admitted to welfare facilities for the elderly. Korea's care industry currently has a high proportion of those related to institutional care. Recently, it has been mentioned that there is a need to expand the proportion of home care, which aids users in maintaining an independent life, due to the recent skepticism about the effectiveness and efficiency of institutional care, and the increase in desire for home care (Kim, 2013).

Meanwhile, Park et al. (2009) emphasized that the care industry should be improved to a higher quality level, and that it should be able to provide services that reflect the diverse needs of consumers with financial resources. Accordingly, in recent years, high-quality personalized private care facilities and national and public care facilities that take into account the physical and mental characteristics of the elderly are being provided in a variety of ways.

2. Pharmaceutical Industry

The age-friendly pharmaceutical industry refers to an industry that researches, develops, manufactures, processes, stores, and distributes medicines related to chronic diseases of the elderly. This industry is expected to continuously increase in size due to the increase in the unhealthy life expectancy and the frequent use of medicines by the elderly. In fact, the market size of this industry is expected to grow to 9,793.8 billion won in 2020, with a compound annual growth rate of 12.6% (Moon, 2019). This is equivalent to about half of that of the parent industry in 2020 (Jeong, 2017).

Among the strategic items of the age-friendly pharmaceutical industry, antihypertensive drugs accounted for 14.1% of the total age-friendly pharmaceutical industry. Next, antipyretic, analgesic, and anti-inflammatory drugs accounted for 10.8%. What is particularly noteworthy is that the number of dementia patients and mild cognitive impairment has rapidly increased in recent years, and the use of central nervous system drugs is rapidly increasing. As a result, the CAGR of this industry over the past five years has reached 22.4%, which is higher than that of the entire age-friendly pharmaceutical industry (Jeong, 2017). Therefore, it seems necessary to react more sensitively to these changes.

New drug development entails a long investment period and high risk, but it is possible to create enormous high added value and achieve public values such as extending lives, and improving the quality of that life (Yang, 2021). In that sense, the pharmaceutical industry is an industry that requires government policy support.

3. Food Industry

The age-friendly food industry refers to an industry that produces, processes, manufactures, cooks, packs, stores, transports, or sells food in consideration of the physical characteristics of the elderly. This industry is largely divided into the general, special medical use, and health functional food industry, and the details of each industry are shown in the table below.

In Korea, age-friendly food industries were not activated due to the sluggish effectiveness of the Senior-friendly Industry Promotion Act (Kim, 2018). However, at the end of 2017, the Ministry of Agriculture, Food, and Rural Affairs recommended age-friendly foods as Korean Industrial Standards (KS), and established the legal basis and system. As a result, various types of softened food for the elderly are being developed (Seok, 2020).

Table 2. Composition of the Age-Friendly Food Industry

Food Industry	Content
General	Foods that are nutritious and cater to the physical needs of the elderly on a daily basis
Special Medical Use	Medical foods specially manufactured and processed for the elderly with a limited or impaired ability to normally ingest, digest, absorb, or metabolize general foods
Health Functional	Health functional foods consumed to maintain the physical health of the elderly

4. Cosmetic Industry

The age-friendly cosmetic industry refers to an industry that produces goods with minor effects, such as application to or spraying on the body, in order to maintain or promote health by cleaning the overall body and beautifying the skin and hair (Yang, 2021). The size of the global anti-aging market grew from USD 140.3 billion in 2015 to USD 216.5 billion in 2021, growing at a CAGR of 7.5% during this period. The domestic anti-aging market has also grown since 2011, and is expected to reach approximately 27 trillion won in 2020 (KHIDI, 2017). Accordingly, global cosmetics companies, including Korea, are developing various cosmetics that take into account the skin type of the elderly, such as wrinkle improvement. In addition, there are increasing cases of hiring women in their 50s - 70s as brand models instead of young people to target elderly with financial resources. These facts show that interest in the age-friendly cosmetics industry is increasing.

Meanwhile, China is becoming an aging society with 250 million elderly people. Although the elderly in China are also interested in cosmetics, the industry for it is not well formed in China. Therefore, it is predicted that there will be a new opportunity for the Korean cosmetic industry.

5. Medical Device Industry

The age-friendly medical device industry is an industry that produces instruments, machines, devices, and materials, used alone or in combination, for the purpose of diagnosing, treating, and preventing disease, or diagnosing, alleviating, and correcting deteriorated body structures and functions (Yang, 2021). The main consumer groups of this industry include not only the elderly but also the prospective elderly and caregivers.

Recently, as interest in health has increased, demand for personalized services such as blood glucose meters and body fat meters are increasing. In addition, the medical device market is expected to expand further due to the increase in demand for beauty and plastic surgery, as well as the development of the IT-based 4th industry.

In general, the age-friendly medical device industry is a small-volume, multi-product industry with varied and inconsistent consumption patterns. Accordingly, it is often classified as a small and medium-sized enterprise (SME) industry. However, since this industry requires convergence technology, it will be necessary for the government and large companies to invest in the future.

6. Age-Friendly Product Industry

Age-friendly products refer to those related to auxiliary devices to promote the convenience of the elderly in their health management, care, and daily life, including personal health and medical supplies, daily household goods, residential equipment, information and communication equipment, and leisure goods. When providing

these age-friendly product services, it is most important to ensure that suitability, convenience, and stability match the characteristics of the elderly.

The growth potential of age-friendly products is somewhat limited because awareness of this product is low, and small private companies produce them. Therefore, it is necessary to strengthen technology development and R&D support for age-friendly product manufacturers. In addition, a consumer protection system for users, education for proper product selection and usage, and a campaign of publicity through exhibition space is demanded.

Table 3. Classification System of the Age-Friendly Product Industry

	Major Groups	Sub-Major Groups
Age-Friendly Products	Personal Health and Medical Supplies	Health measurement products, respiratory treatment products, pressure sore prevention products, heat and cold products, massagers, stimulators, oriental medicine supplies, shoes and clothing, exercise and training products, smoking cessation aids, medication supplies
	Daily Necessities	Mobile devices, bath products, defecation products, food products, wigs, oral products
	Residential Equipment	Bedding supplies, chair furniture, safety handles, residential building parts, safety devices for buildings, cleaning supplies, and other residential equipment
	Information and Communication Equipment	Visual equipment, hearing equipment, vocal equipment, drawing and writing equipment, telephone and communication equipment, signal indicators and alarms
	Leisure Products	Sports equipment, hobby products, Pets

Source: Yang (2021).

7. Financial Industry

The age-friendly financial industry refers to services that help ensure stable income for the elderly through the accumulation and management of personal financial assets. This can be said to be an area where the role of the private sector is emphasized mainly for middle or high-income seniors rather than low-income seniors protected by social security policies (Cho, 2016). The vitalization of this industry is positive as a means of preparing for individual retirement, but it can also be expected to have the effect of preoccupying the future financial market by increasing the competitiveness of domestic financial institutions (Park et al., 2009). Therefore, it will be necessary to develop an age-friendly financial product that can satisfy various demands and nurture professional manpower within organizations that can set up a plan for each individual.

8. Residential Industry

The age-friendly housing industry is an industry that provides a safe and independent living environment for the elderly with reduced physical function, including housing supply

and the remodeling of existing houses. The importance of this industry is growing as the proportion of elderly households increases.[2]

The elderly in Korea tend to prefer living in an independent residence rather than entering facilities (Cho, 2016). Unlike in the past, even if there are difficulties in daily life due to aging, more and more people want to live the rest of their lives in their own houses if a house that allows them to live independently is provided. If the house in which they lived is remodeled according to their physical changes, it will be possible to continue the social relationships of the past, which will have a positive effect on the psychological health of the elderly.

For this reason, there is significant interest in the age-friendly housing industry, but unfortunately, even accurate statistics on the related industry or market have not been prepared. In particular, Korea is different from the West, where various housing alternatives for the elderly have already been developed. There are many welfare facilities for the low-income class and high-end senior housing for the very wealthy few, but in fact, it is difficult for many elderly people to find the type of housing they want. Therefore, it is urgent to come up with appropriate measures (Kwon et al., 2018).

9. Leisure Industry

The age-friendly leisure industry is an important industry that can solve various social problems related to the elderly in an aging society (Yang, 2021). In addition, this industry is expected to grow significantly due to the retirement of the baby boomers, who have high levels of education, income, and consumption.

The age-friendly leisure industry can be broadly classified into four categories (Park et al., 2009): recreational activity-related industries, such as cultural centers and senior welfare centers, leisure activities through residential and facility communities, leisure activities centered on rewarding values, and convergence-type leisure industries. An age-friendly leisure industry is characterized by diversified supply and demand, as well as its small scale.There is a high possibility that the industry will be advanced. However, since the leisure of the elderly has the purpose of health promotion as well as relaxation or pleasure, it is necessary to develop various leisure activities considering the characteristics of the elderly.

More recently, the number of elderly that can utilize the Internet or smart devices skillfully is increasing. The possibility of the development of the leisure industry based on the Internet and smart devices is also increasing. Therefore, it is necessary to focus on developing these industries. Lastly, the elderly have many limitations in cost, time, health, and partnership. In this regard, it will be necessary to develop a leisure industry that takes into account these limitations (Yang, 2021).

IV. Policies to Foster AFI

The activation of AFI helps to solve the difficulties of the elderly in life. Not only that, it will also help to overcome the economic recession caused by an aging population. This is because competitive AFI is expected to greatly contribute to the increase in exports to neighboring Asian countries, including China (Lee, 2012).

However, most AFI in Korea is still limited in operation and maintained only for those related to welfare tools, which are benefits of long-term care insurance for the elderly. As a result, the level of development of the industry is very low. Accordingly, the KHIDI suggests four main measures to foster an AFI: the reinforcement of the policy foundation, quality improvement support, market vitalization support, and expert nurturing. Table 4 shows the main content of each measure, and we will look at these in more detail below.

2. The proportion of elderly households was 21.8% in 2019 and is expected to increase to 46.9% in 2045.

Table 4. The Korean Government's Policy to Foster AFI

	Contents
Reinforcement of Policy Foundation	• Formation and operation of the AFI innovation promotion team • Development of Innovation Plan for AFI • A Survey on the age-friendly product industry • Investigation of demand and consumption characteristics of AFI products and services • Policy forum and information exchange on AFI • Operation of the AFI information bank
Quality Improvement Support	• Support for the advancement of age-friendly high-tech convergence care products • Operation of the excellent age-friendly products designation system • Expansion of the excellent age-friendly products and development of quality standards • Development of age-friendly product usability evaluation index • Awards for merit in AFI
Market Vitalization Support	• Customized consulting support for each stage of market entry • Support for participation in overseas expositions for AFI • Age-friendly product distribution conference • Operation of promotion center for age-friendly products
Nurturing Experts	• Operation of graduate schools specializing in AFI • Research on ways to improve the operation efficiency of graduate schools specializing in AFI

Source: Park et al. (2019) data rearranged by researcher.

1. Reinforcement of the Policy Foundation for AFI

In Korea, discussions on fostering AFI have been promoted since 2004. Then, in 2005, the Basic Plan on Low Fertility and Aging Society in Korea was prepared, and in 2006, the Senior-friendly Industry Promotion Act was enacted. In 2007, as the Long-Term Care Insurance Act for the Elderly was enacted, AFI was revitalized, and as a result, the AFI support center and the age-friendly comprehensive experience center were established in 2008.

In order to improve the AFI policy and system as a means of improving the quality of life of the elderly and national economic growth, it is important to discover new agendas. Accordingly, the Korean government formed an innovation promotion team centered on experts in AFI, and in 2019, four strategies and 12 core tasks were created, as shown in Table 5.

Meanwhile, it is also important to continuously grasp the current situation in order to improve policies and systems for AFI (KHIDI, 2012). Accordingly, the KHIDI is trying to discover effective policies by investigating the characteristics of AFI and the consumers. However, it is also important to immediately provide the collected statistical data and information on (rapidly changing) domestic and foreign policies and systems related to AFI through policy forums and information banks.

2. Support for Quality Improvement

The biggest problem with the AFI in Korea is that the industrial structure is mostly made up of distributors centered on imported products, or

Table 5. Innovative Development of AFI (plan)

Strategy	Core task	Practical task
Establishment and Linkage of the AFI platform	Linkage and cooperation with existing platforms	• AF mobile service platform • AF leisure service platform
	(AI-based) AF platform Establishment and connection	• AF emergency safety care service platform • AF smart care home platform (residential) • AF nutritional food service platform
Building of a New AFI Ecosystem	Real life-based aging-friendly technology innovation (R&I)	• Development and utilization of AF technology innovation based on real life
	Private/Public Governance System on AFI	• Establishment of an independent organization at the pan-government level • Establishment and reinforcement of corporate-university-led networks
	Promote the cultivation of experts in AFI	• Advanced training for filed-based talented workers in AFI • Training technical-service-linked experts
Support for Growth of AF Corporate (Scale-Up)	Discover promising industries and strengthen competitiveness of existing industries	• Support for the creation of product-service convergence industry • Support for the creation of new service industries • Support for convergence of existing industries and advanced technologies
	Support for expansion of domestic and overseas markets	• Domestic market development through multi-channel • Company-led overseas market development
	Improvement of regulations and implementation of regulatory sandbox	• Regulatory improvement • Activation of authentication usability evaluation • Designation of special areas for AFI demonstration
	Enhancing financial accessibility for AFI companies	• Enhancing financial accessibility
	Standardization of AF products, service, and related systems	• AF product-service-system standardization • Systematization of AFI classification
Strengthening the Consumption Capacity of the Elderly	Improving the real purchasing power of elderly consumers	• Activation of AF financial services • Review of economic support for elderly consumers
	Enhancing awareness of elderly consumers and providing customized information	• Establishment of website to provide information • Establishment of community-based AF center

Note: AF stands for age-friendly.
Source: Park et al. (2019).

there are many simple copies of overseas products, while domestic producers are concentrating only on supplying long-term care insurance-related products (KHIDI, 2015). In addition, most industries that produce age-friendly products are often small, making it difficult to develop products. In fact, the technology possessed by age-friendly product manufacturers (649 companies) is 27.4% of the total welfare equipment products, so their competitiveness is very low (KHIDI, 2017). According to a survey conducted in 2018, less than half of the 1,400 AFI companies were engaged in R&D activities (47.5%), which was a decrease of 1.3% compared to 2016 (48.8%). Looking at the past support items of AFI, most support focused on simple products such as canes, prosthetics, and safety handles. Product development based on promising technologies (products) in line with global trends was low. Accordingly, Korea's AFI lacked technology, a decisive factor influencing competitiveness, and was highly dependent on imports for most expensive products. According to the market research firm Aging in Place Technology Watch (APTW), the market for technology devices targeting the elderly was expected to grow from $2 billion in 2013 to $20 billion in 2020. Therefore, quality improvement of age-friendly products is becoming a task that can no longer be delayed in AFI.

Capturing this reality, the Korean government has prepared some support policies to improve the quality of AFI. First, the government operates the excellent age-friendly product designation system. This system enhances technological competitiveness by improving the quality of age-friendly products, and also designates and displays age-friendly products for the development of AFI (Kim et al., 2018). It has been in operation since April 2008, and is based on Article 12 of the Senior-friendly Industry Promotion Act.

The second is an effort to discover items of excellent elderly-friendly products. The diversification of products is essential to meet the needs of the elderly. Accordingly, efforts to expand age-friendly products have been continuously made, and in 2019, a position transducer and waterproof sheet were also selected as expanded items. At the same time, the government is enacting quality standards for excellent products and announcing selected items.

The third is to develop indicators for the usability evaluation of age-friendly products and build a database for the results. This work will be able to contribute to the development of AFI in the future because it will create a feedback system to find the improvement direction for age-friendly products.

3. Support for Market Vitalization

As the aging population is a global trend, the demand for AFI will continue to increase in the future. However, AFI in Korean is mostly limited to the domestic market, mainly the public market, and there is little export performance.[3] Moreover, the commercialization of these products is still incomplete, even in domestic market. Therefore, it is necessary to provide opportunities for AFI companies to open up sales channels in domestic and overseas markets, and support to revitalize the market so as to strengthen export capabilities is more urgent than anything else.

In this regard, the government is making efforts such as customized consulting for age-friendly companies, participation of overseas exhibitions, and the operation of public relations centers. Here, customized consulting support is a system that helps industries grow to the next stage using commercialization experts to investigate the needs of industries, supporting the necessary partnering for that stage, and providing consulting related to negotiation and contract signing (Park et al., 2019). In this process, efforts are being made to provide opportunities for companies to develop overseas markets by supporting participation in overseas exhibitions and helping SMEs strengthen export capabilities.

3. Domestic and Export Status of Age-friendly products: Domestic (45,655,216 thousand won, 99.4%) and export (286,428 thousand won, 0.6%) (Park et al., 2019).

4. Nurturing Experts in AFI

Professional manpower is an essential element for the development of a specific industry and strengthening competitiveness. In this regard, it is very important to train and nurture experts in AFI. In response, the Korean government has designated and operated a specialized graduate school for the elderly as a national support project for five years from 2015. Two universities took charge of this project until 2019, and made efforts to produce experts with interdisciplinary knowledge and practical experience required in the industrial field. Unfortunately, however, the employment rate of the produced manpower is low, and has been evaluated that this manpower was not well prepared to meet industrial demand (Park et al., 2019).

Recently, seven ministries and local governments in Korean are promoting projects to foster a field- and practical-oriented of talent in AFI through industry, academia, and research cooperation. In addition, they are looking for ways to efficiently operate a specialized graduate school for the elderly. To this end, they have reviewed the operation methods and systems of pro-growth specialized graduate schools, analyzed the current trends of overseas expert training programs, and conducted focus group interviews (FGI) with experts. As a result, it was found that it was necessary to expand the quantity and quality of education for the elderly by introducing it in undergraduate and non-degree curriculums as well as graduate schools. The development of AFI-related qualifications and training courses – has been suggested, especially emphasizing the introduction of the key technologies of the 4th industrial revolution, along with field experience through industry-university cooperation.

V. Conclusion

The revitalization of AFI is expected to be a main path to help solve various social problems caused by the aging population. This is because AFI based on advanced technology is expected to contribute to the improvement of the quality of life of the elderly, as well as create a huge market that will help economic growth. In fact, many advanced industrial countries, which became aging societies earlier, have made various efforts to develop the industry. Although it is a bit late, Korea has also shown interest in the age-friendly industries since 2005 and is making efforts to establish related policies and systems, including research. However, despite these efforts for nearly 20 years, Korea's AFI is still evaluated as failing to fulfill its role (Cho, 2016; Jeong, 2017). Accordingly, effective strategies for revitalizing this industry are needed above all else. In this regard, this study intends to propose four suggestions that will help revitalize AFI based on the Korean situation, as reviewed earlier.

First, it is necessary to fully consider the characteristics of the demand group. Understanding the target is important for the development of the industry. For this reason, the KHIDI is also conducting a survey on the demand group. However, most are conducted only in the form of a survey that relies on a fixed questionnaire. The difficulties experienced by the elderly in everyday life are very diverse and complex, unlike those of non-elderly subjects. Therefore, as AFI is a project targeting the elderly, a more specific demand survey on the characteristics of the elderly is necessary. In that respect, a qualitative study on the needs of the elderly can be helpful in deriving a more specific plan for this industrial development. In addition, if the opinions of elderly care experts are also investigated, it will be helpful to understand not only the consumption characteristics but also the needs of consumers in more detail. Then, the results of this investigation can serve as important basic data for establishing practical policies for fostering AFI and various strategies.

Second, support for the diversification and quality improvement of AFI products is needed. Korea's AFI is relatively uninterested in fields other than those related to long-term care services. In other words, current AFI in Korea

is not responding to changes in elderly living healthy and active lives (Cho, 2016). In this respect, it seems necessary to actively support the development of technologies that can satisfy the needs of various elderly individuals, especially those related to the 4th industrial revolution. Meanwhile, in order to improve the quality of AFI products, the Korean government is operating an excellent senior-friendly product designation system. However, many age-friendly enterprises have difficult participating in the public certification system because they are small in size. Therefore, customized consulting support should be continuously provided to these companies.

Third, the accessibility of consumers to AFI should be strengthened. Even if excellent AFI products are developed and produced, it is difficult to revitalize the industry unless active marketing accompanies. In fact, many AFI companies are experiencing great difficulties in promoting products and expanding the market, in addition to financial problems (Park et al., 2009). Although exhibitions and public information halls related to AFI are in operation, consumers are often still unaware. For this reason, it is difficult for the elderly or caregivers to obtain information on which products to buy, and where to buy them. Therefore, in order to solve these problems, active private participation is needed in addition to government efforts, and in particular, it will be necessary to promote publicity centered on residential areas in the region.

Fourth, more practical expert training should be provided. The cultivation of experts is one of the most basic conditions for related industrial development. Accordingly, the Korean government has also selected two universities to designate and operate graduate schools specialized in AFI. However, in addition to these degree programs, it is also necessary to provide opportunities for technology and information to converge more freely through non-degree programs. For example, geriatric psychology and care experts lack technical skills, while technical experts lack the details needed by the elderly. Therefore, if opportunities are provided to work together, it will be helpful in nurturing more practical-oriented experts.

Given the evolving demographic trends, societal dynamics, and economic imperatives prevalent in South Korea, accelerating the development of the age-friendly industry has become a pressing concern. Building on this notion, this study is of considerable importance as it delineates potential trajectories for invigorating aging-friendly industries, informed by previous research. Recognizing the industry's projected centrality to South Korea's contemporary and prospective socio-economic landscape, there is a compelling need for expanded research and scholarly discourse anchored in the insights presented herein.

References

Cho, J. E. (2016). The current status and improvement plan of support policies for senior service industry. *Journal of New Industry and Business*, *34*(1), 53-71. http://dx.doi.org/10.30753/emr.2016.34.1.003

Cho, Y. D. (2014). Current status of the aging-friendly industry and its approach. *Community, 70*, 106-113.

Jeong, D. Y. (2017). Age-friendly industry market status and prospects. *Magazine of the IEEK, 44*(12), 16-24.

Kim, J. S. (2018). Customized food and meal service for the elderly: Its management and policy implications. *Health and Welfare Policy Forum, 264*, 57-69. https://kiss.kstudy.com/thesis/thesis-view.asp?key=3633491

Kim, S. B. (2006). A prospect for the "silver" (aimed for the aged) industry: Crisis? opportunity!. *Korean Architects, 6,* 73-75. https://scienceon.kisti.re.kr/commons/util/originalView.do?cn=JAKO200674553401944&oCn=JAKO200674553401944&dbt=JAKO&journal=NJOU00290372

Kim, S. H., Lee, J. S., Hong, K. H., Yeom, H. S., Nam, Y. S., & Kim J. Y. et al. (2018). Development and

relative validity of semi-quantitative food frequency questionnaire for Korean adults. *Journal of Nutrition and Health, 51*(1), 103-119. http://dx.doi.org/10.4163/jnh.2018.51.1.103

Kim, Y. S. (2013. October 16). *A study on standardization of care service provision standards.* Paper presented at the 4th Social Service Development Forum. Seoul, South Korean. https://www.nkis.re.kr:4445/seminarData_view.do?otpId=KIHASA00028869&otpSeq=0#none

Korea Health Industry Development Institute (KHIDI) (2012). *Current status and prospect of the age-friendly industry*. KHIDI. https://www.khidi.or.kr/board/view?linkId=128958&menuId=MENU00324

Korea Health Industry Development Institute (KHIDI) (2015*). 2014 Survey on the status of the aging-friendly product industry*. KHIDI. https://www.khidi.or.kr/board/view?linkId=161977&menuId=MENU00085

Korea Health Industry Development Institute (KHIDI) (2017). *2017 Survey on the status of the aging-friendly product industry*. KHIDI. https://www.khidi.or.kr/board/view?linkId=48747478&menuId=MENU00314

Kwon, O. J., Kim, J. U., & Lee, Y. M. (2018). Analysis on the home modification related system for the elderly. *Journal of the Korean Institute of Interior Design, 27*(2), 24-36. http://dx.doi.org/10.14774/JKIID.2018.27.2.024

Lee, K. J. (2012). The situations and prospects of old-age friendly industries. *Applied Economy, 14*(2), 149-173.

Moon, H. S. (2019). *Tasks and implications for the development of the age-friendly industry in response to changes in the demand of an aging society* (policy report No. 2019-361). Korea Institute for Industrial Economics and Trade. https://www.kiet.re.kr/research/podataView?podata_no=286

Park, H. S., Kim, Y. J., Bae, N. R., & Heo, K. H. (2009). The comparison study between the senior-friendly industry of Korea and that of Japan depending on the paradigm change into the aged society. *Asia Studies, 12*(2), 71-111.

Park, S. M. (2017). The possibility and limitation of age-friendly industry activation policy of the Korean Government: From the first to third plan for ageing society and population (2006-2020), *Journal of the Korean Gerontological Society, 37(1),* 71-111.

Park, S. O., Kim, W. S., Park, I. S., Lee, K. S., Kim, M. S., & Lee, K. Y. et al. (2019). *Aged-friendly industry promotion project result report* (Policy, Aging Friendly NO. 2019-49). KHIDI. https://www.khidi.or.kr/board/view?linkId=48827522&menuId=MENU00085

Presidential Advisory Committee on Ageing and Future Society (2005). *Strategies to revitalize the aging-friendly industry*. PACoAFS. https://www.khidi.or.kr/board/view?linkId=128958&menuId=MENU00324

Presidential Committee on Ageing Society and Population Policy (2006). *Report on the status of aging-friendly industries and policy tasks*. KHIDI. https://www.khidi.or.kr/board/view?linkId=135424&menuId=MENU00928

Seok, J. H. (2020). *The effect of selection on attitude and purchase intention in the context of care food* (Unpublished Master's thesis). Sejong University.

Shim, S. G. (2019). *A study on the opportunities in the aging-friendly industrial markets* (Unpublished Master's thesis). Keimyung University.

Shin, D. S. (2009). Social security expenditure and financial prospect of local governments: Focused on Daegu metropolitan city. *Korean Local Government Review, 11*(1), 127-144. https://www.kci.go.kr/kciportal/ci/sereArticleSearch/ciSereArtiView.kci?sereArticleSearchBean.artiId=ART001343480

Statistics Korean (2021). *Population projection for Korea: 2020-2070*. https://kosis.kr/publication/publicationThema.do?pubcode=PJ&move=gongDiv_PJ

Yang, Y. A. (2021, May 30). Current status and prospects of an aging society and age-friendly industries. Paper presented at the 27th Journal of Health and Beauty Conference. A New Search for One Asia's Beauty Industry, Daegu, South Korea. https://www.earticle.net/Search/Result?sf=3&q=%EC%96%91%EC%98%81%EC%95%A0

ISSN 1946-5130 (Print), ISSN 2470-4733 (Online)
http://dx.doi.org/10.20294/jgbt.2023.19.5.185

The Journal of Global Business and Trade

Journal of Global Business and Trade

https://www.pfw.edu/jgbt

Impact of Economic Policy Uncertainty on the Outward Foreign Direct Investment of Chinese Firms*

Yuhan Meng[a], Gahee Bak[b], Hongshik Lee[c]**

[abc]*Department of Economics, College of Political Science and Economics, Korea University, South Korea*

Received 2 August 2023, Revised 5 September 2023, Accepted 5 October 2023

ABSTRACT

Purpose – This study empirically investigated the effect of Economic Policy Uncertainty (EPU) on the OFDI of Chinese firms. It also explores other factors influencing OFDI, such as market potential, economic openness, firm size, profitability, and the importance of control variables in the analysis.

Design/Methodology/Approach – The panel data was established from 2004 to 2020, and a fixed-effects model was adopted for empirical analysis. EPU data was used as the main explanatory variable, and country-level variables such as overseas market potential, per capita GDP, and degree of economic openness, and firm-level variables such as firm size, capital structure, and return on total assets were applied as control variables.

Findings – The results of regression using a fixed-effects model suggest that rising policy uncertainty in both Chinese and foreign economies reduces Chinese OFDI. OFDI's decisions were also found to be influenced by a firm's characteristics. This negative relationship is influenced by capital flow restrictions, financing constraints, and a focus on the home market. Additionally, foreign economic policy uncertainty (FEPU) in target countries also has a negative impact on Chinese firm OFDI, influenced by currency risk, policy restrictions, and risk assessment, making firms more cautious of cross-border investments.

Research Implications – To promote Chinese firm Outward Foreign Direct Investment (OFDI), the Chinese government needs to provide a stable and predictable policy environment, as economic policy uncertainty negatively affects OFDI. Additionally, the analysis highlights the importance of understanding and mastering foreign market conditions, including financial policies, legal systems, infrastructure, and business environments, before making OFDI decisions.

Keywords: Chinese firms, economic policy uncertainty, outward foreign direct investment
JEL Classifications: F21, F23, O20

** This study is revised and complemented master thesis by Meng Yuhan (2023).*
*** Corresponding Author, Email: honglee@korea.ac.kr*
© 2023 International Academy of Global Business and Trade. All rights reserved.

I. Introduction

Since 2000, China's government has encouraged firms to invest internationally in an effort to participate in global competition, promote reform, and expand openness. This strategic direction, which is driven by economic globalization, enhances China's engagement with the rest of the world and prompts Chinese firms to engage in outward foreign direct investment (OFDI) and international market competition. In 2013, under the 'One Belt, One Road'[1] initiative, China significantly increased its OFDI, becoming the second-largest global investor with a flow of $145.67 billion. In 2016, Chinese firms achieved the highest net OFDI flow in two decades, totaling $196.15 billion, a significant increase from 2003's $2.9 billion (UNCTAD, 2017). By transferring excess capacity, upgrading industries, and promoting technological progress, China's OFDI drives industrial upgrading, facilitates international cooperation, expands business scope, and enhances China's international competitiveness.

China has actively promoted its OFDI; however, due to the global economic slowdown caused by the 2008 financial crisis and the COVID-19 pandemic, the international investment environment has become increasingly unfavorable, leading to a rise in uncertainty and instability in the world economy. Indeed, the global economic policy uncertainty[2] index soared from 84.57 in April 2000 to 437.25 in April 2020.

The introduction of successive economic stimulus policies, such as financial institution assistance programs in the U.S., economic austerity policies in the EU, and loose monetary policies in China, globally stabilized the short-term macroeconomic situation. However, they led to issues such as overcapacity, rising prices, low demand, and a slow economic recovery. Government interventions and increased policy uncertainty have further amplified macroeconomic fluctuations, thereby prompting academic interest in the impact of economic policy uncertainty on recessions and recoveries.

Introducing various policies can create economic policy uncertainty, which is a significant trigger for economic recession. For example, China's emphasis on the 'One Belt, One Road' initiative, along with other macroeconomic policies, aims to foster international economic cooperation and competition. However, it also introduces uncertainties that impact firm investment decisions domestically and internationally, thus highlighting the need for a further examination of the effects of policy volatility on businesses.

Few studies by Chinese scholars exist on the impact of economic policy uncertainty on Chinese firm outward investment. A review of studies by other scholars around the world shows that most scholars believe that fluctuations in EPU can significantly affect the external business environment of firms. According to Hayashi and Prescott (2002), the decline in domestic investment in the 1990s was brought on by the rising level of uncertainty in the Japanese market environment and the resulting economic downturn. According to Bhagat et al. (2016), India's GDP and fixed investment were significantly impacted negatively by economic policy uncertainty. They also predicted that the significant rise in EPU in India between 2005 and 2013 would result in a 1.36% decline in fixed asset investment, and a 0.56% decline in GDP. According to Cheng (2017), South Korea's economic development was negatively impacted by domestic and international EPU. Because of Korea's high level of international openness and strong international ties, foreign uncertainty shocks have a greater impact on the Korean economy than domestic uncertainty shocks do. Domestic economic policies are also relatively

1. Through infrastructure development, trade facilitation, financial cooperation, and cultural exchanges, China aims to foster regional integration and stimulate economic growth along the routes of the ancient Silk Road.
2. Economic Policy Uncertainty Index website (http://www.policyuncertainty.com)

stable, which limits the effect on Korean economic fluctuations.

Uncertainty in economic policy, according to some scholars, discourages firms from investing. Almeida and Philippon (2007) argued that, from the perspective of cash holdings, firms tend to choose to hold enough cash to cope with the contingencies arising from economic uncertainty. This also indirectly causes a decrease in firm willingness to invest, as well as investment size. Panousi and Papanikolaou (2012) contended that an increase in EPU leads to an increase in firm financing costs from the perspective of cost control. The increase in risk-averse behaviors chosen by firm heads prevents firms from engaging in OFDI behavior. Kim and Kang (2022) explained that informal economics in CIS countries have a negative impact on attracting FDI because foreign investors feel that their assets cannot be protected. In other words, it can be interpreted that uncertainty in the national system itself affects FDI decisions. Bae and Lee (2021) analyzed the determinants of China's FDI locations, and concluded that the institutional quality of the investment destination country does not have a significant impact because China has a high proportion of state-owned enterprises.

Of course, a few scholars hold the opposite view from the perspective of investment motives. Aghion et al. (2005) argued that an increase in EPU will increase firm willingness to invest, learn advanced technologies from the foreign country, and improve market competitiveness through technological innovation, thus realizing long-term gains for OFDI firms looking to learn advanced technologies. Carvalho (1988) analyzed the situation wherein a firm has made significant early preparations for making OFDI and invested in significant silent costs that were irreversible from the perspective of flexibility in the choice of corporate investment behavior. In this case, firms will not easily suspend or change their OFDI plans as EPU in the home country grows. This increases interest in this study's topic, which is the impact of economic policy uncertainty on Chinese OFDI.

Therefore, this study investigates the impact of China's overall economic policy uncertainty on firm OFDI. It holds significant implications for both the government and firms. It is important to reduce market risk through consistent and stable policy establishment, regulation of economic policy uncertainty, and rigorous policy making if policy uncertainty negatively impacts a firm's OFDI. Moreover, it can help as a warning that an uncertain economic background may pose a risk to businesses. Furthermore, it is also important for companies operating in an international environment to be sensitive to changes and uncertainties. This is because it is necessary to adjust the OFDI strategy according to national economic trends to maintain the enterprise's sustainable operation.

In recent years, the volatility of China's economic policy uncertainty has also increased, and the overall uncertainty is higher than the global level. This study analyzes the relationship between Chinese OFDI and macroeconomic policy uncertainty, and clarifies the effects and paths of economic policy uncertainty on Chinese OFDI. It provides a basis for further improving the quality and efficiency of Chinese enterprise "go out" at the policy recommendation level, and to better serve China's "One Belt, One Road" strategic layout.

This study is structured as follows. Chapter 2 examines China's policy uncertainty and FDI status, and Chapter 3 introduces the analysis data and empirical analysis model. Chapter 4 discusses the results of the empirical analysis. Finally, in Chapter 5's conclusion, the research findings are summarized, and the policy implications are discussed.

II. China's Economic Policy Uncertainty and Firm OFDI

Under the background of the new economic normal, it is becoming a new trend for Chinese enterprises to 'go out' to conduct outward investment activities, and China is becoming a major outward direct investment country. By the

end of 2021, Chinese investors had established 46,000 OFDI enterprises in 190 countries, accounting for 10.5% of global OFDI flows and ranking second globally in terms of flow. Since China's accession to the World Trade Organization in 2001, trade and outbound investment conditions have improved. This is shown in Table 1.

Since 2016, the state has continuously introduced policies that support and encourage enterprises to "go out". Regarding outbound investment, China is required by national policy to focus on both expansion of quantity and improvement of quality. In 2017, the international political and economic environment shifted as a result of frequent trade friction between China and the U.S., which triggered a trade war. For the first time since its accession to the World Trade Organization, the growth rate of China's OFDI was negative, down 19.3% from the previous year. However, in the general environment of overall decline in the economic development of various countries, China's total OFDI remains among the highest in the world.

Table 1. China's OFDI Flows & Stocks (2004-2020)

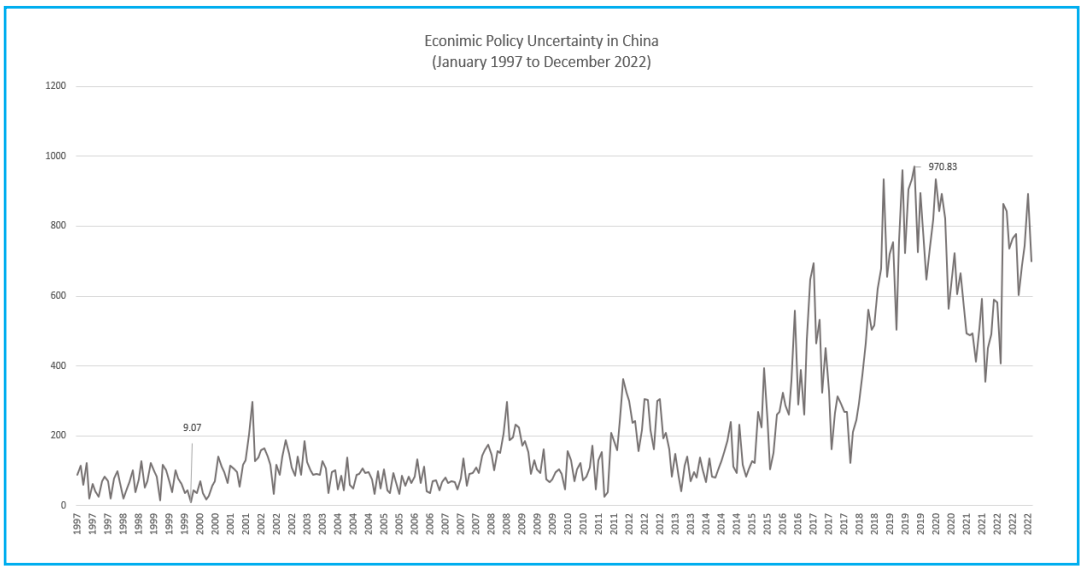
Year	Flow			Stock	
	Amount (billion USD)	Global Rank	Increase over Previous Year (%)	Amount (billion USD)	Global Rank
2004	55.0	20	93.0	448.0	27
2005	122.6	17	122.9	572.0	24
2006	211.6	13	43.8	906.3	23
2007	265.1	17	25.3	1 179.1	22
2008	559.1	12	110.9	1 839.7	18
2009	565.3	5	1.1	24 57.5	16
2010	688.1	5	21.7	3 172.1	17
2011	746.5	6	8.5	4 247.8	13
2012	878.0	3	17.6	5 319.4	13
2013	1078.4	3	22.8	6 604.8	11
2014	1231.2	3	14.2	8 826.4	8
2015	1456.7	2	18.3	10 978.6	8
2016	1961.5	2	34.7	13 573.9	6
2017	1528.9	3	-19.3	18 090.4	2
2018	1430.4	2	-9.6	19 822.7	3
2019	1369.1	2	-4.3	21 988.8	3
2020	1537.1	1	12.3	25 806.6	3

Source: Directory of Chinese Foreign Investment Institutions (2023).

Simultaneously, it demonstrates that changes in economic policies have an obvious impact on Chinese enterprise OFDI. From Table 1, we can visualize large fluctuations in OFDI flows over multiple years. The "One Belt, One Road" policy was implemented in 2013, and the 'Go Global' policy was announced in 2016. In 2017, trade friction between China and the US began.

Because China's economy has entered a new normal, economic policies have been continuously adjusted, and policy fluctuations are more frequent. China has continuously adjusted its monetary, fiscal, and industrial policies to fit its general macro-objectives. Concurrently, China has reacted to multiple pressures from foreign uncertainties in addition to launching a series of macroeconomic policies to stimulate China's economic rebound, which has significantly increased domestic economic policy uncertainty. This uncertainty will lead firms to increase risk expectations, thereby influencing investment decision-making behavior.

Fig 1. Trends in China's Economic Policy Uncertainty Index (1997-2022)



Source: Economic Policy Uncertainty (2023).

The overall trend can be seen in Fig. 1. Over the past 20 years, China's economic policy uncertainty index[3] has exhibited an overall upward trend, with the lowest value being 9.07 in February 2000, and the highest value being 970.830 in October 2019, an increase of approximately 107 times. China's EPU index fluctuated less between 2000 and 2015, with the index staying within 200 and remaining relatively stable.

The trade war between China and the U.S. has resulted in a sharp rise in uncertainty regarding China's economic policies, while the impact of COVID-19 and coercive government measures have further heightened economic policy uncertainties. This challenging environment and global economic stagnation have resulted in greater volatility in international economic policies, including a slowdown in outbound

3. The newspaper-based methods by Baker et al. (2016). See Appendix.

direct investment by Chinese companies and lower growth rates in national outbound direct investment flows.

China is currently stepping into a new stage of building a moderately prosperous society in all aspects. Various major economic policies, such as an innovative foreign investment management system, a personal income tax law re-revision, and a strict cross-border e-commerce platform, have been implemented to adjust the direction of economic development in a timely manner. From the introduction of new policies to full acceptance and familiar application by the market, some time is still required. Most companies will still choose countries with less volatile economic policies for OFDI in search of a more stable business environment. However, this kind of OFDI activity, which aims to avoid risk, is not helpful to China's economic development, and the state should introduce appropriate policies to discourage such investment behavior. Thus, it can be observed that fluctuations in China's economic policy environment will not only impact the investment behavior of enterprises but will also prompt a shift in the purpose of OFDI. Changes will also be made to the extent of the resultant contribution to the enterprise and even the country. In today's increasingly difficult economic and political situation in China and globally, the rational formulation of economic policies while minimizing the negative impact of economic policy uncertainty is one of the current issues that academics and government agencies should focus on.

III. Data and Empirical Model

1. Model[4]

To test the effect of economic policy uncertainty on Chinese enterprise OFDI behavior, both Chinese economic policies and foreign country factors affecting economic policies are analyzed to include the influencing factors affecting enterprise OFDI behavior more comprehensively. Empirical analysis combines Chinese and foreign economic policies with firm-specific characteristics to conduct a comprehensive analysis.

$$OFDI_{kjt} = \beta_0 + \beta_1 CEPU_{t-1} + \beta_2 FEPU_{j,t-1} + \beta_3 \sum Control + \beta_4 \sum Year_t + \beta_5 \sum Industry + \varepsilon_{kjt} \quad (1)$$

Where k represents individual enterprises, j represents the host country j, t represents the year, and t-1 means lagging year t by one period. The dependent variable outward foreign direct investment (OFDI) is the variable that determines whether the firm makes OFDI. If firm k makes direct investment in foreign country j in year t, the dependent variable (OFDI) is set to 1; if not, it is set to 0. The dependent variable is a binary dummy variable that indicates whether an enterprise makes OFDI. Enterprise k takes 1 for OFDI behavior in year t to country j, and 0 for none. The data was obtained from the Directory of China's Foreign Investment Institutions, and the definition of an investment is an enterprise legally established on the territory of the People's Republic of China. Ownership refers to a non-financial enterprise or acquiring ownership, control, management, and other interests in a non-financial enterprise outside of China through new establishment, mergers and acquisitions, and other means. In other words, if an enterprise accidentally registers subsidiaries,

4. A panel unit root test was performed on the variables included in the model, and as a result, it was found that a unit root does not exist.

joint ventures, and associates in mainland China, it will be considered to have made OFDI in the registration year.

Core independent variables in period t-1 are the Chinese economic policy uncertainty (CEPU) index and the host country economic policy uncertainty index foreign economic policy uncertainty (FEPU). These are used to measure the degree of economic policy uncertainty in foreign and home countries. The difference between the two is the mainstream media that each country obtains. The majority of the literature currently employs two types of Chinese economic policy uncertainty indices, one of which is constructed using the South China Morning Post (SCMP) as a text screening platform in Hong Kong, China (Baker et al., 2016). FEPU represents the foreign country's EPU index. After statistical analysis, the percentage of each type of vocabulary was calculated, and the EPU index for each country was constructed as described in the previous section. In this study, the arithmetic mean of monthly data for 12 months per year for each country is used as the annual data for that country for a given year. Ten countries are included, namely the United States, Singapore, Australia, the Netherlands, the United Kingdom, Germany, Canada, Sweden, Russia, and Korea.

∑Control is the second control variable, which includes country-level influences and firm-level influences to control for other influences. The foreign country market potential (PGDP) is measured by the foreign country's GDP per capita. The larger the market size of the foreign country, the greater the demand for the firm's products or services, the more favorable for the firm to achieve its overseas investment objectives, and the stronger the willingness to invest. GDP per capita indicates a country's economic level and the size of the foreign country's population. Most enterprises tend to invest in countries with high level of economic development, complete infrastructure, and large market size. Some companies also choose to invest in countries with underdeveloped markets, and investment decisions are largely influenced by the quality of products or services. Therefore, the indicator of GDP per capita is included in the scope of this study's empirical study.

Foreign country economic openness (OPEN) is measured by the foreign country's total import and export trade as a share of GDP. The greater a country's economic openness, the less it restricts the flow of capital, trade, people, information and other factors, the lower the economic and political risks multinational enterprises face when making OFDI, and the greater their propensity to invest in such countries. Moreover, considering that the economic openness of the foreign country involves the transparency of various economic, political, legal, and cultural institutions, it is difficult to quantify it specifically. On the contrary, trade volume, as a quantifiable indicator of a country's openness to the outside world, has a certain degree of representativeness, so this study selected the foreign trade dependence of the host country to measure the foreign country's economic openness.

The foreign country's natural resource endowment (RE) is expressed as a percentage of exports of mineral and metal export commodities. China's overseas investments are concentrated in the manufacturing, mining, and power supply industries, mainly to obtain foreign natural resources, such as coal and natural gas. Clearly, natural endowment is an important locational advantage for a country. China's important metal resources are mainly imported from countries along the "Belt and Road", South American economies, the European Union, Japan, and the United States. China's overseas investments in minerals and metal resources are substantial, and trade involves many foreign countries. Therefore, the proportion of mineral and metal resource exports in commodity exports from foreign countries is included in this study.

The data of imports of goods from developing economies outside the region (IMPORT) is a percentage of total merchandise imports, representing the sum of the reporting economy's merchandise imports from other developing economies in other World Bank regions as

determined by the World Bank's Classification of Economies. Data are expressed as a percentage of the economy's total merchandise imports. Data are only calculated if at least half of the economies in the partner country group have complete data. Developing economies are defined as those that are substantially more industrialized. It has been shown that developing economies play a significant role in the development of global economic integration. Developing economies' agricultural operating conditions and trends have an impact on international trade that cannot be ignored. The intensification of trade has resulted in a significant increase in the openness of developing economies. Their growth is dependent on international trade, and they strive to increase their import and export capacities to the greatest extent possible. To enhance technological progress through international trade and narrow the actual gap with economically advanced economies, this study adds sub-data to the research model regarding China's economic development.

In addition to external factors, firm OFDI can also be influenced by numerous internal factors. In this study, three firm-level control variables are selected: firm size (SIZE) capital structure (LEV), measured by the gearing ratio, and operating capacity (ROA), measured by the return on total assets (ROA).

In addition, it is believed that industry differences influence outward firm investment behavior. We also control for industry fixed effects (industry). The industry fixed effects are distinguished by the SEC's most recent 2012 industry classification standard. The National Bureau of Statistics proposed this standard based on the homogeneity principle of economic activities to classify national economic industries. That is, each industry category is subdivided according to the nature of the same economic activity, such as opposed to preparation, accounting system, or sectoral management. The national economic industry is divided classified using the line classification and hierarchical coding methods into four levels of categories, major categories, medium categories, and small categories. The code consists of one Latin letter and four Arabic numerals.

This study draws on the treatment of Lu and Dang (2014). Factor intensity was used to perform cluster analysis on statistical industries. Based on the proportion of fixed assets and the proportion of R&D investment expenditure, all enterprises are classified into three major categories: labor-intensive industries, capital-intensive industries, and technology-intensive industries. The classification criteria are detailed in Table 2. Among these, labor-intensive is assigned the value 1, capital-intensive is as assigned the value 2, and technology-intensive is assigned the value 3.

Table 2. Method of Differentiation of Industry Fixed Effects

Feature density	Industry name and code
Labor-Intensive	Agriculture, forestry, animal husbandry and fishery (A), mining (B), food and beverage, textiles, clothing and fur, wood furniture (C3-C21), electricity and gas production and supply (D), construction (E), wholesale and retail trade (F), transportation (G), sports and entertainment (R), general category (S)
Capital-Intensive	Paper printing, petrochemicals and plastics, metals (C22-C33), real estate (K70), social services (L, J, H, O, Q)
Technology-Untensive	Electronics, machinery and equipment, pharmaceutical and biological products, other manufacturing industries (C34-C43), information services (I), scientific research (M)

Enterprise size (SIZE), as an enterprise control variable, can accurately reflect enterprise variability. Theoretically, the larger the enterprise, the more abundant its capital reserves, the more advanced its R&D technology, and the greater its number of employees and capabilities, allowing it to assume greater risks associated with OFDI. EPU is predicted to have a smaller effect on the OFDI behavior of larger firms. To examine the impact of firm size on the subject of this paper, firm size is added to the list of control variables.

A company's capital structure (LEV) is an important financial indicator. It centrally reflects the ratio of a company's capital to its liabilities, which affects the company's strategic decisions. An uncoordinated or unreasonable ratio of capital to liabilities implies that a firm lacks sufficient cash flow to support its OFDI activities, thus hindering the pace of overseas direct investment activities. To evaluate the capital structure of the firm, this study incorporates the gearing ratio in the empirical study.

Profitability (ROA) can reflect the business condition of an enterprise, and is the core competitiveness of an enterprise in the future. In addition, OFDI requires enterprises to have adequate capital and stable operating capacity. If enterprise profitability is low, it is difficult for it to gain a capital advantage in the fierce market competition with similar enterprises in a foreign country. Therefore, when an enterprise has strong profitability, it means that the enterprise is in good operating condition and has a stable capital inflow, which can provide financial and technical support for overseas investment acquisition. It also assists enterprises in obtaining external financing and expanding financing channels, thus maintaining overseas investment activities over time. This implies that, compared with enterprises with low profitability, enterprises with high profitability have greater capital and resource advantages, and thus are more inclined to make outward direct investment. In this study, we use ROA, the return on capital, as a proxy variable for corporate profitability, as is customary in academia. These variables have been used as control variables in analyzes related to Chinese firms. Firm size (SIZE) and the asset-liability ratio (LEV) were also used as control variables by Wu and Jin (2022) when analyzing the impact of blockchain technology on the quality of accounting information of Chinese firms. Bae et al. (2022) used firm leverage (LEV), performance (ROA), and firm size (SIZE) as control variables when looking at the impact of CSR activities on the real earning management on Chinese firm cost of debt. Gao and Jin (2022) used firm-level variables such as SIZE and LEV when studying the relationship between financial technology and the innovation of Chinese firms. Hu et al. (2022) used ROA and firm-financial leverage (LEV) as control variables in a study on the crowding-out effect related to Chines state-owned enterprises.

∑Year and ∑Industry are dummy variables to control for unobserved factors. To mitigate the interference of the model's endogeneity problem on the regression results, the core explanatory variables are assumed to be one period behind.

We matched the A-share listed companies in the Guotaian database with the Directory of Chinese Foreign Investment Institutions and obtained the data used in this study. The scope of the study is from 2004 to 2020. Due to the relatively late start of Chinese OFDI and the untimely update of individual index data contained in this paper, 2004 is chosen as the initial year. This study matches data related to the timing of OFDI, the countries of investment, and whether OFDI was made by A-share listed companies in China. Following statistical analysis and collation, the empirical study's final sample contains three-dimensional unbalanced panel data of OFDI of 116 A-share listed companies in 10 countries from 2004 to 2020, with a total of 19,890 valid observations. The basic statistics are as follows.

Table 3. Data Sources and Interpretation

Variable Property	Variable	Implication	Data Source
Dependent Variable	OFDIkjt	Whether firm k made OFDI in country j in year t	(1) Directory of Chinese Foreign Investment Institutions
Independent Variables	CEPUt-1	EPU Index for China in year t	(2) EPU Index website
	FEPUjt-1	EPU index of country j in year t	
Control Variables (country-level)	PGDPjt	GDP per capita in country j in year t	(3) World Bank
	OPENjt	Economic openness of country j in year t (trade dependence)	
	REjt	Mineral and metal exports of country j as a share of merchandise exports in year t	
	IMPORTjt	Country j's imports of goods from developing economies outside the region in year t	
Control Variables (firm-level)	SIZEkt	The size of year t k enterprises	(4) CSMAR Database
	LEVkt	The gearing ratio of firm k in year t	
	ROAkt	Year t k corporate profitability	

Table 4. Statistical Analysis

VarName	Obs	Mean	SD	Min	Max
OFDIkjt	19890	0.0310	0.1734	0.0000	1.0000
CEPUt-1	19890	1.2533	0.8217	0.5044	3.6336
FEPUj,t-1	19890	1.3879	0.7529	0.4303	5.4277
Log(PGDP)	19890	10.5531	0.5295	8.3193	11.1294
OPEN	19890	7.8136	7.0194	1.8190	34.3480
RE	19890	0.6436	0.8622	0.0720	4.0000
IMPORT	19890	2.8375	1.2500	0.2648	5.1014
SIZE	19890	22.9228	1.5300	18.8100	28.1935
LEV	19890	0.5092	0.1915	0.0000	1.1700
ROA	19890	0.0521	0.0620	-0.8489	0.4276

IV. Results

The impact of economic policy uncertainty in China and foreign countries on firm OFDI was examined. Because the study is on the impact of policy changes on firm investment behavior, it is more reasonable to use one-period lagged data. Moreover, multiple regressions were conducted by excluding insignificant variables. Column (4) was finally selected, and the results were obtained after excluding the firm control variable "LEV". The regression results are shown in Table 5.

Table 5. Baseline Regression Results

Variable	(1)	(2)	(3)	(4)
CEPUt-1	-0.030*** (0.004)	-0.030*** (0.004)	-0.030*** (0.004)	-0.030*** (0.004)
FEPUj,t-1	-0.007*** (0.002)	-0.007*** (0.002)	-0.007*** (0.002)	-0.007*** (0.002)
PGDP	0.018** (0.008)	0.018** (0.008)	0.018** (0.008)	0.018** (0.008)
OPEN	-0.006*** (0.001)	-0.006*** (0.001)	-0.006*** (0.001)	-0.006*** (0.001)
RE	-0.026*** (0.059)	-0.026*** (0.006)	-0.026*** (0.006)	-0.026*** (0.006)
IMPORT	0.036*** (0.010)	0.036*** (0.010)	0.036*** (0.010)	0.036*** (0.010)
SIZE	0.005 (0.003)	0.005* (0.003)		0.004* (0.003)
LEV	-0.004 (0.017)	-0.011 (0.015)	0.000 (0.016)	
ROA	0.045* (0.025)		0.050* (0.025)	0.047** (0/022)
Year	-2.966*** (0.316)	-2.981*** (0.318)	-2.875*** (0.309)	-2.968*** (0.319)
INDUSTRY	Yes	Yes	Yes	Yes
Number of Obs.	19,890	19,890	19,890	19,890
R-sq	0.038	0.038	0.036	0.038

Note: Robust t-statistics in parentheses ***p<0.01, **p<0.05, *p<0.1.

The regression results for the 19,890 experimental samples show that CEPU regression results are significantly negative at the 1% level of significance. This indicates that the firms are less likely to make OFDI as the index of Chinese EPU increases. There could be several reasons for this, including capital flow restrictions. When economic policy uncertainty is high, the government may restrict capital flows to control financial market volatility and capital outflows. These may include restrictions such as tighter controls on foreign exchange and increased capital control measures. These restrictions may make it increasingly difficult for companies to make OFDI, thereby limiting their capital liquidity and flexibility. Second, Chen et al. (2019) reached

the same conclusion that when the uncertainty of China's economic policies increases, OFDI firms face greater financing constraints and their endogenous financing funds are constrained. Moreover, firms have a harder time obtaining funds from external banks and equity markets, which inhibits OFDI. Third, when occupying home market opportunities in the presence of high economic policy uncertainty, firms are more likely to seek opportunities within the domestic market to secure position. FEPU regression results are also significantly negative at 1% level of significance. This indicates that the greater the index of economic policy uncertainty in a foreign country, the less likely it is for Chinese firms to make OFDI. Several factors contribute to this, including currency risk and exchange rate fluctuations. Uncertainty in foreign economic policies could result in greater currency fluctuations in the target country. This can increase the exchange rate risk for Chinese companies making OFDI. Uncertain economic policies may lead to uncertainty in currency devaluation or appreciation expectations, causing firms to be more cautious of international investments. Second, policy restrictions and protectionism are an issue. Foreign economic policy uncertainty may lead to policy restrictions and protectionist measures. Policy shifts and uncertainties may result in an increase in OFDI barriers, such as investment controls and market access restrictions. This will reduce the possibility of Chinese companies making OFDI. Third, the purpose of risk evaluation. When making OFDI, enterprises must conduct risk assessment, including policy risk assessment. Zhu (2019) suggested that the increase in foreign economic policy uncertainty will make the foreign market environment more complex, companies will reduce cross-border investment for market-seeking purposes, and hold a wait-and-see attitude toward such investment. This suggests that Chinese firms tend to adopt a conservative wait-and-see strategy, and reduce their foreign direct investment to reduce risk whenever economic policy uncertainty in the home country or abroad rises in the previous year.

The regression results of the other control variables are analyzed as follows. There is a positive correlation between the market potential of a foreign country (PGDP) and the probability of OFDI by firms. This indicates that the higher the market potential of a foreign country, the higher the probability of Chinese firms investing directly in that country. There are two reasons for this. First, a higher GDP per capita usually implies a higher level of consumption power and demand in that country. Chinese companies can enter such a country through direct investment to meet local consumer demands for high-quality products and services, thereby increasing market share and revenue. Second, countries with a high GDP per capita usually have greater technological and intellectual innovation capacity. By making direct investments in these countries, Chinese companies can acquire advanced technology, management experience, and market insight, thereby facilitating technological upgrading, boosting the competitiveness of domestic enterprises. The level of economic openness of foreign countries (OPEN) correlates negatively with the probability of OFDI by firms, indicating that the higher the level of economic openness of foreign countries, the less attractive it is for Chinese firms to make OFDI. This may be because the greater the openness of a foreign economy, the greater the opportunities and resources. As a result, Chinese firms invest more time and energy to enter the market and ensure success. In addition, foreign governments may adopt protectionist policies that restrict foreign firms from making direct investments in their countries, thus diminishing the attractiveness of OFDI by Chinese firms. However, there is a significant positive correlation with a foreign country's import of goods from developing economies outside the region (IMPORT). This indicates that when making overseas investments, Chinese firms prefer to consider the demand degree of the foreign country rather than the supply degree of the foreign country itself. In addition, the foreign country's natural resource

endowment (RE) is significantly and negatively related to the probability of enterprise OFDI. This indicates that the larger the share of natural resources exports in the foreign country, the greater the likelihood that China will import resources to meet the domestic market demand, and the lower the likelihood that Chinese firms will engage in OFDI.

From the firm side, the size of the firm (SIZE) is significantly and positively related to the probability of OFDI by the firm at the 1% level of significance. The reasons first include financial stability. Larger firms usually have greater financial resources and can more easily afford the required capital expenditures for OFDI. Direct investment involves high investments such as purchasing assets, building facilities, and conducting marketing. Larger companies can finance or invest with their own funds more easily, thus increasing the probability of OFDI. Second are the technological and innovative benefits. Larger enterprises usually have technological development and innovation advantages. They may have self-developed technologies, patents, and core competencies. These technological and innovative capacities can contribute to OFDI by enhancing product competitiveness and market share. However, this impact is insignificant. There are three reasons for this. First are resource constraints. Theoretically, larger firms have more capital and resources, but in practice they may face other capital needs and constraints. These constraints may arise from financial constraints, debt burdens, operating costs, and the need for other investment plans. Thus, while larger firms may have the potential to make OFDI, due to resource constraints, they may not be able to fully capitalize on this opportunity. Second, business focus. Larger firms may be more focused on consolidating and expanding domestic market position, which is likely to be the long-term source of profits. This may make them less interested in investing in international markets, or less likely to pursue outbound direct investment. Rather than investing in new international markets, firms may prefer to expand within existing core markets. Third are legal and policy restrictions. Some countries impose restrictions and regulatory measures on OFDI, especially for larger firms. These legal and policy restrictions may expose larger firms to additional challenges and uncertainties, thus decreasing the probability of OFDI. The profitability of enterprises (ROA) has a positive impact on Chinese enterprises OFDI. The reasons are as follows. First is the reason of cash flow. High profitability firms can often generate more cash flows and profits on their own and have more funding sources. This facilitates fundraising efforts for OFDI. High profitability increases a company's creditworthiness and attractiveness. This leads to better financing terms and an expansion of the scale and scope of outward investment. Second, it increases competitiveness. Firms with greater profitability are usually more competitive. High profitability reflects a firm's efficiency, capacity for innovation, and ability to provide products and services with a competitive advantage. This makes the firm more attractive and capable of entering and developing foreign markets, as well as better at competing globally with other firms. Increased profitability improves a firm's negotiating power and position in foreign investments. Moreover, each year contributes -2.96 to the change in the dependent variable OFDI, meaning as the year increases, OFDI decreases.

The robustness test was conducted by substituting the previous year's EPU index with the current year's index. If the lagged term is not used, the default economic policy change in the current year has an immediate impact on the decision making of corporate decision makers in the current year and on corporate OFDI at that time. As shown in Table 6, the regression results for CEPU are significantly negative at the 1% level of significance, and the regression results for FEPU are significantly negative at the 1% level of significance. The previous regression results of the benchmark model have not changed. The robustness of the benchmark model is fully illustrated.

Table 6. Robustness Test Results

Variable	(1)	(2)	(3)	(4)
CEPUt-1	-0.009** (0.004)	-0.009** (0.004)	-0.009** (0.004)	-0.009** (0.004)
FEPUj,t-1	-0.007*** (0.002)	-0.007*** (0.002)	-0.007*** (0.002)	-0.007*** (0.002)
PGDP	0.067*** (0.010)	0.067*** (0.010)	0.067*** (0.010)	0.067*** (0.010)
OPEN	-0.004** (0.001)	-0.003** (0.001)	-0.003** (0.001)	-0.003** (0.001)
RE	-0.029*** (0.006)	-0.029*** (0.006)	-0.029*** (0.006)	-0.029*** (0.006)
IMPORT	0.015 (0.010)	0.015 (0.010)	0.015 (0.010)	0.015 (0.010)
SIZE	0.005 (0.003)	0.005* (0.003)		0.005* (0.003)
LEV	-0.008 (0.017)	-0.011 (0.017)	-0.004 (0.017)	
ROA	0.018 (0.024)		0.023 (0.024)	0.023 (0.023)
YEAR	-3.326*** (0.373)	-3.335*** (0.375)	-3.211*** (0.367)	-3.328*** (0.373)
INDUSTRY	Yes	Yes	Yes	Yes
Number of Obs.	18,720	18,720	18,720	18,720
R-sq.	0.015	0.015	0.014	0.015

Note: Robust t-statistics in parentheses ***p<0.01, **p<0.05, *p<0.1.

V. Conclusion

As a result of the promotion of China's going-out policy, an increasing number of enterprises are opting to enter the international market, and both the flow and stock of Chinese OFDI have experienced rapid and steady growth. Regarding empirical analysis, this paper chose a panel fixed effect model to determine the relationship between the role of economic policy uncertainty and Chinese firm OFDI. Overall, the analysis provides insights into the factors influencing

OFDI by Chinese firms, including economic policy uncertainty, market potential, economic openness, firm size, and profitability.

First, the regression results indicate that CEPU has a significantly negative impact on OFDI, indicating that greater levels of uncertainty in economic policies reduce the likelihood of firms making OFDI. The negative relationship is influenced by capital flow restrictions, financing constraints, and a focus on the home market. This means that the Chinese government needs to provide a stable and predictable policy environment. This will help enterprises in coping with external risks, reduce the perception of the riskiness of OFDI, and increase willingness to invest. Furthermore, FEPU in target countries has a negative impact on Chinese firm OFDI. This relationship is influenced by currency risk, policy restrictions, and risk assessment, which causes firms to be more cautious of cross-border investments.

Next, the control variable analysis reveals that the market potential of foreign countries (PGDP) has a positive correlation with the probability of OFDI, as a higher GDP per capita signifies greater consumption power, demand, and access to advanced technology and knowledge. There is a negative correlation between the level of economic openness in foreign countries (OPEN) and the probability of OFDI, as greater economic openness implies more competition and potential barriers for Chinese firms. Import of goods from developing economies (IMPORT) by the foreign country influences OFDI positively, suggesting that Chinese firms consider the degree of demand rather than the degree of supply of the foreign country when investing. The natural resource endowment (RE) of the foreign country has a negative effect on the probability of OFDI, indicating that Chinese firms are more likely to import resources to meet domestic market demand than to invest in foreign countries with abundant natural resources. Therefore, before making OFDI, firms should fully understand and master the financial policies, legal system, infrastructure, business environment, and other related information of the foreign country, and engage in cautious investment behavior.

Meanwhile, size of the firm (SIZE) influences the probability of OFDI positively from the firm's perspective, primarily due to financial strength and technology/innovation advantages. However, this effect may be limited by resource constraints, business focus, and legal/policy restrictions. The profitability of enterprises (ROA) has a positive effect on OFDI, as greater profitability enables firms to generate more cash flows and attract investment capital. It also increases international market competitiveness and negotiating leverage. Lastly, there is a negative relationship between the year and OFDI, suggesting a decreasing trend in OFDI over time. Therefore, the Chinese government should take the lead in establishing a multi-level capital market, building a new platform for open cooperation, building and broadening corporate financing channels, encouraging diversified financing methods, and loosening restrictions on capital borrowing by SMEs.

During the process of overseas investment, Chinese companies can fully learn and utilize foreign high technology, improve the technology according to China's national conditions and consumer demand, and apply it on a large scale to their production. This will not only improve the productivity and profitability of the enterprises but will also promote the industrial progress of the entire country. Therefore, the Chinese government should encourage and advocate overseas investment by companies searching for technology. However, compared to labor-intensive and capital-intensive enterprises, the OFDI behavior of technology-seeking enterprises is more susceptible to fluctuations in economic policies. To advocate technology-seeking enterprises to conduct OFDI activities, the government should establish a sound and targeted policy protection system. In addition, firms should strengthen their R&D investment and risk resistance capabilities, as well as the ability to respond flexibly according to situation.

References

Aghion, P., Bloom, N., Blundell, R., Griffith, R., & Howitt, P. (2005). Competition and innovation: An inverted-U relationship. *The Quarterly Journal of Economics, 120*(2), 701-728.

Almeida, H., & Philippon, T. (2007). The risk-adjusted cost of financial distress. *The Journal of Finance*, *62*(6), 2557-2586.

Bae, J. C., Rong, X., Kim, M. I., & Cheng, S. (2022). Does CSR affect the impact of real earnings management on the cost of debt?, *Journal of Global Business and Trade*, *18*(3), 41-60.

Bae, M. J., & Lee, S. H. (2021). A comparative study on location choice of outward foreign direct investment between Korea and China: Focused on institutional quality, *Journal of International Trade & Commerce*, *17*(3), 325-346.

Baker, S. R., Bloom, N., & Davis, S. J. (2016). Measuring economic policy uncertainty. *The Quarterly Journal of Economics*, *131*(4), 1593-1636.

Bhagat, S., Ghosh, P., & Rangan, S. (2016). Economic policy uncertainty and growth in India, *Econoic and Political Weekly*, 72-81.

Carvalho, F. J. C. D. (1988). Keynes on probability, uncertainty, and decision making. *Journal of Post Keynesian Economics*, *11*(1), 66-81.

Chen, Y., Sun Q., Wen, W., & Huang, Y. (2019). Home country economic policy uncertainty, financing constratints and foreign direct invesetment of enterprises. *International Trade Issues*, *6*, 133-144.

Cheng, C. H. J. (2017). Effects of foreign and domestic economic policy uncertainty shocks on South Korea. *Journal of Asian Economics*, 51, 1-11.

Directory of Chinese Foreign Investment Institutions (2023, April 29). *All year round results*. http://db.cei.cn

Economic Policy Uncertainty (2023, April 4). *Economic policy uncertainty index*. http://www.policyuncertainty.com

Gao, Y., & Jin, S. (2022). How does financial technology drive enterprise innovation in China?. *Journal of Global Business and Trade*, *18*(1), 25-45.

Hayashi, F., & Prescott, E. C. (2002). The 1990s in Japan: A lost decade. *Review of Economic Dynamics*, *5*(1), 206-235.

Hu, C., Yun, K. H., & Cai, R. (2022). Crowding-out effect of SOEs on market-based organizational forms in china: Implication for Korea, *Journal of International Trade & Commerce*, *18*(4), 1-20.

Kim, D. H., & Kang, M. S. (2022). The inverse relationship between the informal economy and FDI inflows in CIS countries, *Journal of International Trade & Commerce*, *18*(5), 115-135.

Knight, F. H. (1921). *Risk, uncertainty and profit* (Vol. 31). Houghton Mifflin.

Lu, T., & Dang, Y. (2014). Corporate governance and technological innovation: Comparision by industry. *Economic Research*, *49*(6), 115-128.

Panousi, V., & Papanikolaou, D. (2012). Investment, idiosyncratic risk, and ownership. *The Journal of Finance*, *67*(3), 1113-1148.

UNCTAD (2017). *World investment report 2017.* https://unctad.org/system/files/official-document/wir2017_en.pdf

Wu, C., & Jin, S. (2022). Does blockchain technology promote the quality of enterprise accounting information?. *Journal of Global Business and Trade*, *18*(5), 1-15.

Zhu, W. B. (2019). *Research on the impact of economic policy uncertainty on China's foreign direct investment* (Master's thesis). Nanjing Audit University.

Appendix

Measurement of EPU by Baker et al. (2016)

Uncertainty is not a new concept[a], but the impact of uncertainty in economic policy on the economy has attracted the attention of many scholars since the 2008 global financial crisis.

Several scholars, such as Baker et al. (2016), have provided a novel definition of economic policy uncertainty. Baker et al. (2016) identified policy uncertainty as the economic risk caused by the uncertainty of government changes in fiscal policy, monetary policy, and tax policy. There are two sources of uncertainty. First is the uncertainty created when the government intervenes in the economy by introducing various policies to stop a recession, or even a crisis, when the economy is in a recession. The other is a shock caused by sudden external events to the economy, such as terrorist attacks, the emergence of a new epidemic, a change in government leadership, financial crisis, which makes the future of economic performance uncertain.

To cope with the negative impact of the economic environment fluctuations, the government introduces corresponding policy measures, which generate economic risks due to its inability to predict policy outcomes. Most scholars in academia accept, widely adopt, and apply this definition in research. Baker et al. (2016) used text retrieval and filtering methods via web search engines and social media by calculating the frequency of terms related to the economy, policy, and uncertainty in the news. The economic policy uncertainty index was constructed as a quantitative measure of economic policy uncertainty. This study employed the economic policy uncertainty index developed by Baker et al. (2016). Co-published by Stanford University and the University of Chicago, the index is relatively mature and widely accepted.

Because enterprises and consumers in the market economy mainly obtain the latest market information through the news media, timely access to news information will be an important basis in the majority of economic agent decisions. For example, when media reports of economic policy uncertainty in a foreign country increase, multinational enterprises will reduce OFDI to the foreign country out of caution. OFDI inflows are likely to increase only when the economic environment becomes stable.

Therefore, Baker et al. (2016) built an economic policy uncertainty (EPU) index globally and for each major economy by counting data from major media reports on economic policy uncertainty in each country. The construction of the EPU index is mainly based on news reports. Therefore, the choice of the news platform affects the accuracy of the EPU index. Therefore, the researchers mainly select major news media with strong authority and credibility, both locally and internationally, as news screeners. Each country's EPU Index reflects the relative frequency of articles in the country's leading newspapers, which contain three terms related to the economy (E), policy (P), and uncertainty (U) during a given month. In other words, the national EPU index value for each month is proportional to the proportion of articles discussing EPU in national newspapers during the month. Furthermore, it is vital to note that the economic policy uncertainty index does not only refer to the uncertainty caused by changes in government economic policies, it also includes economic uncertainty caused by, for example, financial crises, terrorist attacks, wars, environmental issues, and major political events.

a. Knight (1921) argued that a fundamental difference exists between "uncertainty" and "risk". In the research, the difference between risk and uncertainty lies in the availability of the probability distribution of the occurrence of the event. Uncertainty means that the outcome of an event cannot be predicted or calculated in advance by any form of mathematics, experience, or reasoning. Following 『General Theory written by Keynes, he argued that economic behavior is influenced by uncertainty about future expectations, and that the nature of economic fluctuations in the market is actually instability due to uncertainty about the future.

A brief explanation of Baker's EPU calculation method is provided. The United States EPU index consists of three components. The first component is the news index, calculated by constructing an index of search results from 10 major newspapers across the United States to portray economic policy uncertainty. The second component is the Tax Law Failure Index, which is mainly compiled by the Congressional Budget Office (CBO) with a list of all temporary federal tax law provisions. The third component is the economic forecast spread index, which is calculated using the spread of the Federal Reserve Bank's (FED) inconsistent economic forecasts for the future economy.

The EPU index for all other countries is the News-Based EPU, the initial component of the composite index. The researchers set a series of keywords such as "policy" and "uncertain/uncertainty" as the search target for each country's major local news media. The search results were normalized to the EPU index using a series of keywords such as "policy", "regulation", "economic/economy", and other related articles reflecting economic policy uncertainty.

For China, a mixed index is used, meaning an average of an index based on the South China Morning Post in Hong Kong, China, and an index based on mainland newspapers (People's Daily and Guangming Daily). The South China Morning Post in Hong Kong, China, was founded in November 1903, and currently has a circulation of approximately 110,000. It has been one of the most credible newspapers in Hong Kong, China, and Asia.

ISSN 1946-5130 (Print), ISSN 2470-4733 (Online)
http://dx.doi.org/10.20294/jgbt.2023.19.5.203

The Journal of Global Business and Trade

Journal of Global Business and Trade

https://www.pfw.edu/jgbt

Does CEO Power Affect the Relations between CEO Compensation and Risk-Taking?

Yong Jae Shin[a], Unyong Pyo[b]*, Fan Ye[c]

[a]*Department of Business Administration, Hankyong National University, South Korea*
[b]*Department of Finance, Operations, and Information Systems (FOIS), Goodman School of Business, Brock University, Canada*
[c]*Customer Service Representative, ICBK Canada, Canada.*

Received 24 July 2023, Revised 28 August 2023, Accepted 5 October 2023

ABSTRACT

Purpose – This study investigates the effect of incentive compensation and CEO power on a firm's risk-taking behavior, leveraging stock return volatility and earnings volatility as the key indicators of risk-taking.

Design/Methodology/Approach – A comprehensive analysis is conducted using data from 1,958 U.S. firms over a 28-year period (1992-2019). The study employ both ordinary least square (OLS) regression and two-stage least square (2SLS) regression for analysis. Pay-volatility sensitivity (PVS) and CEO-pay slice (CPS) are used as proxies for incentive compensation and CEO power, respectively.

Findings – The findings offer solid empirical proof that PVS and CPS have a negative influence on both earnings volatility and stock return volatility. Furthermore, the detrimental effect of PVS on managerial risk-taking is significantly more pronounced for CEOs with lower CPS compared with those with higher CPS. While incentive compensation appears to deter CEOs from embracing higher risks, CEOs with more power are less risk-averse when offered incentive compensation compared to their less powerful counterparts.

Research Implications – This study significantly contributes to existing literature by revealing the interactive effects between CEO power and incentive compensation on a firm's risk-taking behavior. Understanding these dynamics is pivotal as it offers a nuanced view of how CEO compensation structures and power hierarchies within a firm influence its risk-taking propensity, which is critical for both firm performance and broader financial stability considerations. The insights derived from this analysis can inform more balanced executive compensation structures and governance models that ensure an optimal level of risk-taking.

Keywords: CEO compensation, CEO pay slice, CEO power, pay-volatility sensitivity
JEL Classifications: G30, G35, J33

* *Corresponding Author, Email: upyo@brocku.ca*
© 2023 International Academy of Global Business and Trade. All rights reserved.

I. Introduction

Managerial risk-taking is a crucial aspect of corporate governance and has been extensively researched in the field of corporate finance for many years. The prominent role of managerial risk-taking should not be overlooked, because a managerial strategy would be futile if it cannot address the risks associated with an unpredictable organizational environment (Hoskisson et al., 2017). Agency theory posits that shareholders are risk-neutral, because they can reduce risks by diversifying their ownership portfolios (Murphy, 1999). Conversely, corporate executives, whose financial wealth and non-financial benefits are heavily concentrated in the firms, are inherently risk-averse and will therefore avoid risky projects and adopt less risky corporate strategies (Hoskisson et al., 2009; Smith & Stulz, 1985).

Equity-based compensation (EBC), a mechanism derived from agency theory, is granted to CEOs to align their interests with those of shareholders. EBC structures the managers' payoff as a convex function of stock return volatility. In other words, an increase in the firm's stock price will enhance the value of CEOs' stock and option holdings in the firm, making risky investments more appealing to CEOs (Agrawal & Mandelker, 1987; Haugen & Senbet, 1981; Smith & Stulz, 1985). Consequently, EBC encourages CEOs to take more risks by increasing their payoffs from maximizing the firm's stock price (Carpenter et al., 2003; Rajgopal & Shevlin, 2002). Additionally, recent literature indicates that EBC promotes managerial risk-taking by reducing CEOs' apprehension about unemployment (Cowen et al., 2016).

Although Hoskisson et al. (2017) find that EBC can encourage CEOs' risk-taking propensity when implemented within certain limits, other studies present contrasting views. Lambert et al. (1991), for instance, suggest that executive stock options could potentially heighten CEOs' risk aversion if the options are highly likely to be profitable. Wiseman and Gomez-Mejia (1998) propose that the accumulated value of EBC could negatively affect CEOs' inclination towards risky strategies, as they may perceive their wealth to be at risk, given that more of their wealth is tied to firm performance. Sanders (2001) contends that two forms of EBC, namely restricted stock options and short-term incentives, dissuade CEOs from undertaking risky investments. Similarly, Seo and Sharma (2018) also discover that the positive effect of EBC on CEOs' risk-taking progressively diminishes as CEOs engage in increasingly risky projects to pursue uncertain high returns.

Although EBC cannot fully determine CEOs' risk-taking behavior (Hoskisson et al., 2017), the influence of EBC on managerial risk-taking remains uncertain. A contingent factor, such as CEO power—defined as the extent to which a CEO has dominant decision-making power and authority over a firm's management (Bebchuk et al., 2011)—has been examined extensively in the literature on CEO power and managerial risk-taking. The relationship between CEO power and managerial risk-taking has elicited divergent views in previous studies. For instance, May (1995) suggests that a more powerful CEO might be risk-averse and reluctant to undertake risky yet value-increasing investments. Pathan (2009) demonstrates that CEO power negatively affects managerial risk-taking. Parrino et al. (2005) find that in leveraged firms, such as banks, powerful managers tend to choose overly safe projects. Tadele and Kalyebara (2020) measure CEO power by CEO duality and tenure, finding a negative correlation between CEO power and risks. Conversely, Lewellyn and Muller-Kahle (2012) argue that CEO power positively correlates with the excess risks taken by CEOs. Chen and Zheng (2014) contend that CEOs with longer tenures, confident in managing uncertainties and risks with their experience and skills, may induce higher risks.

While numerous studies have explored the relationship between managerial risk-taking and incentive compensation, as well as the relationship between managerial risk-taking and CEO power, independently, the existing literature does not offer a unified conclusion. Moreover,

managerial risk-taking is complex and influenced by a multitude of factors, a slight modification of which could alter a CEO's propensity to take risks. Therefore, examining the influence of a single factor on managerial risk-taking does not provide a comprehensive explanation. Consequently, it is both logical and crucial to examine the effects of incentive compensation and CEO power on managerial risk-taking in a combined manner.

However, the interplay between incentive compensation and CEO power in relation to managerial risk-taking is less studied. Drawing on previous literature, this study investigates the combined effect of incentive compensation and CEO power on managerial risk-taking, as indicated by earnings volatility and stock return volatility. We estimate equity incentives of EBC using pay-volatility sensitivity (PVS) or vega, a measure of the sensitivity of CEO wealth to stock return volatility (Coles et al., 2006). Furthermore, we gauge CEO power using CEO pay slice (CPS), defined as the CEO's compensation proportionate to the total compensation of the top five executive members of the firm, including the CEO (Bebchuk et al., 2011; Li et al., 2022).

This study contributes to the existing literature by examining whether the presence of PVS (CPS) influences or alters the effect of PVS (CPS) on managerial risk-taking. An additional contribution is that we separate observations based on the median of the CPS, which provides insights into the effects of PVS on managerial risk-taking at both low and high levels of CPS.

Our findings indicate that both PVS and CPS negatively affect managerial risk-taking. More specifically, the adverse effect of PVS on managerial risk-taking is more pronounced for CEOs with lower CPS levels than for those with higher CPS levels. In other words, under EBC, CEOs with more power tend to be less risk-averse than those with less power. While EBC does not successfully encourage CEOs to take on risks, its negative effect on managerial risk-taking varies between less powerful and more powerful CEOs.

The remainder of the paper is structured as follows. Section 2 reviews the relevant literature. Section 3 develops our empirical hypotheses. Section 4 describes the data and empirical methodologies, and Section 5 presents our results. Section 6 concludes the paper.

II. Literature Review

A significant body of literature underscores the positive correlation between managerial risk-taking and the sensitivity of CEO wealth to stock return volatility, also known as PVS or vega. Guay (1999), for instance, explains that the convex payoff structure generated by option grants determines the degree to which CEO wealth is sensitive to stock return volatility, PVS, and that there exists a positive correlation between PVS and a firm's stock return volatility. Coles et al. (2006) deduce managerial risk-taking from the financial and investment policies enacted and discover that a higher vega incentivizes CEOs to opt for riskier policies. These include increased investment in research and development, reduced investment in property, plant, and equipment, a narrower focus on fewer business lines, and higher leverage.

Low (2009) proposes estimating firm risk directly through the variance of daily stock returns, as this volatility encapsulates the cumulative effect of all managerial risk-taking activities. Moreover, to tackle endogeneity issues stemming from selection bias and omitted variables (Coles et al., 2014; Feng & Rao, 2018), and to more accurately determine the causal effect of CEO incentive compensation on managerial risk-taking decisions, Low (2009) recommends investigating whether CEOs alter firm risks in response to exogenous risks, rather than utilizing a system of simultaneous equations or implementing instrumental variables.[1] Low (2009) concludes that it is the CEO's portfolio vega that incites CEO risk-taking.

1. To address endogeneity issues, Rajgopal and Shevlin (2002), Rogers (2002), and Coles et al. (2006) attempt to use a system of simultaneous equations, while Armstrong and Vashishtha (2012) employ instrumental variables.

Gormley et al. (2013) explore the reactions of CEOs to increases in unanticipated material risk, specifically the risk of substantial legal liabilities and expensive regulation, under their previous equity incentives. They discover that CEOs with higher PVS do not typically respond to counterbalance the heightened risk, as they are less inclined to reduce risk in the face of exogenous shocks. Similarly, Chava and Purnanandam (2010) observe that CEOs with higher PVS tend to assume greater leverage in firms. Armstrong and Vashishtha (2012)

present a parallel argument, suggesting that CEOs with higher PVS are motivated to escalate firm risks.

While a significant body of literature suggests that pay-for-performance sensitivity (PVS) positively influences a firm's risk-taking, some studies dispute the existence of a direct positive correlation between PVS and managerial risk-taking. For instance, Bharati and Jia (2018) find no evidence of vega positively affecting the risk-taking of banking firms. Similarly, Feng and Rao (2018) discover a positive relationship between vega and a firm's cash holdings, which is more pronounced in firms exhibiting higher risk aversion. Chakraborty et al. (2019) contend that PVS does not affect the risk level of firms with high social responsibility. Iqbal and Vahamaa (2019) conclude that the relationship between vega and managerial risk-taking is ambiguous and unstable.

Compared with the widely used PVS for measuring equity incentives and investigating the relationship between incentive compensation and managerial risk-taking, CEO pay slice (CPS), a proxy for CEO power, has received less attention. CPS, as defined by Bebchuk et al. (2011), is the fraction of the top-five ranked compensation that CEOs receive. Liu and Jiraporn (2010) use CPS to represent the relative importance of the CEO in the top management team, providing evidence that powerful CEOs are more likely to undertake risk-reducing projects. Following Bebchuk et al.'s (2011) method of estimating CEO power, Chintrakarn et al. (2015) discover that CEOs with smaller CPS are more risk-averse, and an increase in CPS leads to less risky corporate strategies. However, when CPS surpasses a certain threshold, specifically the 75th percentile of CPS, an increase in CPS correlates with less moderate, more risk-taking strategies.

Recent studies have begun to directly explore whether a CEO's power can influence the relationship between equity incentives and risk-taking, as well as the interaction between these factors. More specifically, these studies question whether CEO power or equity compensation has a greater influence on a firm's propensity for risk-taking. For instance, Victoravich et al. (2011) develop an index to measure CEO power, incorporating five control variables: CEO duality, a staggered board of directors, the proportion of insiders on the board, the proportion of affiliated board members, and whether the CEO is a founder. They discovered that, in the banking sector, the level of CEO power does not affect the relationship between equity compensation and a firm's risk-taking. Their findings suggest that when a CEO's personal wealth is closely tied to the long-term value of the firm, more powerful CEOs are more likely to take on additional risk.

III. Hypotheses

Existing literature does not agree on the relationship between PVS and managerial risk-taking, nor on the connection between CPS and managerial risk-taking. While numerous studies document a positive effect of PVS on managerial risk-taking (Armstrong & Vashishtha, 2012; Chava & Purnanandam, 2010; Coles et al., 2006; Guay, 1999; Gormley et al., 2013; Low, 2009), others suggest that the effect of PVS may not be inherently positive (Bharati & Jia, 2018; Chakraborty et al., 2019; Feng & Rao, 2018; Iqbal & Vahamaa, 2019).

Compared with PVS, the influence of CPS on managerial risk-taking remains largely

unexplored. The effect of CPS on managerial risk-taking is inconsistent. Liu and Jiraporn (2010) provide evidence that powerful CEOs are more likely to undertake risk-reducing projects. Conversely, Chintrakarn et al. (2014) discover that CEOs with less CPS tend to be more risk-averse. However, CEOs with CPS levels exceeding the 75th percentile are more likely to adopt risky strategies. The aforementioned literature examines the relationship between PVS and managerial risk-taking, as well as the relationship between CPS and managerial risk-taking separately, and has not arrived at a consistent conclusion. Given that using either PVS or CPS exclusively fails to explain managerial risk-taking, we formulate hypotheses to examine the effect of PVS (CPS) on managerial risk-taking in the presence of CPS (PVS):

H1: CPS influences the effect of PVS on managerial risk-taking.

H2: PVS influences the effect of CPS on managerial risk-taking.

The empirical findings from Chintrakarn et al. (2015) suggest that CEOs with less power tend to avoid risk and make moderately risky decisions, and an increase in CPS will lead CEOs to adopt less risky corporate strategies. However, as a CEO's power increases and surpasses a certain threshold, they are more inclined to adopt risky strategies. Specifically, more powerful CEOs, confident in their ability to control the decision-making process despite potential objections, exhibit less risk aversion than their less powerful counterparts, and are therefore more likely to make risky investment decisions when granted EBC (Chintrakarn et al., 2015). Consequently, we examine the following hypothesis:

H3: The effects of PVS on risk-taking for CEOs with high CPS differ from those for CEOs with low CPS.

IV. Data and Methodology

1. Data Sources

We primarily gather data from three databases. We extract data on stock returns from the Centre for Research in Security Prices (CRSP) database and accounting and financial data of firms from the CompuStat database. We collect data on CEO compensation from the Standard & Poor's ExecuComp database, which we use to calculate CPS and PVS.

Our sample period is 1992 to 2019, because the ExecuComp database does not supply compensation data prior to 1992. Furthermore, owing to the ExecuComp database's differing reporting formats for accounting for EBC before and after the fiscal year 2006, we employ distinct methods to compute PVS for the periods 1992–2006 and 2006–2019, in accordance with Coles et al. (2006). We also source risk-free rates for the period 1992–2006 from the Federal Reserve website to calculate option value using the Black–Scholes–Merton model.

The ExecuComp database sometimes fails to identify certain executives as CEOs, even though, according to the dates they assumed and left the CEO position, they appear to have been CEOs during the specified fiscal years. We have classified such executives as CEOs. Furthermore, in line with Coles et al. (2006), we have excluded financial firms and utilities from our sample, as these highly regulated industries may cause CEOs to behave differently when granted EBC. To mitigate the effects of extreme values, we have winsorized PVS and CPS at the 5th and 95th percentiles. After removing missing values, our data comprise 31,584 firm-year observations for CEO's PVS from 2,732 unique firms, and 23,603 firm-year observations for CPS from 1,958 unique firms during the sample period.

Table 1 presents the descriptive statistics of the key variables used in the regression analyses. Earnings volatility, one of the dependent variables, has a mean of 0.0428 and a median of 0.0287,

aligning with the findings of Boubakri et al. (2013), which reported a mean and median of 0.035 and 0.023, respectively. Another dependent variable, stock return volatility, exhibits a mean of 0.0271 and a median of 0.0237, consistent with the findings of Bettis et al. (2018) and Coles et al. (2006), which reported means of 0.024 and 0.0305, respectively. One of the primary independent variables, PVS, has a mean of 4.0289 and a median of 4.3047, in line with the findings of Coles et al. (2006), which reported a mean of 2.69. The other primary independent variable, CPS, has a mean of 0.3966 and a median of 0.4036, consistent with the findings of Bebchuk et al. (2011) and Li et al.(2022), which reported means of 0.357 and 0.37, respectively.

Table 1. Descriptive Statistics of Key Variables

Variables	N	Mean	SD	Minimum	Q1	Median	Q3	Maximum
E.volatility	70	0.0428	0.0472	0.0011	0.0170	0.0287	0.0505	0.9630
R.volatility	70	0.0271	0.0198	0.0038	0.0176	0.0237	0.0321	1.1627
PVS	70	4.0289	1.8367	0.0000	3.0912	4.3047	5.3023	9.1643
lag(PVS)	70	4.0289	1.8368	0.0000	3.0912	4.3049	5.3023	9.1643
CPS	70	0.3966	0.1098	0.0000	0.3336	0.4036	0.4621	0.9768
lag(CPS)	70	0.3966	0.1098	0.0000	0.3336	0.4037	0.4621	0.9768
Market cap	70	11116	32608	3.9741	731.65	2110.1	7327.8	504239
Firm size	70	7.7855	1.6842	1.3798	6.5953	7.6545	8.8994	13.1308
MtB	70	4.0784	12.7521	0.0912	1.6506	2.5582	4.0667	759.6177
ROA	70	0.0427	0.1316	-2.9084	0.0214	0.0569	0.0933	0.9534
Stock return	70	0.0007	0.0024	-0.0197	-0.0002	0.0007	0.0015	0.1296
Leverage	70	0.1845	0.1600	0.0000	0.0216	0.1690	0.2893	0.8522
CapEx	70	0.0457	0.0423	-0.3689	0.0203	0.0345	0.0582	0.7824
R&D	70	0.0469	0.0642	0.0000	0.0047	0.0240	0.0692	1.0029
CEO tenure	70	11.4061	7.1066	2.0000	7.0000	10.0000	14.0000	61.0000
CEO age	70	4.0224	0.1240	3.3673	3.9512	4.0254	4.1109	4.5109

Note: This table presents the descriptive statistics of the key variables. E.volatility denotes earnings volatility, defined as the volatility of the firm's EBITDA to total assets ratio. R.volatility signifies stock return volatility, calculated as the annualized standard deviation of daily stock returns throughout the fiscal year. PVS refers to pay for volatility sensitivity, represented by the logarithm of one plus PVS, which measures the sensitivity of CEO wealth to stock return volatility. CPS is the proportion of total compensation (as per ExecuComp item TDC1) received by the CEO out of the top-five executives' total compensation. Firm size is the logarithm of market capitalization, the product of a firm's outstanding

shares and share prices. MTB is the ratio of the market value of assets to the book value of assets, serving as a proxy for investment opportunities. ROA, or return on assets, is calculated by dividing operating income by the book value of assets. Stock return refers to the return over the fiscal year. Book leverage is the total debt to total assets ratio. CapEx is the capital expenditures to assets ratio. R&D is the R&D expenditures to total assets ratio. CEO tenure is the logarithm of the years the CEO has held the position. CEO age is the logarithm of the CEO's age as reported on Compustat. The data on PVS is measured in USD, market capitalization is in millions of USD, and CEO tenure and age are measured in years.

Table 2 displays the sample correlations of the key variables employed in the regression analyses. The majority of the correlations between these variables are significant at the 1% level. The correlation coefficient between stock return volatility and earnings volatility is 0.26, suggesting a weak positive correlation. Conversely, the correlation coefficients of PVS with stock return volatility and earnings volatility are -0.17 and -0.11, respectively, suggesting weak negative correlations.

Table 2. Sample correlations of key variables

	E.vol	R.vol	PVS	LPVS	CPS	LCPS	Size	MTB	ROA	Ret	Lev	CapEx	R&D	Ten	Age
E.vol	1														
R.vol	0.26*	1													
PVS	-0.11*	-0.17*	1												
lPVS	-0.12*	-0.15*	0.72*	1											
CPS	-0.10*	-0.10*	0.21*	0.14*	1										
lCPS	-0.09*	-0.08*	0.15*	0.21*	0.39*	1									
Fsize	-0.24*	-0.34*	0.48*	0.42*	0.14*	0.12*	1								
MTB	0.07*	-0.01	0.03*	0.01	0.01	0	0.10*	1							
ROA	-0.29*	-0.26*	0.11*	0.08*	0.09*	0.04*	0.28*	0.02	1						
Ret	0.04*	0.49*	-0.02*	-0.05*	-0.01	-0.01	0.05*	0.07*	0.11*	1					
Lev	-0.17*	-0.09*	0.07*	0.07*	0.12*	0.11*	0.15*	0.08*	-0.09*	-0.06*	1				
CapEx	0.05*	0.06*	-0.01	-0.02	-0.04*	-0.04*	-0.02*	0.03*	0.09*	-0.02	-0.06*	1			
R&D	0.43*	0.15*	0.01	0	-0.12*	-0.12*	-0.09*	0.08*	-0.31*	0.02	-0.24*	-0.08*	1		
Ten	0	0.02*	0.02*	0.01	-0.06*	-0.05*	-0.04*	-0.01	0.07*	0.02*	-0.10*	-0.01	0.02	1	
Age	-0.11*	-0.11*	-0.03*	-0.01	0.04*	0.06*	0.06*	-0.02*	0.08*	-0.01	0.05*	-0.05*	-0.11*	0.26*	1

Note: This table presents the correlations of the principal variables. The data sample encompasses the fiscal years from 1992–2019. E.vol denotes earnings volatility, R.vol signifies stock return volatility, PVS represents pay for volatility sensitivity, CPS refers to the CEO pay slice, MTB is the market-to-book ratio, Ret is the stock return, Lev stands for book leverage, CapEx is the capital expenditure, Ten indicates CEO tenure, and Age is the CEO's age. An asterisk (*) denotes a statistical significance level of 5% or less.

2. Methodology

2.1. Managerial Risk-taking

In line with the methods of Bettis et al. (2018) and Coles et al. (2006) we assess the risk taken by CEOs using the logarithm of the standard deviation of daily stock returns (R.vol) over the fiscal year. This approach aligns with the literature, because estimating firm risk with the risk of the firm's debt or with the volatility of yearly cash flow proves unstable, owing to data scarcity (Low, 2009). Moreover, using equity risk to approximate firm risk aligns with the reality that executive stock options are based on the firm's equity (Low, 2009).

Another indicator of managerial risk-taking is the volatility of company-level earnings (E.vol), defined as the fluctuation in the ratio of a company's earnings before interest, tax, depreciation, and amortization (EBITDA) to its total assets. Following the approaches of John et al. (2008), Faccio et al. (2011), and Boubakri et al. (2013), we calculate the corporate earnings volatility over five-year overlapping periods, as follows:

$$\text{Evol}_{i,t} = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}\left(E_{i,t} - \frac{1}{T}\sum_{t=1}^{T}E_{i,t}\right)^2} \quad (1)$$

$$\text{where } E_{i,t} = \frac{\text{EBITDA}_{i,t}}{\text{Total Asset}_{i,t}}$$

2.2. Equity Incentives: PVS

Our measure of equity incentives is the pay-volatility sensitivity (PVS), which quantifies the sensitivity of a manager's wealth to a 0.01 change in stock-return volatility (Coles et al., 2006). In line with Guay (1999), Knopf et al. (2002), and Rajgopal and Shevlin (2002), we use the PVS of the option portfolio as a proxy for the aggregate PVS of the stock and option portfolio, given that the PVS of the option portfolio is significantly higher than the PVS of the stock portfolio. Following the methodologies of Guay (1999) and Core and Guay (2002), which are grounded on the Black and Scholes (1973) formula for valuing European call options, as adapted by Merton (1973), we compute the option value and PVS as follows:

$$\text{Option value} = \left[Se^{-dT}N(Z) - Xe^{-rT}N\left(Z - \sigma T^{(1/2)}\right)\right] \quad (2)$$

$$\text{Where } Z = \left[\ln(S/X) + T\left(r - d + {}^{\sigma^2}/_{2}\right)\right]/\sigma T^{(1/2)}$$

N = cumulative probability function for the normal distribution
S = price of the underlying stock
X = exercise price of the option
σ = expected stock-return volatility over the life of the option
r = natural logarithm of risk-free interest rate
T = time to maturity of the option in years
d = natural logarithm of expected dividend yield over the life of the option

The sensitivity of a manager's wealth with respect to a 0.01 change in stock-return volatility is calculated as

$$PVS = \left[\frac{\partial(\text{option value})}{\partial(\text{stock volatility})}\right] \times 0.01 = e^{-dT}N'(Z)ST^{(1/2)} \times (0.01) \quad (3)$$

2.3. CEO Power: CPS

The CPS provides a more objective method for estimating CEO power, because it reflects the CEO's relative importance within the top executive team. As per Bebchuk et al. (2011), we compute the CPS as the ratio of the CEO's remuneration to the total compensation of the company's top five executive members, including the CEO, as follows:

$$CPS_{i,t} = \frac{\text{CEO compensation}_{i,t}}{\sum \text{compensation of the firm's top five executive members}_{i,t}} \quad (4)$$

Total compensation includes salary, bonuses, other annual pay, the total value of restricted stock granted within the year, the Black-Scholes value of stock options granted within the year, long-term incentive payouts, and all other total compensation, as reported in the ExecuComp item TDC1 (Bebchuk et al., 2011). Following Bebchuk et al. (2011), we exclude firm-year observations where the CEO did not serve for the entire year, because a low CPS resulting from the CEO receiving compensation for only part of the year could be misleading. Furthermore, compensation data from the ExecuComp database are not comparable before and after the format used to compute compensation data was altered in 2006 (Brockman et al., 2016; Walker, 2011). Following the methodologies of Coles et al. (2014) and Brockman et al. (2016), we adjust the total compensation (TDC1) data from the ExecuComp database prior to 2006 as follows:

$$\begin{aligned} TDC1 = {} & \text{Salary} + \text{Bonus} + \text{Rstkgrnt} + \text{Performance based stock award} + \text{Option awards BLK value} \\ & + \text{Performance based stock award} + \text{Othann} + \text{Allothtot}^2 \end{aligned} \quad (5)$$

2.4. Control Variables

Following Bebchuk et al. (2011), Chintrakarn et al. (2015), and Coles et al. (2006), we employ the subsequent control variables: (1) firm size, determined as the logarithm of the market capitalization, a product of the outstanding shares and share prices of firms; (2) MTB, the ratio of market value of assets to book value of assets, serving as a proxy for investment opportunities; (3) ROA, the return on assets calculated as operating income divided by the book value of assets; (4) stock return, the return over the fiscal year; (5) book leverage, the ratio of total debt

2. Coles et al. (2014) define the Execucomp variables as follows: (1) Salary refers to the base annual salary; (2) Bonus denotes performance-based pay; (3) Rstkgrnt represents the value of restricted stock granted during the year; (4) Option awards BLK value signifies the value of options granted during the year; (5) Othann encompasses perquisites and other personal benefits, above-market earnings on restricted stock, options/SARs or deferred compensation paid during the year but deferred by the officer, earnings on long-term incentive plan compensation paid during the year but deferred at the officer's discretion, tax reimbursements, and the dollar value of the difference between the price paid by the officer for company stock and the actual market price of the stock under a stock purchase plan that is not generally available to shareholders or employees of the company; (6) Allothtot includes severance payments, debt forgiveness, imputed interest, payouts for cancellation of stock options, payment for unused vacation, tax reimbursements, signing bonuses, 401K contributions, and life insurance premiums.

to total assets; (6) CapEx, the ratio of capital expenditures to assets; (7) R&D, the ratio of R&D expenditures to total assets; (8) CEO tenure, the logarithm of the number of years the CEO has held the position; (9) CEO age, the logarithm of the CEO's reported age on Compustat; (10) industry dummies, capturing the variation across industries, determined by the first two digits of the SIC; and (11) year dummies, capturing the year fixed effects. Kim and Shin (2022) analyze the impact of information asymmetry and financial constraints on management risk of Korean listed firms. They use firm size, MTB, book leverage, and industry dummies as control variables affecting management risk.

2.5. Ordinary Least Aquare (OLS) Regression

To examine the effect of EBC on managerial risk-taking in the presence of CPS, and correspondingly, the effect of CEO power on managerial risk-taking in the presence of PVS, we implement the following regression model:

$$Risk_{i,t} = \alpha_0 + \alpha_1 \log(1 + PVS_{i,t}) + \alpha_2 CPS_{i,t} + \alpha_3 \text{Control Variables}_{i,t} + \varepsilon_{i,t} \quad (6)$$

where stock return volatility and earnings volatility are both used as proxies for managerial risk-taking. This equation represents the risk undertaken by CEOs as a function of both PVS and CPS, after accounting for firm-specific and CEO-specific variables. Then, we further examine the interaction effect of EBC and CEO power on managerial risk-taking using the following regression model:

$$Risk_{i,t} = \alpha_0 + \alpha_1 \log(1 + PVS_{i,t}) + \alpha_2 CPS_{i,t} + \alpha_3 \log(1 + PVS_{i,t}) \times CPS_{i,t} + \alpha_4 \text{Control Variables}_{i,t} + \varepsilon_{i,t} \quad (7)$$

where managerial risk-taking is also measured as stock return volatility and earnings volatility. This equation models managerial risk-taking as a function of PVS, CPS, and the product of PVS and CPS, after controlling for firm-specific and CEO-specific variables.

Moreover, we incorporate lagged terms of PVS, CPS, and their product into the aforementioned regression model to align our results with those of Coles et al. (2006). This approach also addresses the issue of endogeneity, because parameters estimated from an ordinary least squares (OLS) can exhibit bias when regressors are determined endogenously by dependent variables (Coles et al., 2006).

V. Results

1. Main Results

1.1. Earnings Volatility

We begin by measuring managerial risk-taking through earnings volatility. To investigate the effects of PVS and CPS on earnings volatility and to test Hypotheses 1 and 2, we employ the regression models as per Eq. (6). Table 3 presents the results of the OLS regressions, with earnings volatility as the dependent variable. Column 1 displays the regression results of earnings volatility solely with PVS and control variables. Column 2 exhibits the regression results of earnings volatility exclusively with CPS and control variables. Column 3 reveals the regression results of earnings volatility with both PVS and CPS. In Column 4, we introduce the product term of PVS and CPS (PVS × CPS), demonstrating the interaction effect of PVS and CPS on earnings volatility. In Column 5, we incorporate the lagged term of PVS and CPS, along with the product of the lagged terms (lag(PVS) × lag(CPS)).

Table 3. OLS Regressions for Earnings Volatility

	Earnings volatility				
	(1)	(2)	(3)	(4)	(5)
PVS	-0.0010*** (-3.20)		-0.0009*** (-2.90)	-0.0029*** (-3.16)	-0.0023** (-2.37)
lag(PVS)					-0.0002 (-0.25)
CPS		-0.0083* (-1.83)	-0.0057 (-1.24)	-0.0256*** (-2.58)	-0.0300*** (-2.83)
lag(CPS)					0.0126 (1.20)
PVS×CPS				0.0050** (2.27)	0.0058** (2.46)
lag(PVS)×lag(CPS)					-0.0025 (-1.07)
Firm size	-0.0042*** (-11.64)	-0.0048*** (-14.89)	-0.0043*** (-11.64)	-0.0043*** (-11.75)	-0.0041*** (-11.28)
MtB	0.0002*** (5.66)	0.0002*** (5.69)	0.0002*** (5.66)	0.0002*** (5.62)	0.0002*** (5.55)
ROA	-0.0542*** (-13.01)	-0.0539*** (-12.94)	-0.0540*** (-12.96)	-0.0538*** (-12.91)	-0.0543*** (-13.01)
Stock return	0.7280*** (3.42)	0.7757*** (3.65)	0.7334*** (3.44)	0.7459*** (3.50)	0.7184*** (3.37)
Book leverage	-0.0204*** (-5.83)	-0.0209*** (-5.97)	-0.0202*** (-5.77)	-0.0199*** (-5.68)	-0.0200*** (-5.69)
CapEx	0.0731*** (5.64)	0.0732*** (5.66)	0.0730*** (5.64)	0.0727*** (5.62)	0.0718*** (5.55)
R&D	0.2660*** (28.41)	0.2641*** (28.16)	0.2653*** (28.28)	0.2658*** (28.33)	0.2660*** (28.32)
CEO tenure	-0.0002*** (-3.15)	-0.0002*** (-3.20)	-0.0002*** (-3.18)	-0.0002*** (-3.36)	-0.0002*** (-3.30)
CEO age	-0.0142*** (-3.39)	-0.0139*** (-3.34)	-0.0142*** (-3.39)	-0.0138*** (-3.30)	-0.0138*** (-3.30)
Intercept	0.1284*** (6.56)	0.1324*** (6.74)	0.1301*** (6.63)	0.1370*** (6.90)	0.1339*** (6.69)
Industry dummy	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes
Obs	7070	7070	7070	7070	7069
R-Sq	0.2949	0.2942	0.2950	0.2955	0.2968

Note: This table presents the coefficients and t-values of the regressors in the OLS regression model of earnings volatility, with earnings volatility as the dependent variable. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. PVS represents the logarithm of one plus PVS, which is the sensitivity of CEO wealth to stock return volatility. CPS is the proportion of total compensation (ExecuComp item TDC1) received by the CEO out of the total compensation for the top five executives. Firm size is the logarithm of market capitalization, calculated as the product of outstanding shares and share prices. MtB, the ratio of market value to book value of assets, serves as a proxy for investment opportunities. ROA is the return on assets, calculated as operating income divided by the book value of assets. Stock return refers to the return over the fiscal year. Book leverage is the ratio of total debt to total assets. CapEx is the ratio of capital expenditures to assets. R&D is the ratio of R&D expenditures to total assets. CEO tenure is the logarithm of the number of years the CEO has held the position. CEO age is the logarithm of the CEO's age as reported on Compustat. The unit of data on PVS is one USD. The unit of market capitalization is millions of USD. The units for CEO tenure and CEO age are years.

According to Columns 1 and 2, both PVS and CPS negatively affect earnings volatility. However, when PVS and CPS are simultaneously included in Column 3, PVS continues to negatively affect earnings volatility, while the negative effect of CPS becomes insignificant. This suggests that the presence of PVS modifies the effect of CPS on earnings volatility. This finding aligns with Hypothesis 2, which is further corroborated by the result in Column 4. Given that the coefficient of the product term of PVS and CPS (PVS × CPS) is positive and significant at the 5% level, it is prudent to investigate the interaction effect of PVS and CPS on earnings volatility.

To evaluate Hypothesis 3, we employ the model depicted in Eq. (8). Given that the coefficients of the lagged terms of PVS and CPS, as well as the product of these lagged terms (lag(PVS) × lag(CPS)), are nonsignificant, even at the 10% level, according to Column 5, we focus our analysis on the interaction effect solely between PVS and CPS using their product term. Specifically, we use the estimated coefficients of the variables in Column 4.

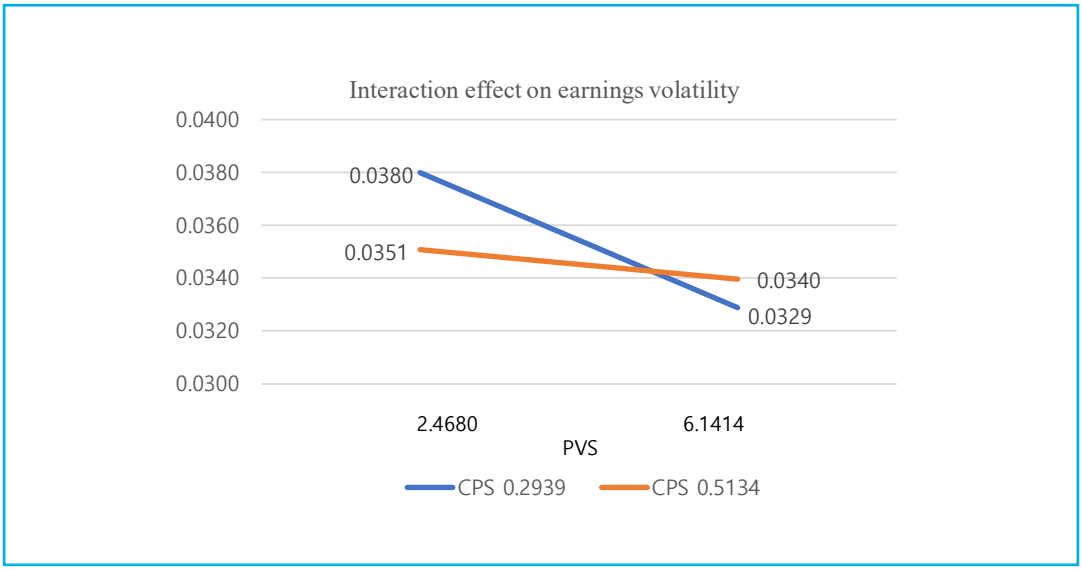
$$\begin{aligned}\text{Earnings Volatilty} = {} & 0.1370 \times \text{Intercept} - 0.0029 \times \text{PVS} - 0.0256 \times \text{CPS} + 0.0050 \times \text{PVS} \\ & \times \text{CPS} - 0.0043 \times \text{Firm Size} + 0.0002 \times \text{MtB} - 0.0538 \times \text{ROA} + \\ & 0.7459 \times \text{Srock Return} - 0.0199 \times \text{Book leverage} + 0.0727 \times \text{CAPEX} \\ & + 0.2658 \times \text{R\&D} - 0.0002 \times \text{CEO Tenure} - 0.0138 \times \text{CEO Age} \end{aligned} \quad (8)$$

We begin by setting significant control variables at their median values to demonstrate the interaction effect. We define the high and low levels of PVS and CPS as one standard deviation above and below their median, respectively. By inserting these parameter values into Eq. (8), we calculate earnings volatility for various combinations of the high and low levels of PVS and CPS, as depicted in Table 4 and Fig. 1. Fig. 1 graphically presents the interaction effects of PVS and CPS on earnings volatility.

Table 4. Earnings Volatility Calculated as Combinations of the High and Low Levels of PVS and CPS

		CPS	
		0.2939	0.5134
PVS	2.4680	0.0380	0.0351
	6.1414	0.0329	0.0340

Fig. 1. Interaction Effect on Earnings Volatility



When the CPS is set at a high level (0.5134), there is a slight decrease in earnings volatility from 0.0351 to 0.0340 because the PVS increases from a low level (2.4680) to a high level (6.1414). This implies that an increase in PVS results in a marginal decline in earnings volatility when CPS is high. Therefore, PVS has a weak negative effect on earnings volatility when CPS is high. Conversely, when CPS is set at a low level (0.2939), earnings volatility significantly decreases from 0.0380 to 0.0329 as PVS increases from its low level to its high level. Consequently, an increase in PVS results in a substantial decrease in earnings volatility when CPS is low. Furthermore, the negative effect of PVS on earnings volatility is more pronounced when CPS is low than when it is high. In summary, when CEO power is high, an increase in PVS slightly reduces firms' risk-taking level, as measured by earnings volatility. However, when CEO power is low, a small increase in PVS dramatically reduces firms' risk-taking level. While incentive compensation discourages CEOs from taking on more risk, the negative effect of incentive compensation is greater for less powerful CEOs than for more powerful ones. CEOs with less power tend to be more risk-averse under EBC. However, CEOs with more power are less risk-averse when granted EBC. Consequently, Hypothesis 3 is supported when earnings volatility is used as a measure of managerial risk-taking.

1.2. Stock Return Volatility

In addition to earnings volatility, we estimate managerial risk-taking using stock return volatility. To test Hypotheses 1 and 2, we examine the effect of PVS and CPS on stock return volatility by running regression models in accordance with Eq. (6). Table 5 displays the results of OLS regressions, with stock return volatility as the dependent variable. Columns 1 and 2 provide the regression results of stock return volatility solely with PVS and CPS, respectively. Column 3 presents the regression results of stock return volatility with both PVS and CPS. We include the product term of PVS and CPS (PVS × CPS) in Column 4, the lagged term of PVS and CPS, and the product of the lagged term (lag(PVS) × lag(CPS)) in Column 5.

Table 5. OLS Regressions for Stock Return Volatility

	Stock return volatility				
	(1)	(2)	(3)	(4)	(5)
PVS	-0.0002** (-2.12)		-0.0002* (-1.79)	-0.0004 (-1.34)	-0.0005* (-1.69)
lag(PVS)					0.0001 (0.38)
CPS		-0.0026* (-1.87)	-0.0021 (-1.49)	-0.0042 (-1.36)	-0.0026 (-0.78)
lag(CPS)					-0.0043 (-1.32)
PVS×CPS				0.0005 (0.75)	0.0003 (0.42)
lag(PVS) ×lag(CPS)					0.0006 (0.83)
Firm size	-0.0027*** (-23.68)	-0.0028*** (-28.03)	-0.0027*** (-23.69)	-0.0027*** (-23.70)	-0.0027*** (-23.80)
MtB	0.0000* (-1.83)	0.0000* (-1.80)	0.0000* (-1.82)	0.0000* (-1.83)	0.0000* (-1.77)
ROA	-0.0313*** (-24.30)	-0.0312*** (-24.22)	-0.0312** (-24.23)	-0.0312*** (-24.21)	-0.0311*** (-24.12)
Stock return	5.0175*** (76.28)	5.0276*** (76.59)	5.0196*** (76.30)	5.0209*** (76.29)	5.0294*** (76.37)
Book leverage	-0.0003 (-0.31)	-0.0004 (-0.36)	-0.0003 (-0.24)	-0.0002 (-0.21)	-0.0002 (-0.21)
CapEx	0.0305*** (7.64)	0.0306*** (7.64)	0.0305*** (7.63)	0.0305*** (7.62)	0.0307*** (7.66)
R&D	0.0059** (2.03)	0.0054* (1.85)	0.0056* (1.93)	0.0057** (1.95)	0.0055* (1.89)
CEO tenure	0.0000 (-0.48)	0.0000 (-0.52)	0.0000 (-0.51)	0.0000 (-0.57)	0.0000 (-0.63)
CEO age	-0.0065*** (-5.02)	-0.0064*** (-4.99)	-0.0065*** (-5.02)	-0.0064*** (-4.98)	-0.0064*** (-4.97)
Intercept	0.0706*** (11.67)	0.0717*** (11.82)	0.0713*** (11.74)	0.0720*** (11.72)	0.0729*** (11.78)
Industry dummy	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes
Obs	7070	7070	7070	7070	7069
R-Sq	0.6155	0.6155	0.6157	0.6157	0.6162

Note: This table presents the coefficients and t-values of the regressors in the OLS regression model of earnings volatility. The dependent variable is stock return volatility. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. PVS represents the logarithm of the sum of one plus PVS, which measures the sensitivity of CEO wealth to stock return volatility. CPS is the proportion of total compensation (ExecuComp item TDC1) received by the CEO relative to the top-five executives' total compensation. Firm size is the logarithm of market capitalization, calculated as the product of outstanding shares and share prices. MtB, the ratio of market value to book value of assets, serves as a proxy for investment opportunities. ROA, the return on assets, is calculated as operating income divided by the book value of assets. Stock return refers to the return over the fiscal year. Book leverage is the ratio of total debt to total assets. CapEx is the ratio of capital expenditures to assets. R&D is the ratio of R&D expenditures to total assets. CEO tenure is the logarithm of the number of years the CEO has held the position. CEO age is the logarithm of the CEO's age as reported on Compustat. The data on PVS is measured in USD, the market capitalization is in millions of USD, and both CEO tenure and CEO age are measured in years.

In both columns 1 and 2, the coefficients of PVS and CPS are negative and significant, indicating that PVS and CPS negatively affect stock return volatility. However, when PVS and CPS are included together in column 3, the coefficient of PVS remains negative and significant, while the coefficient of CPS loses its significance. This aligns with Hypothesis 2, which posits that the presence of PVS alters the effect of CPS on stock return volatility, effectively nullifying the negative effect of CPS.

However, the coefficients of the product term of PVS and CPS (PVS × CPS) in Column 4, and the product term of lagged PVS and CPS (lag(PVS) × lag(CPS)) in Column 5, are nonsignificant. We are unable to construct a model for stock return volatility similar to that for earnings volatility, as shown in Eq. (8). To test Hypothesis 3, we divide observations into two subsamples based on the median value of CPS, and apply the following regression model:

$$Risk_{i,t} = \alpha_0 + \alpha_1 \log(1 + PVS_{i,t}) + \alpha_2 \text{Control Variables}_{i,t} + \varepsilon_{i,t} \quad (9)$$

Table 6 presents the results. For the subsample comprising CPS values smaller than the median, PVS negatively affects stock return volatility, with a significant coefficient of -0.0013 at the 5% level. For the subsample with CPS values larger than the median, PVS also negatively affects stock return volatility, with a coefficient of -0.0005. Thus, the negative effect of PVS is greater at lower CPS levels than at higher ones. This implies that while incentive compensation discourages CEOs from taking excessive risks, CEOs with less power tend to be more risk-averse in their investment strategies than those with more power. This finding aligns with Hypothesis 3.

1.3 Interaction Effects Using Law Number of PVS

We convert PVS into its raw numbers to accurately represent the magnitude of the interaction effects of PVS and CPS on earnings volatility, given that PVS is calculated as the logarithm of its raw value. The corresponding low and high levels of the raw numbers of PVS are USD 11,798.34 and USD 464,699.47, respectively. To demonstrate the actual effects of PVS and CPS on earnings volatility, we construct models solely with PVS and CPS, using their product term (PVS × CPS), and the estimated coefficients of Column 4 in Table 3 to illustrate the interaction effects:

Table 6. OLS Regressions for Earnings Volatility and Stock Return Volatility

	Earnings volatility		Stock return volatility	
	Low CPS	High CPS	Low CPS	High CPS
PVS	-0.0013** (-2.52)	-0.0005* (-1.39)	-0.0003*** (-3.01)	-0.0001* (-0.54)
Firm size	-0.0046*** (-8.00)	-0.0043*** (-9.38)	-0.0024*** (-21.56)	-0.0028*** (-15.49)
MtB	0.0006*** (5.46)	0.0001*** (3.71)	0.0001*** (4.12)	0.0000 (-1.91)
ROA	-0.0671*** (-11.49)	-0.0305*** (-4.93)	-0.0209*** (-18.33)	-0.0413*** (-16.93)
Stock return	2.1263*** (4.52)	0.1620 (0.79)	1.0837*** (11.79)	6.5415*** (81.33)
Book leverage	-0.0270*** (-4.81)	-0.0115*** (-2.71)	-0.0002 (-0.19)	-0.0021 (-1.26)
CapEx	0.0774*** (4.06)	0.0516*** (3.02)	0.0298*** (8.01)	0.0348*** (5.15)
R&D	0.2434*** (17.73)	0.2748*** (21.12)	0.0079*** (2.96)	0.0181*** (3.52)
CEO tenure	-0.0004*** (-3.40)	0.0000 (-0.02)	0.0000 (-0.55)	0.0000 (-0.44)
CEO age	-0.0151*** (-2.38)	-0.0109** (-2.05)	-0.0082*** (-6.61)	-0.0032 (-1.53)
Intercept	0.1353*** (4.53)	0.1124*** (4.52)	0.0792*** (13.58)	0.0526*** (5.35)
Industry dummy	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes
Obs	3532	3538	3538	3538
R-Sq	0.3116	0.2801	0.5974	0.7254

Note: This table presents the coefficients and t-values of the regressors in the OLS regression model of earnings volatility. The dependent variables are earnings volatility and stock return volatility, respectively. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. PVS represents the logarithm of the sum of one plus PVS, which measures the sensitivity of CEO wealth to stock return volatility. CPS is the proportion of the total compensation (ExecuComp item TDC1) for the top-five executives that the CEO receives. Firm size is the logarithm of market capitalization, calculated as the product of outstanding shares and share prices. MtB, the ratio of market value of assets to book value of assets, serves as a proxy for investment opportunities. ROA, the return on assets, is calculated as operating income divided by the book value of assets. Stock return refers to the return over the fiscal year. Book leverage is the ratio of total debt to total assets. CapEx is the ratio of capital expenditures to assets. R&D is the ratio of R&D expenditures to total assets. CEO tenure is the logarithm of the number of years the CEO has held the position. CEO age is the logarithm of the CEO's age as reported on Compustat. The data on PVS is measured in USD 1. The market capitalization is measured in millions of USD. CEO tenure and CEO age are measured in years.

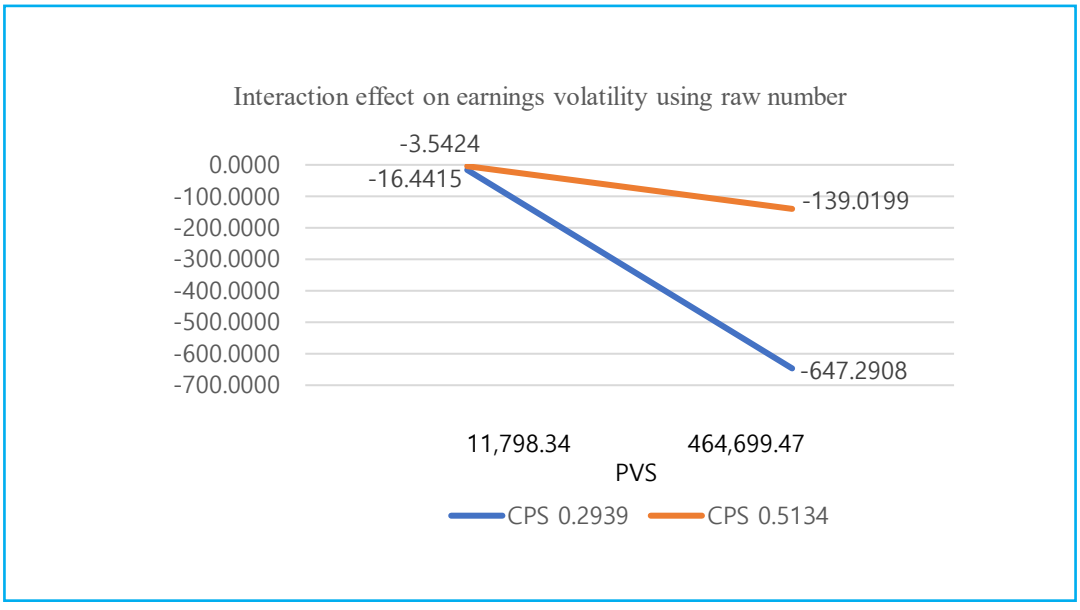
$$\text{Earnings Volatilty} = -0.0028 \times \text{PVS} - 0.0256 \times \text{CPS} + 0.0050 \times \text{PVS} \times \text{CPS} \quad (10)$$

By employing the two aforementioned equations, we calculate earnings volatility and stock return volatility as various combinations of the high and low levels of the raw numbers of PVS and CPS. Table 7 and Fig. 2 display the results. When CPS is set at the low level (0.2939), earnings volatility significantly decreases from -16.4415 to -647.2908 as the raw value of PVS escalates from USD 11,798.34 to USD 464,699.47. Conversely, when CPS is set at the high level, there is a less pronounced decline in earnings volatility (from -3.5424 to -139.0199) with the increase of the raw value of PVS. Thus, although PVS negatively affects earnings volatility, a unit divergence in the raw value of PVS has a more pronounced effect on earnings volatility when CPS is set at the low level than when it is set at the high level. As depicted in Fig. 2, the same increase in the raw value of PVS, when CPS is set at the low level, results in a more substantial decrease in earnings volatility than when CPS is set at the high level.

Table 7. Earnings Volatility Calculated as Raw Numbers of PVS

		CPS	
		0.2939	0.5134
PVS	11,798.34	-16.4415	-3.5424
	464,699.47	-647.2908	-139.0199

Fig. 2. Interaction Effect on Earnings Volatility Using Raw Numbers



2. Robustness Check

The risk-taking behavior of firms could be attributed to some unobservable characteristics, which are correlated with PVS and CPS (Coles et al., 2014). Consequently, the estimated effects of PVS and CPS on earnings volatility and stock return volatility, derived from the OLS regressions, might be biased. To mitigate this potential endogeneity issue, we implement a two-stage least square regression (2SLS). In line with Chintrakarn et al. (2015), we employ the median value of CPS at the industry level as the instrumental variable for CPS. The rationale is that while the degree of risk-taking at the firm level could influence the firm-specific CPS, it is highly improbable that it would affect the industry median CPS (Chintrakarn et al., 2015). Following Coles et al. (2006), we use book leverage as the instrumental variable for PVS. In the first stage, we designate PVS and CPS as dependent variables, respectively. The control variables remain the same as in Eq. (6):

$$PVS_{i,t} = \alpha_0 + \alpha_1 \text{book leverage}_{i,t} + \alpha_2 \text{Contral Variables}_{i,t} + \varepsilon_{i,t} \quad (11)$$

$$CPS_{i,t} = \alpha_0 + \alpha_1 \text{CPS median}_{i,t} + \alpha_2 \text{Contral Variables}_{i,t} + \varepsilon_{i,t} \quad (12)$$

In the second stage, we regress earnings volatility and stock return volatility on the PVS and CPS obtained from the first stage, as well as on the control variables. The model for the second stage is as follows:

$$Risk_{i,t} = \alpha_0 + \alpha_1 PVS_{i,t} + \alpha_2 CPS_{i,t} + \alpha_3 \text{Contral Variables}_{i,t} + \varepsilon_{i,t} \quad (13)$$

Table 8 presents the results of the 2SLS regression. Panel A displays the results of the first stage, demonstrating that both the coefficients of book leverage and industry median CPS are statistically significant. This indicates that book leverage and industry median CPS serve as valid instrumental variables for PVS and CPS, respectively. Panel B details the results of the second stage, showing that while the coefficients of PVS are statistically significant, the coefficients of CPS are not, when the dependent variables are set as both earnings volatility and stock return volatility. This suggests that, in the presence of both PVS and CPS, PVS negatively affects managerial risk-taking, whereas CPS does not significantly influence it. These findings align with the results from the OLS regressions.

Moreover, we divide the observations into two subgroups based on the median values of CPS derived from the initial stage. We then regress earnings volatility and stock return volatility on PVS, obtained from the first stage, and control variables using the following model:

$$Risk_{i,t} = \alpha_0 + \alpha_1 PVS_{i,t} + \alpha_2 \text{Contral Variables}_{i,t} + \varepsilon_{i,t} \quad (14)$$

Table 8. 2SLS Regressions for Earnings Volatility and Stock Return Volatility

Panel A: First Stage	PVS	CPS
Book leverage	0.8304*** (6.34)	
CPS median		0.8089*** (22.27)
Firm size	0.5615*** (47.07)	0.0077*** (9.53)
MtB	-0.0014 (-0.99)	0.0001 (0.63)
ROA	0.0192 (0.12)	0.0219** (2.09)
Stock return	-43.7835*** (-5.50)	0.0256 (0.05)
CapEx	-0.3521 (-0.73)	-0.0374 (-1.13)
R&D	1.0148*** (2.89)	-0.1354*** (-5.83)
CEO tenure	0.0001 (0.04)	-0.0004** (-2.14)
CEO age	-0.2180 (-1.39)	-0.0005 (-0.05)
Intercept	-1.6790*** (-2.29)	0.0037*** (0.07)
Industry dummy	Yes	Yes
Year dummy	Yes	Yes
Obs	7070	7070
R-Sq	0.3456	0.1479
Panel B: Second Stage	Earnings volatility	Stock return volatility
PVS	-0.0010*** (-3.17)	-0.0002*** (-1.79)
CPS	-0.0178 (-1.11)	-0.0021 (-1.49)
Firm size	-0.0042*** (-11.64)	-0.0027*** (-23.69)
MtB	0.0002*** (5.66)	0.0001* (-1.82)
ROA	-0.0541*** (-12.97)	-0.0312*** (-24.23)
Stock return	0.7352*** (3.45)	5.0196*** (76.30)
Book leverage	-0.0204*** (-5.81)	-0.0003 (-0.24)
CapEx	0.0732*** (5.65)	0.0305*** (7.63)
R&D	0.2661*** (28.41)	0.0056* (1.93)
CEO tenure	-0.0002*** (-3.16)	-0.0004 (-0.51)
CEO age	-0.0142*** (-3.40)	-0.0065*** (-5.02)
Intercept	0.1343*** (6.62)	0.0713*** (11.74)
Industry dummy	Yes	Yes
Year dummy	Yes	Yes
Obs	7070	7070
R-Sq	0.3456	0.1479

Note: The instrumental variable of PVS is leverage, and that of CPS is the median value of CPS at the industry level. Panel A shows the regression results of the first stage. Panel B shows the regression results of the second stage. The dependent variable of Column 1 of Panel B is earnings volatility, and the dependent variable of Column 2 of Panel B is stock return volatility. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 9 presents the results. For earnings volatility, the coefficient of PVS for the subsample with a lower CPS is -0.0270, while it is -0.0219 for the subsample with a higher CPS. The negative effect of PVS on earnings volatility is significantly stronger in the presence of a lower CPS than a higher CPS. This suggests that incentive compensation discourages CEOs from taking increased risks, and CEOs with less power exhibit greater risk aversion than those with more power. Similarly, for stock return volatility, the coefficient of PVS for the subsample with a lower CPS is -0.0003, compared to -0.0001 for the subsample with a higher CPS. Therefore, PVS negatively affects stock return volatility at both CPS levels. However, the negative effect of PVS on stock return volatility is more pronounced in the presence of a lower CPS than a higher CPS.

Table 9. OLS Regressions for Earnings Volatility and Stock Return Volatility Using PVS and CPS Obtained from the 2SLS Regressions

	Earnings volatility		Stock return volatility	
	low CPS	high CPS	low CPS	high CPS
PVS	-0.0270***	-0.0219***	-0.0003**	-0.0001*
	(-4.39)	(-3.74)	(-2.49)	(-1.08)
Firm size	0.0104***	0.0070**	-0.0023***	-0.0030***
	(2.95)	(2.04)	(-16.54)	(-18.70)
MtB	0.0005***	0.0001**	0.0000***	0.0000
	(5.07)	(2.57)	(0.89)	(-1.25)
ROA	-0.0623***	-0.0308**	-0.0234***	-0.0384***
	(-12.19)	(-4.22)	(-17.55)	(-17.38)
Stock return	-0.0147	-0.5399***	2.2625***	6.3780***
	(-0.03)	(-1.46)	(22.50)	(80.47)
CapEx	0.0644***	0.0477**	0.0224***	0.0443***
	(3.89)	(2.16)	(5.20)	(6.55)
R&D	0.2697***	0.3093***	0.0203***	-0.0054
	(19.52)	(24.61)	(5.65)	(-1.42)
CEO tenure	-0.0005***	0.0001	0.0000	0.0000
	(-4.80)	(0.78)	(-0.22)	(-1.18)
CEO age	-0.0158***	-0.0227***	-0.0085***	-0.0018
	(-2.79)	(-3.44)	(-5.77)	(-0.90)
Intercept	0.0705***	0.0886***	0.0782***	0.0464***
	(2.54)	(2.84)	(11.26)	(5.16)
Industry dummy	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes
Obs	3535	3535	3535	3535
R-Sq	0.3278	0.2850	0.5573	0.7223

Note: This table presents the coefficients and t-values of the regressors in the OLS regression model of earnings volatility. The dependent variables are earnings volatility and stock return volatility, respectively. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. PVS and CPS are derived from the first stage of the 2SLS regressions. PVS is the logarithm of the sum of one plus PVS, representing the sensitivity of CEO wealth to stock return volatility. CPS is the proportion of the total compensation (ExecuComp item TDC1) for the top five executives that the CEO receives. Firm size is the logarithm of market capitalization, calculated as the product of outstanding shares and firm share prices. MtB is the ratio of the market value of assets to the book value of assets, serving as a proxy for investment opportunities. ROA is the return on assets, calculated as operating income divided by the book value of assets. Stock return is the return over the fiscal year. Book leverage is the ratio of total debt to total assets. CapEx is the ratio of capital expenditures to assets. R&D is the ratio of R&D expenditures to total assets. CEO tenure is the logarithm of the number of years the CEO has held the position. CEO age is the logarithm of the CEO's age as reported on Compustat. The unit of data on PVS is one USD. The unit of market capitalization is millions of USD. The units of CEO tenure and CEO age are years.

In summary, the findings from the 2SLS regression corroborate the results derived from examining the interaction effect of PVS and CPS on both stock return volatility and earnings volatility. Moreover, these results align with those obtained from the OLS regressions. However, one limitation of this study is the use of book leverage as the instrumental variable for PVS, because higher leverage is associated with a higher risk level (Coles et al., 2006). Consequently, the results may be susceptible to endogeneity.

VI. Conclusion

This study explores whether the presence of PVS affects the influence of CPS on managerial risk-taking. It does this by investigating the interaction effect of PVS and CPS, and by dividing observations into two sub-samples based on the median value of CPS. Managerial risk-taking is approximated by earnings volatility and stock return volatility. We provide robust empirical evidence that, when examined individually, both PVS and CPS negatively correlate with managerial risk-taking. However, when PVS and CPS are included in the regression model simultaneously, only PVS has a significant coefficient, whereas the coefficient of CPS becomes nonsignificant. Specifically, when examined individually, incentive compensation and CEO power both negatively affect CEOs' risk-taking propensity. However, in the presence of PVS, the negative effect of CPS vanishes. In other words, the negative effect of incentive compensation alters the effect of CEO power on managerial risk-taking. It is essential to examine the effects of incentive compensation and CEO power on managerial risk-taking collectively. In conclusion, although EBC is granted to CEOs to align their risk preferences with those of shareholders, incentive compensation discourages CEOs from taking risks. CEO power also negatively affects managerial risk-taking by making CEOs more risk-averse.

This study builds on previous research by examining the interactive effects of PVS and CPS on managerial risk-taking. Our findings show that the negative effect of PVS on earnings volatility is more pronounced for CEOs with lower CPS levels than for those with higher CPS levels. A similar conclusion applies to stock return volatility. Specifically, CEOs with more power are less risk-averse than their less powerful counterparts when granted EBC. However, EBC does not encourage CEOs to adopt riskier investment strategies, owing to various factors, such as CEO tenure and age, which contribute to higher levels of CEO power. The significant interactive effects of incentive compensation and CEO power on managerial risk-taking suggest that these two factors are interconnected and influence managerial risk-taking interactively. The underlying rationale for this result is that while granting EBC to CEOs does not effectively align the risk preferences of

CEOs with those of shareholders or encourage CEOs to take more risks, EBC results in worse outcomes for less powerful CEOs compared to more powerful ones.

In addition, to ensure the reliability of the results, we use the ratio of R&D to total assets as a proxy of managerial risk-taking[2] and apply the same OLS and 2SLS regression models. We find the results are consistent.

One potential extension of this study involves using an alternative instrumental variable of PVS, such as the median value of PVS at the industry level, to conduct the 2SLS regression. Another potential extension involves dividing the sample period into two sub-periods, namely, 1992–2007 and 2008–2019, because the 2008 financial crisis may have altered CEOs' behavior under EBC.

References

Agrawal, A., & Mandelker, G. (1987). Managerial incentives and corporate investment and financing decisions. *Journal of Finance, 42*(4), 823-837. https://doi.org/10.1111/j.1540-6261.1987.tb03914.x

Armstrong, C., & Vashishtha, R. (2012). Executive stock options, differential risk-taking incentives, and firm value. *Journal of Financial Economics, 104*(1), 70-88. https://doi.org/10.1016/j.jfineco.2011.11.005

Bargeron, L., Lehn, K., & Zutter, C. (2010). Sarbanes-oxley and corporate risk-taking. *Journal of Accounting & Economics, 49*(1), 34-52. https://doi.org/10.1016/j.jacceco.2009.05.001

Bebchuk, L., Cremers, K., & Peyer, U. (2011). The CEO pay slice. *Journal of Financial Economics, 102*(1), 199-221. https://doi.org/10.1016/j.jfineco.2011.05.006

Bettis, B. (2018). Performance-vesting provisions in executive compensation. *Journal of Accounting & Economics, 66*(1), 194-221. https://doi.org/10.1016/j.jacceco.2018.05.001

Bharati, R., & Jia, J. (2018). Do bank CEOs really increase risk in vega? Evidence from a dynamic panel GMM specification. *Journal of Economics and Business, 99*, 39-53. https://doi.org/10.1016/j.jeconbus.2018.06.001

Black, F., & Scholes, M. (1973). The pricing of options and corporate liabilities. *Journal of Political Economy, 81*(3), 637-654. https://doi.org/10.1086/260062

Boubakri, N., Cosset, J., & Saffar, W. (2013). The role of state and foreign owners in corporate risk-taking: Evidence from privatization. *Journal of Financial Economics, 108*(3), 641-658. https://doi.org/10.1016/j.jfineco.2012.12.007

Brockman, P., Lee, H., & Salas, J. (2016). Determinants of CEO compensation: Generalist–specialist versus insider–outsider attributes. *Journal of Corporate Finance, 39*, 53-77. https://doi.org/10.1016/j.jcorpfin.2016.04.007

Carpenter, M. A., Pollock, T. G., & Leary, M. M. (2003). Testing a model of reasoned risk-taking: Governance, the experience of principals and agents, and global strategy in high-technology IPO firms. *Strategic Management Journal, 24*(9), 803-820. https://doi.org/10.1002/smj.338

Chakraborty, A., Gao, L., & Sheikh, S. (2019). Managerial risk taking incentives, corporate social responsibility and firm risk. *Journal of Economics and Business, 101*, 58-72. https://doi.org/10.1016/j.jeconbus.2018.07.004

Chava, S., & Purnanandam, A. (2010). CEOs versus CFOs: Incentives and corporate policies. *Journal of Financial Economics, 97*(2), 263-278. https://doi.org/10.1016/j.jfineco.2010.03.018

2. The ratio of R&D to total assets is an alternative measure to approximate managerial risk-taking level, and is used by Li et al. (2013), Bargeron et al. (2010), and Coles et al. (2006).

Chen, D., & Zheng, Y. (2014). CEO tenure and risk-taking. *Global Business and Finance Review*, *19*(1), 1-20. https://doi.org/10.17549/gbfr.2014.19.1.01

Chintrakarn, P., Jiraporn, P., & Tong, S. (2015). How do powerful CEOs view corporate risk-taking? Evidence from the CEO pay slice (CPS). *Applied Economics Letters, 22*(2), 104-109. https://doi.org/10.1080/13504851.2014.927565

Coles, J., Daniel, N., & Naveen, L. (2006). Managerial incentives and risk-taking. *Journal of Financial Economics, 79*(2), 431-468. https://doi.org/10.1016/j.jfineco.2004.09.004

Coles, J., Daniel, N., & Naveen, L. (2014). Co-opted boards. *The Review of Financial Studies, 27*(6), 1751-1796. https://doi.org/10.1093/rfs/hhu011

Core, J., & Guay, W. (2002). Estimating the value of employee stock option portfolios and their sensitivities to price and volatility. *Journal of Accounting Research, 40*(3), 613-630. https://doi.org/10.1111/1475-679X.00064

Cowen, A., King, A., & Marcel, J. (2016). CEO severance agreements: A theoretical examination and research agenda. *The Academy of Management Review, 41*(1), 151-169. https://doi.org/10.5465/amr.2011.0435

Faccio, M., Marchica, M., & Mura, R. (2011). Large shareholder diversification and corporate risk-taking. *The Review of Financial Studies, 24*(11), 3601-3641. https://doi.org/10.1093/rfs/hhr065

Feng, H., & Rao, R. (2018). Cash holdings and CEO risk incentive compensation: Effect of CEO risk aversion. *International Review of Financial Analysis, 60,* 162-176. https://doi.org/10.1016/j.irfa.2018.09.009

Gormley, T., Matsa, D., & Milbourn, T. (2013). CEO compensation and corporate risk: Evidence from a natural experiment. *Journal of Accounting and Economics, 56*(2-3), 79-101. https://doi.org/10.1016/j.jacceco.2013.08.001

Guay, W. (1999). The sensitivity of CEO wealth to equity risk: an analysis of the magnitude and determinants. *Journal of Financial Economics, 53*(1), 43-71. https://doi.org/10.1016/S0304-405X(99)00016-1

Haugen, R., & Senbet, L. (1981). Resolving the agency problems of external capital through options. *Journal of Finance, 36*(3), 629-647. https://doi.org/10.1111/j.1540-6261.1981.tb00649.x

Hoskisson, R., Castleton, M. W., & Withers, M. C. (2009). Complementarity in monitoring and bonding: More intense monitoring leads to higher executive compensation. *Academy of Management Perspectives, 23*(2), 57-74. https://doi.org/10.5465/AMP.2009.39985541

Hoskisson, R., Chirico, F., Zyung, J., & Gambeta, E. (2017). Managerial risk taking: A multitheoretical review and future research agenda. *Journal of Management, 43*(1), 137-169. https://doi.org/10.1177/0149206316671583

Iqbal, J., & Vähämaa, S. (2019). Managerial risk-taking incentives and the systemic risk of financial institutions. *Review of Quantitative Finance and Accounting, 53*(4), 1229-1258. https://doi.org/10.1007/s11156-018-0780-z

John, K., Litov, L., & Yeung, B. (2008). Corporate governance and risk-taking. *The Journal of Finance (New York), 63*(4), 1679-1728. https://doi.org/10.1111/j.1540-6261.2008.01372.x

Kim, S. H., & Shin, C. W. (2022). The effects of information asymmetry and financial constrains on the relationship between management risk and effective tax rates. *Journal of International Trade & Commerce*, *17*(1), 631-649. http://dx.doi.org/10.16980/jitc.17.1.202102.631

Knopf, J., Nam, J., & Thornton, J. (2002). The volatility and price sensitivities of managerial stock option portfolios and corporate hedging. *Journal of Finance, 57*(2), 801-813. https://doi.org/10.1111/1540-6261.00442

Lambert, R., Larcker, D., & Verrecchia, R. (1991). Portfolio considerations in valuing executive compensation. *Journal of Accounting Research, 29*(1), 129-149. https://doi.org/10.2307/2491032

Lewellyn, K., & Muller-Kahle, M. (2012). CEO power and risk taking: Evidence from the subprime lending industry. *Corporate Governance: An International Review, 20*(3), 289-307. https://doi.org/10.1111/

j.1467-8683.2011.00903.x

Li, K., Griffin, D., Yue, H., & Zhao, L. (2013). How does culture influence corporate risk-taking? *Journal of Corporate Finance (Amsterdam, Netherlands), 23,* 1-22. https://doi.org/10.1016/j.jcorpfin.2013.07.008

Li, Q., Shin, Y. and Pyo, U. (2022). Impacts of CEO incentives and power on employee wages. *Journal of Global Business and Trade 18*(6), 33-57. http://dx.doi.org/10.20294/jgbt.2022.18.6

Liu, Y., & Jiraporn, P. (2010). The effect of CEO power on bond ratings and yields. *Journal of Empirical Finance, 17*(4), 744-762. https://doi.org/10.1016/j.jempfin.2010.03.003

Low, A. (2009). Managerial risk-taking behavior and equity-based compensation. *Journal of Financial Economics, 92*(3), 470-490. https://doi.org/10.1016/j.jfineco.2008.05.004

May, D. (1995). Do managerial motives influence firm risk reduction strategies? *Journal of Finance, 50*(4), 1291-1308. https://doi.org/10.1111/j.1540-6261.1995.tb04059.x

Merton, R. (1973). Theory of rational option pricing. *The Bell Journal of Economics and Management Science, 4*(1), 141-183. https://doi.org/10.2307/3003143

Murphy, K. (1999). Chapter 38 executive compensation. *Handbook of Labor Economics, 3*, 2485-2563. https://doi.org/10.1016/S1573-4463(99)30024-9

Rajgopal, S., & Shevlin, T. (2002). Empirical evidence on the relation between stock option compensation and risk taking. *Journal of Accounting and Economics, 33*(2), 145-171. https://doi.org/10.1016/S0165-4101(02)00042-3

Parrino, R., Poteshman, A., & Weisbach, M. (2005). Measuring investment distortions when risk-averse managers decide whether to undertake risky projects. *Financial Management*, *34*(1), 21-60. https://doi.org/10.1111/j.1755-053X.2005.tb00091.x

Pathan, S. (2009). Strong boards, CEO power and bank risk-taking. *Journal of Banking and Finance, 33*(7), 1340-1350. https://doi.org/10.1016/j.jbankfin.2009.02.001

Rogers, D. (2002). Does executive portfolio structure affect risk management? CEO risk-taking incentives and corporate derivatives usage. *Journal of Banking and Finance, 26*(2), 271-295. https://doi.org/10.1016/S0378-4266(01)00222-9

Sanders, G. (2001). Behavioral responses of CEOs to stock ownership and stock option pay. *Academy of Management Journal, 44*(3), 477-492. https://doi.org/10.2307/3069365

Seo, K., & Sharma, A. (2018). CEO overconfidence and the effects of equity-based compensation on strategic risk-taking in the U.S. restaurant industry. *Journal of Hospitality & Tourism Research, 42*(2), 224-259. https://doi.org/10.1177/1096348014561026

Smith, C., & Stulz, R. (1985). The determinants of firms' hedging policies. *The Journal of Financial and Quantitative Analysis, 20*(4), 391-405. https://doi.org/10.2307/2330757

Tadele, H., & Kalyebara, B. (2020). CEO power and bank risk in the UAE. *Banks and Bank Systems, 15*(3), 117-128. https://doi.org/10.21511/bbs.15(3).2020.11

Victoravich, L., Grove, H., Xu, P., & Buslepp, W. (2011). CEO power, equity incentives, and bank risk taking. *Banking And Finance Review, 3*(2). http://www.bankingandfinancereview.com/bfr/index.php/bfr/article/view/226

Walker, D. (2011). Evolving executive equity compensation and the limits of optimal contracting. *Vanderbilt Law Review, 64*(2), 609-674. http://dx.doi.org/10.2139/ssrn.1443170

Wiseman, R., & Gomez-Mejia, L. (1998). A behavioral agency model of managerial risk taking. *The Academy of Management Review, 23*(1), 133-153. https://doi.org/10.2307/259103

Appendix

In this appendix, we list and define the variables used in this research.

Earnings volatility (Erisk) is the volatility of the ratio of firm's EBITDA relative to the firm's total assets.

Stock return volatility (Srisk) is the logarithm of the standard deviation of daily stock returns over the fiscal year.

PVS is calculated as the logarithm of the sum of one plus PVS, which is the sensitivity of CEO wealth to stock return volatility. The unit of data on PVS is USD 1.

CPS is the fraction of the total compensation (ExecuComp item TDC1) to the group of top-five executives that is received by the CEO.

Firm size is the logarithm of market capitalization, which is the product of the outstanding shares and share prices of firms. The unit of market capitalization is millions of USD.

MtB is the ratio of market value of assets to book value of assets.

ROA is computed as operating income divided by book value of assets.

Stock return is the return over the fiscal year.

Book leverage is the ratio of total debt to total assets.

CapEx is the ratio of capital expenditures to assets.

R&D is the ratio of R&D expenditures to total assets.

CEO tenure is the logarithm of the number of years that the CEO has held the position.

CEO age is the logarithm of the age of CEO, as reported on Compustat.

ISSN 1946-5130 (Print), ISSN 2470-4733 (Online)
http://dx.doi.org/10.20294/jgbt.2023.19.5.229

The Journal of Global Business and Trade

Journal of Global Business and Trade

https://www.pfw.edu/jgbt

The Russia-Ukraine War and Its Impact on the Food Security of Korea, China, and Japan: A CGE Approach

Esambe Sone[a], Jong-Hwan Ko[b]*

[ab]*Division of International and Area Studies & Department of Global and Area Studies, Pukyong National University, South Korea*

Received 13 July 2023, Revised 20 August 2023, Accepted 2 October 2023

ABSTRACT

Purpose – In 2021, Ukraine and Russia exported 12% and 17% of global wheat, being significant grain producers and exporters. However, Russia's invasion of Ukraine greatly impacts Ukraine's wheat production and trade. In this regard, this study examines the impact of Russia's invasion of Ukraine on global food security using the computable general equilibrium approach.

Design/Methodology/Approach – We utilized the global multi-sector standard GTAP model, specifically the GTAP Database Version 11, with a base year of 2017. For this research purpose, the original 160 regions and 65 sectors of the GTAP database were aggregated into 23 regions and 24 sectors. Due to the uncertain nature of the conflict duration between Russia and Ukraine, we designed three scenarios: Slight, Medium, and Severe. Each scenario represents varying degrees of wheat production, trade disruption, and an increase in wheat production by third producers for shocks.

Findings – The study reveals several effects: real GDP decreases for Ukraine, Russia, Turkey, India, and Georgia, while countries like Egypt, Turkey, Azerbaijan, India, Korea, and Japan experience diminished economic welfare. Russia's invasion can affect wheat imports of countries like Turkey, India, Mongolia, and Egypt. Ukraine, Egypt, Turkey, and India registered trade surpluses, while others recorded deficits

Research Implications – The ongoing conflict complicates assessing long-term consequences on global food security. Policymakers are advised to monitor closely, implement strategies to mitigate disruptions, and foster international collaboration to alleviate adverse effects on trade, economies, and food security, particularly of nations heavily reliant on Ukraine's wheat exports, like Egypt, Turkey, Mongolia, Georgia, and Azerbaijan.

Keywords: computable general equilibrium model, global food security, Russia-Ukraine War, wheat production, trade disruption

JEL Classifications: C68, D58, F14, F15

* *Corresponding Author, Email: jonghko@pknu.ac.kr*

© 2023 International Academy of Global Business and Trade. All rights reserved.

I. Introduction

Russia's invasion of Ukraine on February 24th' 2022, has had far-reaching consequences beyond the political and humanitarian realms. One significant area of impact is global food security, particularly due to disruptions in Ukraine's agricultural production and trade. Ukraine, often referred to as the "breadbasket of Europe", is renowned for its fertile soil, vast agricultural resources, and status as a major global grain exporter. However, the conflict has severely hindered the country's ability to fulfill its agricultural potential, leading to repercussions that extend to the global stage. This paper explores the impact of Russia's invasion of Ukraine on global food security, with a specific focus on agricultural production and trade disruption in Ukraine.

Both Russia and Ukraine play crucial roles as major food suppliers to the global market. Under normal circumstances, Ukraine exports approximately three-quarters of its grain production. Therefore, the ongoing war and its consequences on grain exports carry significant implications, especially for regions in the global south that heavily depend on these supplies. The United Nations (2022) issued a warning that the combination of disrupted agricultural production in Ukraine and the obstruction of remaining product exports due to Russia's invasion could potentially plunge 49 million people into conditions of famine or famine-like circumstances. Russia's invasion of Ukraine has had a profound and wide-ranging impact on food security. The cessation of Ukrainian exports, coupled with labor shortages caused by conscription and population displacement, has severely disrupted agricultural production. Access to fertilizers is restricted, casting uncertainty over future harvests. In addition to these challenges, the conflict has exacerbated existing vulnerabilities within food systems already weakened by climate change (Kitetu & Ko, 2020) and the COVID-19 pandemic (Kim et al., 2022; Yoon and Ko, 2022). As a result, this will likely lead to a deteriorating food security crisis. According to the World Bank (2022), Russia's invasion of Ukraine has not only been a tragic ordeal for its people but has also brought about far-reaching economic consequences on a global scale. The World Bank report concentrates on the direct repercussions of the war on international trade and investment. It identifies five key channels through which countries will experience the impact of the conflict in Ukraine on trade and investment activities. The report reveals that global trade will witness a 1% decline, resulting in a decrease of 0.7% in global GDP, and of 1% in the GDPs of low-income countries. However, it is important to recognize that the long-term effects of this war on global trade and investment will heavily rely on the responses of governments to the evolving geopolitical landscape.

Compounding the situation is the unfortunate timing of the war with global food markets. Prior disruptions in the supply chain due to the COVID-19 pandemic, coupled with high global demand and poor harvests in certain countries, had already led to elevated food prices. The conflict-related disruptions in global food and fertilizer markets further exacerbate concerns about price and availability, intensifying the overall impact on global food security. Given the urgency of the situation and ongoing developments, it is crucial to understand how the war's implications for food security will unfold. This paper provides a timely and essential assessment of the situation, offering valuable insights into the far-reaching consequences and pressing need for immediate action to address the challenges posed by the war on food security.

The rest of the paper is organized into the following sequence. Section II gives an overview of Ukraine's agricultural sector and an update on the conflict related to agricultural produce. Section III focuses on literature, and Section IV looks at methodology and data. Section V accounts for the simulated results, and Section VI contains the conclusion and some policy recommendations.

II. Ukraine's Agriculture

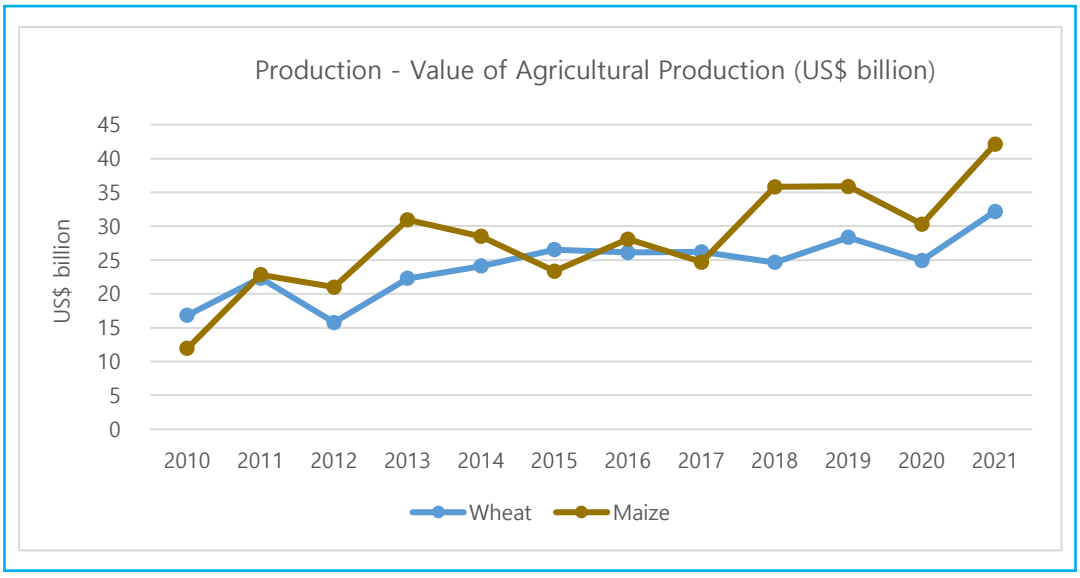
The invasion of Ukraine by Russia has had significant implications for wheat production, trade decrease, and global food security. Ukraine is known as one of the world's largest wheat exporters, and any disruptions in its agricultural sector can have far-reaching consequences for global markets and food security. According to Statista (2023a), Ukraine was expected to produce 21 million metric tons of wheat in the marketing year of 2022/2023. That would mark a decrease of 36 percent compared to the previous year. However, according to Crop Explorer (2023), wheat production for the marketing year 2022/23 is forecast at 21.5 million metric tons, down 35% from last year. The war has directly impacted wheat production in Ukraine. The conflict zone in Eastern Ukraine, which includes major agricultural regions, has suffered from damaged infrastructure, landmine contamination, and the displacement of farmers. These factors have resulted in reduced cultivation and lower yields, leading to a decline in wheat production within the country.

The disruption of the wheat trade has been another significant consequence of the conflict. Ukraine's role as a major exporter of wheat has been affected by logistical challenges, trade restrictions, and changes in market dynamics. Export routes have been disrupted, and trade flows have been redirected or limited due to the conflict, impacting global wheat markets and supply chains. This disruption in the wheat trade has contributed to price volatility and uncertainty in the global grain market.

The implications of the Russian attack on Ukraine on wheat production and trade decrease extend beyond the country itself as other countries (third producers) see the need to increase production due to the existing demand for wheat by other regions. As a key player in global wheat markets, any disturbances in Ukraine's production and export capabilities have repercussions on global food security. Reduced availability and increased prices of wheat can affect food access and affordability, particularly for countries reliant on imported wheat for domestic consumption.

Fig. 1. Ukraine's Agricultural Production 2010-2021

(US$ billion)



Source: FAO (2023).

The impact of Russia's incursion into Ukraine on wheat production, trade decrease, and global food security underscores the interconnectedness of agricultural systems, as well as the vulnerability of the global food system to geopolitical conflicts. It highlights the need for coordinated efforts among nations, international organizations, and agricultural stakeholders to address the challenges faced by Ukraine and mitigate the potential risks to global food security.

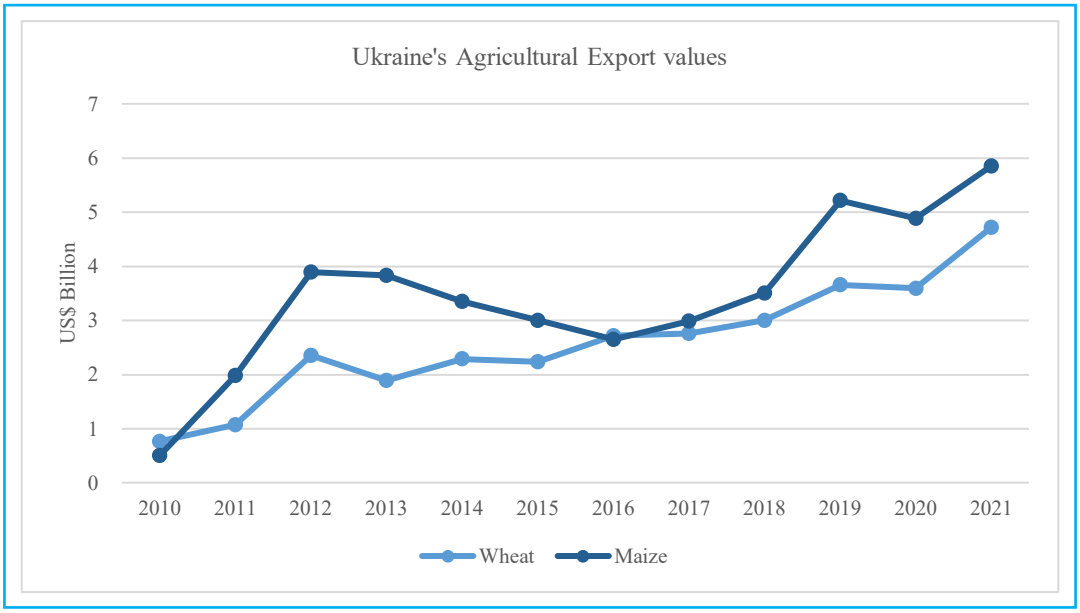
In light of these challenges, it becomes crucial to examine and understand the specific effects of Russia's invasion on Ukraine and global food security. By analyzing the available literature and research on this topic, we can gain valuable insights into the extent of the impact, underlying factors, and potential strategies for mitigating the adverse effects and promoting sustainable agricultural practices in the region.

Ukraine is one of the world's top agricultural producers and exporters, and plays a critical role in supplying oilseeds and grains to the global market. Agricultural products are Ukraine's most important exports. In 2021 they totaled $27.8 billion, accounting for 41 percent of the country's $68 billion in overall exports. Fig. 1 represents the value of agricultural production from 2010 to 2021. Wheat production witnessed an increase from US$ 17 billion in 2010 to US$ 32 billion in 2021. In 2021, the agricultural sector in Ukraine contributed approximately 10.7 percent of the value added to the country's gross domestic product (GDP). Though Ukraine's maize production varied considerably in recent years, it tended to increase through the 2002 - 2021 period, ending at US$ 42.1 billion in 2021.

Fig. 2 is a representation of Ukraine's agricultural value. Ukraine is one of the world's major exporters of wheat and maize, and its export revenues from these commodities can be influenced by factors such as production volumes, global demand, trade policies, and international market prices. The region's agricultural export values from 2010 to 2021 were between US$ 14.1 billion to US$ 23.5 billion. For wheat, export values ranged between US$ 1 billion (2010) to

Fig. 2. Ukraine's Agricultural Exports

(US$ billion)



Source: FAO (2023).

US$ 5 billion (2021), while maize registered export values of US$ 0.5 billion in 2010 to US$ 5.8 billion in 2021.

According to Statista (2023b), Ukraine exported wheat worth over 475 million US$ dollars to Turkey, which was the leading export destination of that commodity in 2022. Romania, to which Ukraine's wheat export value reached over 332 million US$, ranked second. In total, Ukraine's wheat exports exceeded 2.6 billion US$ in that year. As of the 2022/2023 marketing year, Ukraine ranked fifth among the largest exporters of wheat worldwide, with the total export volume reaching over 13.5 million metric tons. Moreover, the country accounted for about nine percent of the global wheat trade share.

There has been a trade agreement between Russia and Ukraine since the war started in 2022. According to CNN World News (2022), Ukraine and Russia agreed on a deal that would allow the resumption of vital grain exports from Ukrainian Black Sea ports, a major diplomatic breakthrough aimed at easing the global food crisis sparked by the war.

The deal also allowed the unchecked access of Russian fertilizers to global markets. Russia is a major producer of fertilizers, which are vital to maximizing food production, and the cost of the produce has spiraled since the invasion. The ships were monitored by a Joint Coordination Center (JCC), which was established in Istanbul and included representatives from Ukraine, Russia, and Turkey. Both parties agreed that there would be no attacks on any of the vessels going from those ports out of territorial waters into the Black Sea by any party. The breakthrough followed months of negotiations and promises to unblock ports on the Black Sea to allow the safe passage of grain and oilseeds, some of Ukraine's most important exports. Russia has so far blocked maritime access to those ports, meaning that millions of tons of Ukrainian grain have not been exported to the many countries that rely on it. The World Food Programme (WFP, 2023) estimates that 47 million people have moved into a stage of severe hunger as a consequence of the war, and Western officials have accused Russia of using food as a weapon during its invasion (CNN World News, 2022).

According to Reuters (2023), the destruction of the Kakhovka dam is expected to result in the flooding of tens of thousands of hectares of agricultural land in Southern Ukraine. Furthermore, it could potentially transform at least 500,000 hectares of land left without irrigation into arid deserts. Ukraine, which possesses a total of 33 million hectares of farmland according to BBC News (2023b), may face a threat to nearly 2% of its agricultural area. It is estimated that about 42,000 people are at risk from the flooding, and the dam's collapse left hundreds of thousands without normal access to drinking water.

In an interview with BBC News (2023b), Ukraine's Ministry of Agriculture revealed that before Russia's full-scale invasion, the irrigation systems supported approximately 584,000 hectares of land in 2021. Farmers were able to harvest around 4 million tons of grains and oilseeds from these irrigated lands, representing approximately 4% of the country's total output. In 2021, Ukraine's grain and oilseed production reached 104 million tons. The ministry also cited preliminary estimates indicating that approximately 10,000 hectares of agricultural land on the right bank of the Kherson region would be subject to flooding.

According to Fox Business (2023), the global prices of corn and wheat have experienced a significant surge due to the destruction of a major dam in Southern Ukraine. This event marks a reversal from the downward trend in prices witnessed earlier after Russia invaded Ukraine in February 2022. PBS NewsHour (2023) confirmed that the collapse of the dam in Southern Ukraine has had a direct impact on global wheat and corn prices, driving them higher. In early trading at the Chicago Mercantile Exchange, wheat prices rose by 2.4%, reaching $6.39 per bushel. Furthermore, the cost of corn increased by over 1%, amounting to $6.04 per bushel, while oats experienced a gain of 0.73%, reaching $3.46 per unit.

The Guardian (2023) emphasized the

implications of the Nova Kakhovka dam's destruction on the region and the global food supply. Ukraine, being responsible for 40% of global trade in sunflower meal, 35% of sunflower oil, and 5% of wheat, barley, and corn exports, has raised concerns about the availability and stability of these commodities worldwide.

Early July 2023, Russian President Vladimir Putin complained that parts of the deal allowing the export of Russian food and fertilizers had not been honored. Russia's threat to quit the trade deal stated that it would return to the agreement if its conditions were met (BBC News, 2023a). This was made known by Moscow, which notified the UN, Turkey, and Ukraine that it would not renew the deal, accusing the West of not keeping its side of the bargain. This move was greatly condemned by world leaders, as it will have a huge impact on humanity.

III. Literature Review

Bhaskara and Rao (2017) provided insights into the economic impact of the conflict in Ukraine on the global grain market. They highlighted disruptions in grain production and trade and the broader implications for market dynamics, competition, and food security. The article also discusses the implications of the conflict for food security and price stability in importing countries, particularly those heavily reliant on Ukrainian grain. The authors emphasized the importance of understanding the economic consequences of the conflict for policymakers and stakeholders involved in the global grain market. Kang (2022) analyzed the determinants of Korea's agricultural trade using the gravity model. From the results gathered, the study suggested that there is need for a well-structured model with respect to simple combined or multiplied independent variables and also the need to intensify the utilization of FTA for an increase in Korea's agricultural exports.

Choma and Dobija (2017) provided insights into the consequences of the Ukrainian conflict on the global wheat market. They highlighted the disruptions in wheat production and trade, the adjustments made by market participants, and potential long-term implications for the Ukrainian wheat sector. They considered factors such as the restoration of infrastructure, investment in agricultural technology, and policy measures aimed at revitalizing the sector. Similarly, Yang and Li (2021) analyzed the factors necessitating the price of china grain futures, and its prospective implications on Korea. The paper systematically analyzed the factors affecting the Chinese grain futures price by introducing speculative factors and pork prices for the first time. If China's grain futures market opens in the future, it can be expected to become an important investment market, Yang and Li (2021). Based on the outcome of their study, both authors suggested that as Korea is also a grain importer, changes in China's grain market should be closely monitored.

Martin-Shields and Stojetz (2019) underscored the complex relationship between food security and armed conflict using the Uppsala Conflict Data Program and FAO databases, and illustrated how intervening factors influence the relationship between conflict and food security at the micro and macro levels. They highlighted the empirical challenges of studying this nexus and proposed future research opportunities and policy implications. The authors emphasized the importance of addressing food security in conflict settings to promote stability, peace, and the well-being of affected populations.

Song and Kim (2022) used the Global Trade Analysis Project (GTAP) model to simulate the impact of Regional Comprehensive Economic Partnership (RCEP) on South Korea's agricultural trade from the perspective of tariff reduction. The study concluded that although RCEP has a negative impact on most agricultural products, in the long run, participating in RCEP is more beneficial than resisting. Cheong (2023) opined that the upsurge of regional trade agreements is of the opinion that regional trade agreements that paved the way to dispute settlement systems are increasing and the content is becoming more sophisticated. However, regional trade agreement members prefer to

resolve disputes through World Trade Organization (2023) - Dispute Settlement Mechanism (WTO-DSM) rather than Regional Trade Agreements – Dispute Settlement Mechanisms (RTA-DSM) to resolve disputes. In light of the recent international tensions rooted in the rivalry between the United States and China, it is evident that opportunities for both regional and global collaboration are on the rise. This trend is driven by an increasing level of cooperation among established global players due to their interdependence on the international stage. Within this context, the approach to fostering sustainability within the international community, as outlined in the United Nations' sustainable development agenda, emerges as a significant mechanism for promoting economic growth, facilitating recovery, and ensuring stability in nations across the globe (Kim et al., 2023). Abay et al. (2022) emphasized that the Russia-Ukraine crisis posed a serious food security threat for Egypt. The study emphasized Egypt's heavy reliance on imported wheat, with Russia and Ukraine being key suppliers. The authors argued that the crisis could disrupt global grain markets, raising food prices and scarcity. Egypt, already facing economic challenges, may need help to afford expensive wheat imports, worsening food security. The paper suggests proactive measures, such as diversifying wheat sources and strengthening domestic agricultural production, to mitigate the impact on Egypt's food security. Li et al. (2022) underlined the detrimental effects of the civil war in Syria on crop production and food security. They emphasized the urgent need for interventions and supported the revitalization of the agricultural sector, rebuilding of infrastructure, and ensuring access to inputs and markets. The authors argued that addressing food security challenges in Syria required humanitarian assistance and long-term strategies for agricultural recovery and development.

Kuzmenko and Öztürk (2020) provided potential intuitions into the effects of the Russian-Ukrainian conflict on global agricultural commodity markets. They highlighted disruptions in supply, trade flows, market dynamics, and broader economic implications. The authors examined the adjustments made by alternative exporters to fill the gap in global supply, as well as the implications for importing countries reliant on Ukrainian agricultural commodities. Understanding these effects is crucial for policymakers, market participants, and stakeholders involved in the agricultural sector. Guerrieri et al. (2022) examined the macroeconomic effects of the COVID-19 pandemic, focusing on the interplay between negative supply shocks and demand shortages. The paper highlights the interconnectedness between negative supply shocks and demand shortages in the context of the COVID-19 pandemic. It emphasizes the need for comprehensive policy responses addressing supply-side disruptions and demand-side challenges to promote economic recovery and stability. Similarly, Stephens et al. (2022) focused on the supply chain disruptions caused by the outbreak of the COVID-19 pandemic by carrying out a comparative study on the relational capital on ambidextrous innovation and firm performance between Korean and U.S firms.

A paper by Glauber et al. (2022) delves into the detrimental effects of export restrictions imposed due to Russia's invasion of Ukraine. The authors highlighted the disruption caused by these restrictions in global food supply chains, particularly for agricultural commodities like wheat, maize, and soybeans. The reduced availability of these commodities leads to higher food prices and reduced access, exacerbating global food insecurity. The paper emphasizes that these restrictions affect vulnerable regions and populations. It also highlights secondary effects such as market volatility and reduced market efficiency. The authors call for coordinated international efforts to address the situation, ensuring open trade, transparency, and affordable food access for the most affected populations.

The duration of the Russia-Ukraine conflict will impact the wheat harvest and therefore exacerbate the global food insecurity crisis already challenged by the COVID-19 pandemic (Yan et al., 2021). Wheat production in Ukraine is likely to decline due to the Russia - Ukraine conflict. Based

on Andrimont et al. (2021), the total wheat area in Ukraine revealed by satellite observations is about 6.57 million hectares, close to the official statistics of Ukraine (i.e., 6.87 million hectares in 2021).

These studies collectively highlight the various dimensions and consequences of Russia's invasion of the agricultural sector. They examine the impact on production, trade, market dynamics, and structural changes. Additionally, the studies emphasize the challenges farmers face, the need for policy interventions, and the potential for recovery and development in the post-conflict period.

IV. Methodology and Data

1. Method

To provide an assessment of Russia's invasion of Ukraine and its impact on food security, we utilized the global multi-sector standard GTAP model. The standard GTAP is a static CGE model. CGE models can be applied to analyze various policy issues such as trade, tax, environment, climate, energy, water, poverty, immigration, and health-related issues, such as the COVID-19 pandemic. The standard GTAP model provides a detailed representation of the economy, including the interlinkage between bilateral trading partners and economic sectors. The model has a database and parameter files that can be applied directly or indirectly through model extensions. Using a set of equations and economic data, the model captures the structure of the economy and the behavioral responses of economic agents.

The model's inbuilt capacity and flexibility enable researchers to evaluate the economy-wide impact of policy shocks decomposed into direct or indirect effects. The model accounts for a policy shock's demand and supply-side impacts, but also allows the prices and quantities supplied or demanded to adjust. The model utilizes simultaneous equations guided by economic theory and economic data to derive adjustments of the economy computationally, and the responses by economic agents such as firms, private households, and governments resulting from policies or shocks in the economy. This framework enables researchers to trace the changes in key economic variables such as welfare, income, and expenditure resulting from policy changes.

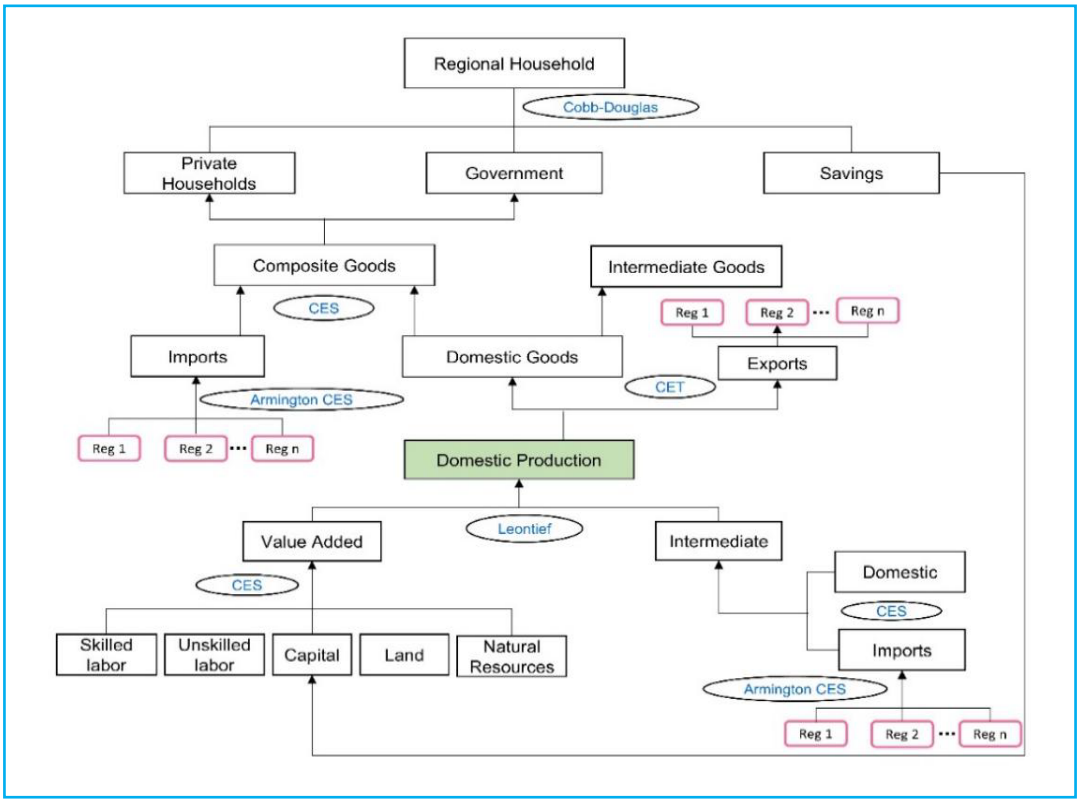
The regional household receives all factor incomes (land, skilled labor, unskilled labor, capital, and natural resources) and all taxes on domestic and imported commodities, as shown in Fig. 3. The regional household then allocates all income across the components of final demand: private household consumption, government expenditure, and savings investment, following the Cobb-Douglas utility structure. Whereas government expenditure and savings-investment behavior follow a constant elasticity of substitution (CES) functional form, the model assumes a constant difference elasticity (CDE) form to account for private household consumption behavior.

Production in the standard GTAP model assumes perfect competition with constant returns to scale (Hertel, 1997). The theoretical background of the model argues that producers aim to maximize profits under the constraints of existing production technologies and input prices. At the same time, private households try to maximize utility under budget constraints. The production follows a nested CES production function whereby firms combine a value-added composite with an intermediate bundle to produce a commodity. Product differentiation between imports from different sources and domestic and imported goods in the domestic market follows the Armington (CES) utility function. This utility function explains why two regions trade in similar product categories (Armington, 1969).

Since the GTAP database covers a broad range of countries and regions, it accounts for all bilateral trade flows between each country and the ROW. The economic representation of each country or region follows a standard pattern with differences in base data and critical behavioral parameters. Nevertheless, the accounting of some countries comes through regional aggregates. This

framework of the GTAP model makes it easy to interpret simulation outcomes and provides an avenue for the extension of the model (Corong et al., 2017). Unlike partial equilibrium and macroeconomic models that focus on a single sector or a few sectors, the GTAP model employs a general equilibrium framework encompassing the representation of the whole economy. Profoundly, the standard GTAP model applies a comparative static approach, whereby simulation outcomes compare the status of the global economy under two assumptions: a base case and a policy case at a fixed time, or a base period and a future projected time.

Fig. 3. Structure of the GTAP Model



Source: Ko (2018).

2. Data and Policy Scenarios

2.1. Data

In this model design, the GTAP Database Version 11 (Aguiar et al., 2023) was employed to analyze Russia's invasion of Ukraine and its impact on global food security. The initial step involves aggregating the original dataset, consisting of 160 regions and 65 sectors, into a more manageable structure of 23 regions and 24 sectors, as shown in Table 1. This aggregation allows for an inclusive assessment while still maintaining relevant details.

Table 1. Classification of Regions and Sectors

No.	Region Code	Description	No.	Sector Code	Description
1	UKR	Ukraine	1	Wheat	Wheat
2	RUS	Russia	2	OthGrains	Other Grains
3	EGY	Egypt	3	VegOil	Vegetable Oil
4	TUR	Turkey	4	Crops	Crops
5	GEO	Georgia	5	MeatLstk	Meat & Livestock
6	AZE	Azerbaijan	6	Oil	Oil
7	MNG	Mongolia	7	Gas	Gas
8	CHN	China	8	Extraction	Extraction
9	IND	India	9	ProcFood	Processed Food
10	USA	U.S.A.	10	TextWapp	Textile Wear apparel
11	CAN	Canada	11	WdPapPbl	Wood, Paper prdts & Publishing
12	AUS	Australia	12	PetroCoalPr	Petro Coal Products
13	FRA	France	13	Chemicals	Chemicals
14	DEU	Germany	14	Metals	Metals
15	ARG	Argentina	15	Electronics	Electronics
16	KOR	Korea	16	Machinery	Machinery
17	JPN	Japan	17	Autos	Automobiles
18	RestSEAsia	Rest of South East Asia	18	OthMnfc	Other Manufacturing
19	RestAmer	Rest America	19	Util_Cons	Utility & Construction
20	WestEurope	Western Europe	20	Trade	Trade
21	MENA	Middle East & North Africa	21	TransportS	Transport Services
22	SSA	Sub-Saharan Africa	22	Communication	Communication
23	ROW	Rest of the World	23	FinanInsur	Finance & Insurance
			24	OthSvcs	Other Services

Source: Authors' classification using GTAP DB Version 11.

2.2. Policy Scenarios

The ongoing military intervention by Russia in Ukraine has brought about uncertainties concerning the duration and severity of the ongoing conflict. To assess the potential ramifications on worldwide food security, we have formulated three distinct scenarios: Slight, Moderate, and Severe, as outlined in Table 3. Each scenario encompasses three key variables for shock. The initial variable pertains to the wheat output (production) within Ukraine. This variable serves to gauge the adjustments in production across various sectors. The second variable focuses on trade and is utilized to quantify the export sales of wheat from Ukraine to other regions. Our third shock mirrors the first, involving the wheat output (production) by other external producers. These scenarios are grounded in divergent assumptions regarding the potential reduction in wheat production within Ukraine and the subsequent global trade reverberations.

In each of the depicted scenarios (SC) presented in Table 2, we simulated three shock variables. For instance, within SC1, we introduced our first shock variable (S1), which represented a 35% reduction in wheat production in Ukraine. The second shock (S2) involved a 20% disruption in wheat trade, while the third shock (S3) accounted for a 2% increase in wheat production from third-party producers. These corresponding adjustments are applicable across all three scenarios (SC) outlined in Table 2. Therefore, to evaluate the ramifications of the Russia-Ukraine war, we consider the combined effects of the three shocks (S1, S2, and S3) within each scenario (SC).

Third-party wheat producers might increase production during the Russia-Ukraine war for several reasons. The conflict could disrupt the global wheat supply chain due to the prominence of these countries as exporters, creating an opportunity for other producers to meet demand. Higher wheat prices resulting from reduced supply could attract third-party producers aiming to capitalize on increased profits. With Russia and Ukraine's export capabilities compromised, third-party producers could fulfill export opportunities and diversify supply sources for countries reliant on these nations. Concerns over global food security might drive increased production, while speculation on rising prices due to the conflict could motivate producers to expand output. Some might strategically position themselves in the market, contribute to humanitarian aid, or respond to underlying demand growth. The specific motivations would depend on individual circumstances and objectives.

To evaluate the consequences of the Ukraine war, we used productivity shifters to simulate the aforementioned three scenarios. A productivity shifter is a specific type of shock or change implemented in the model to simulate the effects of productivity changes in an economy. That is, the productivity levels of specific sectors or industries in the economy are altered. To assess the impact of Russia's invasion of Ukraine on food security, we used Ukraine's wheat production and trade, as well as an increase in the production of wheat by third producers as shock values for policy scenarios; the productivity shifter is lowered, except for that of third producers where the productivity shifter is augmented.

Scenario 1: (Slight) assumes a 35% decrease in wheat production in Ukraine, a trade disruption of 20%, and a 2% increase in wheat production by third producers (China, India, USA, Canada, Australia, France, Germany, and Argentina).

Scenario 2: (Moderate) assumes the situation worsens compared to Scenario 1. We assume a 45% decrease in wheat production in Ukraine, indicating a more significant decline in agricultural output. Trade is disrupted by 30%, with a 3% increase in wheat production by third producers.

Scenario 3: (Severe) assumes a worst-case scenario, leading to a severe impact on wheat production in Ukraine. We assume a 55% decrease in Ukraine's wheat production and a 40% disruption in trade, indicating a drastic decline in agricultural output. To redress the

situation of a limited supply of wheat from Ukraine as a result of the war, a 5% increase in wheat production by third producers is assumed.

Table 2. Policy Scenarios

Scenario	Description
SC1 - Slight	35% decrease in wheat production in Ukraine (S1)
	20% wheat trade disruption (S2)
	2% increase in wheat production by third producers (S3)
SC2 - Moderate	45% decrease in wheat production in Ukraine (S1)
	30% wheat trade disruption (S2)
	3% increase in wheat production by third producers (S3)
SC3 - Severe	55% decrease in wheat production in Ukraine (S1)
	40% wheat trade disruption (S2)
	5% increase in wheat production by third producers (S3)

Source: Authors' assumptions.

The simulation enables the assessment of the causes of the repercussions on Ukraine's wheat production and the associated trade disruption. By analyzing the results, researchers can gain insights into the changes in production levels, trade patterns, and economic indicators. This model design provides a structured framework for understanding the potential consequences of the Russian war on Ukraine's wheat sector, and offers valuable information for policymakers and stakeholders in formulating strategies to address the challenges arising from the conflict.

In our analysis, our first shock entailed a decrease in Ukraine's wheat production. In the second shock, we considered the same decrease in Ukraine's wheat production and disruption in trade, and the third shock accounts for an increase in wheat production by third producers. To assess the impact of this increase in wheat production by third producers, we calculated the difference between results. This allowed the determination of its effects on real GDP, welfare, export volume, import volume, trade balance, and output by sector.

V. Simulation Results

This section illustrates the macroeconomic impacts of Russia's invasion of Ukraine on real GDP, equivalent variation (EV) as a measure of welfare, export and import volumes, trade balance, and output by sector. The simulation results report the cumulative differences between the policy scenarios. The results in Columns 2 to 4 are based on shocks on wheat production in Ukraine and trade disruption (S1+S2), while for Columns 5 to 7, the shocks are comprised of wheat production in Ukraine and trade disruption with an additional shock on wheat production by third producers (S1+S2+S3), as shown in Table 2.

As seen in Table 3, Russia's invasion of Ukraine is expected to lead to a decline in the real GDP of India of -0.001%. In Columns 5 to 7 of Table 3, with an increase in wheat production by third producers, the expected outcome on the real GDP of countries such as China (0.101%), India (0.073%), and Japan (0.001%), (SC1) witnessed a slight increase as compared to Column 2.

Table 3. Impact of the Russia-Ukraine War on Real GDP (%)

Region	Decrease in wheat production in Ukraine (S1) + wheat trade disruption (S2)			A decrease in wheat production in Ukraine (S1) + wheat trade disruption (S2) + an increase in wheat production by third producers (S3)		
	Slight (SC1)	Moderate (SC2)	Severe (SC3)	Slight (SC1)	Moderate (SC2)	Severe (SC3)
UKR	-0.195	-0.260	-0.328	-0.205	-0.269	-0.331
RUS	-0.000	-0.000	-0.001	-0.001	-0.001	-0.002
EGY	0.007	0.008	0.009	0.005	0.005	0.004
TUR	-0.000	-0.001	-0.001	0.001	0.001	0.002
GEO	-0.000	-0.000	-0.001	-0.000	-0.000	-0.000
AZE	0.000	-0.000	-0.000	-0.001	-0.002	-0.003
MNG	0.000	-0.000	-0.000	-0.001	-0.001	-0.001
CHN	0.000	0.000	0.000	0.101	0.147	0.205
IND	-0.001	-0.001	-0.001	0.073	0.108	0.178
USA	0.000	-0.000	-0.000	0.003	0.004	0.005
CAN	0.000	0.000	0.000	-0.001	-0.001	0.001
AUS	0.001	0.001	0.001	0.006	0.008	0.014
FRA	0.000	0.000	0.000	-0.001	-0.001	0.000
DEU	0.000	-0.000	-0.000	-0.000	-0.000	0.001
ARG	0.000	0.000	0.000	0.005	0.007	0.013
KOR	0.000	0.000	0.000	0.000	0.000	0.000
JPN	0.000	0.000	0.000	0.001	0.001	0.002
RestSEAsia	0.001	0.001	0.001	0.001	0.001	0.002
RestAmer	0.000	0.000	0.000	-0.001	-0.002	-0.002
WestEurope	-0.000	-0.000	-0.000	-0.002	-0.003	-0.004
MENA	0.000	-0.000	-0.000	-0.001	-0.001	-0.002
SSA	0.000	0.000	0.000	-0.003	-0.005	-0.007
ROW	-0.000	-0.001	-0.001	-0.002	-0.003	-0.004

Source: Authors' simulation using GTAP Database Version 11 (Aguiar et al., 2023).

The results in Table 4 are the difference between (a decrease in wheat production in Ukraine and trade disruption) (S1+S2) and (a decrease in wheat production in Ukraine and trade disruption plus an increase in wheat production by third producers) (S1+S2+S3). as shown in Table 3. Its impact on the real GDP of countries such as Egypt, Azerbaijan, and Mongolia are negative. The impact of an increase in wheat production by third producers on Ukraine's real GDP registered -0.011% in SC1, while in SC2 and SC3, the country's real GDP declined by -0.009% and -0.003%, respectively. Japan and China registered slight increases in real GDP in all scenarios, as shown in Table 4. The outcome of the slight increase might be attributed to a series of factors.

Table 4. Impact of an Increase in Wheat Production by Third Producers (S3) on Real GDP (%)

Region	Slight (SC1)	Moderate (SC2)	Severe (SC3)
Ukraine	-0.011	-0.009	-0.003
Russia	-0.001	-0.001	-0.001
Egypt	-0.002	-0.003	-0.005
Turkey	0.001	0.002	0.003
Georgia	0.000	0.000	0.000
Azerbaijan	-0.001	-0.002	-0.003
Mongolia	-0.001	-0.001	-0.001
China	0.101	0.147	0.205
India	0.074	0.109	0.180
USA	0.003	0.004	0.006
Canada	-0.001	-0.002	0.001
Australia	0.006	0.008	0.013
France	-0.001	-0.001	0.000
Germany	-0.000	-0.000	0.001
Argentina	0.005	0.007	0.013
Korea	-0.000	0.000	0.000
Japan	0.001	0.001	0.002
Rest of South East Asia	0.000	0.000	0.001
Rest America	-0.001	-0.002	-0.002
Western Europe	-0.002	-0.003	-0.003
Middle East & North Africa	-0.001	-0.001	-0.001
Sub-Saharan Africa	-0.003	-0.005	-0.007
Rest of the World	-0.002	-0.003	-0.004

Source: Authors' simulation using GTAP Database Version 11 (Aguiar et al., 2023).

In SC3, the impact of Russia's invasion of Ukraine will affect more countries when policymakers and stakeholders fail to formulate strategies to address the challenges arising from the war. This, in effect, would affect trade among countries, thereby negatively affecting the global economy.

Regions that rely on Ukraine for wheat may experience varying impacts on GDP. The overall increase in global wheat production by third producers will help offset some of the shortages resulting from the drop in Ukraine's wheat production. As a result, the real GDP of regions such as Egypt, Azerbaijan, Mongolia, and Canada will be negatively affected, as it would have been if global wheat production had remained stagnant or decreased. However, the real GDP impact would still depend on the severity of the conflict and the extent to which other wheat-producing regions could compensate for Ukraine's reduced output.

Table 5. Impact of the Russia-Ukraine War on Welfare (US$ Million)

	Decrease in wheat production in Ukraine (S1) + wheat trade disruption (S2)			A decrease in wheat production Ukraine (S1) + wheat trade disruption (S2) + an increase in wheat production by third producers (S3)		
Region	Slight (SC1)	Moderate (SC2)	Severe (SC3)	Slight (SC1)	Moderate (SC2)	Severe (SC3)
UKR	-140.1	-223.9	-308.7	-243.5	-357.8	-491.7
RUS	13.0	20.8	28.8	-106.8	-151.5	-228.4
EGY	-17.8	-28.1	-38.4	-13.3	-21.2	-20.5
TUR	-6.0	-9.5	-13.1	-6.3	-10.4	-6.8
GEO	0.1	0.2	0.3	-0.1	-0.2	-0.0
AZE	-0.2	-0.4	-0.5	0.9	1.3	2.4
MNG	0.0	0.0	0.0	1.0	1.5	2.4
CHN	6.5	10.3	14.1	14,486.5	21,072.1	29,204.0
IND	-19.9	-31.2	-42.5	2,054.0	3,047.8	5,043.7
USA	12.3	19.6	27.1	-171.1	-249.4	-262.2
CAN	15.3	24.4	33.7	-388.6	-552.8	-747.3
AUS	34.6	55.2	76.3	-158.4	-219.6	-291.0
FRA	13.8	22.1	30.6	-194.5	-274.8	-336.2
DEU	1.6	2.7	3.7	48.2	71.3	124.6
ARG	4.5	7.1	9.8	-57.1	-80.3	-109.7
KOR	-5.8	-9.1	-12.3	98.6	140.4	198.9
JPN	-0.2	-0.2	-0.3	122.0	173.1	259.3
RestSEAsia	-36.4	-57.6	-79.1	45.2	63.3	167.4
RestAmer	-3.3	-5.4	-7.4	-210.3	-302.6	-380.7
WestEurope	-0.0	0.6	1.4	-630.8	-903.4	-1,216.2
MENA	-42.2	-67.3	-92.8	-141.3	-203.9	-235.5
SSA	-12.6	-20.1	-27.8	-110.5	-151.0	-149.9
ROW	-4.3	-6.8	-9.4	-86.7	-122.9	-166.3

Source: Authors' simulation using GTAP Database Version 11 (Aguiar et al., 2023).

Table 6. Impact of an Increase in Wheat Production by Third Producers (S3) on Welfare

(US$ Millions)

Region	Slight (SC1)	Moderate (SC2)	Severe (SC3)
UKR	-103.4	-133.9	-183.1
RUS	-119.8	-172.3	-257.2
EGY	4.5	6.9	17.9
TUR	-0.3	-0.9	6.2
GEO	-0.3	-0.4	-0.3
AZE	1.2	1.7	2.9
MNG	1.0	1.5	2.4
CHN	14,480.0	21,061.8	29,190.0
IND	2,073.9	3,079.1	5,086.2
USA	-183.4	-269.0	-289.4
CAN	-403.8	-577.2	-781.0
AUS	-193.0	-274.8	-367.3
FRA	-208.3	-296.9	-366.8
DEU	46.5	68.6	120.8
ARG	-61.6	-87.4	-119.5
KOR	104.4	149.5	211.3
JPN	122.2	173.3	259.6
RestSE Asia	81.5	121.0	246.4
RestAmer	-207.0	-297.2	-373.3
WestEurope	-630.7	-904.0	-1,217.5
MENA	-99.1	-136.6	-142.7
SSA	-97.9	-130.9	-122.2
ROW	-82.5	-116.1	-156.9

Source: Authors' simulation using GTAP Database Version 11 (Aguiar et al., 2023).

Table 5 shows the impact of the war on welfare in terms of equivalent variation (EV) in US$ million. The results in Columns 2 to 4 are based on shocks in wheat production in Ukraine and trade disruption (S1+S2), while for Columns 5 to 7, the shocks are comprised of wheat production in Ukraine and trade disruption with an additional shock on wheat production by third producers (S1+S2+S3), as shown in Table 2. Korea and Japan registered declines of $5.8 million and

$0.2 million, as shown in Column 2 (SC1), respectively. The results of both countries worsen as the conflict intensifies, as shown in Columns 3 and 4. In Columns 5 to 7, there is a significant improvement in the welfare of Korea and Japan, the same as other countries. This boost is a result of an increase in the production of wheat by third producers, as seen in Table 5. Contrarily, China and Germany's welfare experienced a slight improvement in all scenarios (Columns 2 to 4). This is further improved for both countries (Columns 5 to 7) due to an increase in the production of wheat by third producers.

Countries such as the US (US$ 183.4 million), Canada (US$ 403.8 million), Australia (US$ 193.0 million), and France (US$ 208.3 million) show a decline in welfare, as shown in Table 6. Other than Georgia, the rest of the above-mentioned countries are third producers of wheat likely to experience higher exports to other nations, thereby negatively impacting economic welfare, probably due to increased prices in both domestic and foreign markets. For Georgia, the outcome might be related to its dependence on Ukraine's agricultural wheat production.

Under the severe scenario (SC3), the impact on the welfare of these countries keeps declining, as most countries that initially relied on Ukraine's wheat exports will seek alternative routes, thereby increasing the export volume of these third producers at the expense of home consumption, as shown in Column 4 of Table 6.

Contrarily, the welfare of countries such as China (US$ 14,480.0 million), Korea (US$ 104.4 million), India (US$ 2,073.9 million), Germany (US$ 46.5 million), Japan (US$ 122.2 million), and Egypt (US$ 4.5 million) registered an increase. For fear of inflationary pressures and potential food security concerns, countries that heavily rely on Russian and Ukrainian wheat imports might face higher prices or supply constraints due to war-related disruptions, and have sought alternative measures to meet existing demand by relying on other producers for sustainability and livelihood.

The impact on welfare in regions that depend on Ukraine's wheat is influenced by several factors. A rise in global wheat production could help stabilize wheat prices and ensure a steadier supply, alleviating some of the immediate food security concerns. However, the situation might still be challenging if Ukraine's wheat production and trade disruptions persist for an extended period without any measures taken to averse the situation. Other factors, such as government policies, income distribution, and the ability of countries to access alternative food sources, would also play a role in determining the overall welfare impact.

The results in Columns 2 to 4 in Table 7 are based on shocks on wheat production in Ukraine and trade disruption (S1+S2), while in Columns 5 to 7, the shocks are comprised of wheat production in Ukraine and trade disruption with an additional shock on wheat production by third producers (S1+S2+S3), as shown in Table 2. As illustrated in Column 2 of Table 7, China and Japan's export volumes declined by 0.002% and 0.001%, respectively (SC1), in Column 3, 0.002%, and 0.002% (SC2), and 0.004% and 0.002%, as seen in Column 4 (SC3). Korea, on the other hand, records positive export volumes in all scenarios with the same results. With an additional shock of an increase in wheat production by third producers, Korea and Japan record significant export volumes in all three scenarios, while China's export volume witnessed a decline in all scenarios.

The results in Columns 2 to 4 on Table 8 are based on shocks on wheat production in Ukraine and trade disruption, while for Columns 5 to 7, the shocks are comprised of wheat production in Ukraine and trade disruption with an additional shock on wheat production by third producers, as shown in Table 2. As demonstrated in Table 8, China and Korea's import volumes declined. The same occurs for countries such as Egypt (-034%) and India (-0.006%) in (SC1), -0.043% and -0.009% (SC2), and -0.053% and -0.011% (SC3). Korea and China, on the other hand, record positive import volumes in all three scenarios (Columns 5 to 7). Japan, for its part, records a decline in import volumes in all scenarios.

Table 7. Impact of the Russia-Ukraine War on Exports (%)

Region	Decrease in wheat production in Ukraine (S1) + wheat trade disruption (S2)			A decrease in wheat production Ukraine (S1) + wheat trade disruption (S2) + an increase in wheat production by third producers (S3)		
	Slight (SC1)	Moderate (SC2)	Severe (SC3)	Slight (SC1)	Moderate (SC2)	Severe (SC3)
UKR	-0.251	-0.303	-0.361	-0.117	-0.113	-0.083
RUS	0.002	0.003	0.004	0.075	0.108	0.147
EGY	0.022	0.034	0.047	0.038	0.057	0.069
TUR	-0.002	-0.002	-0.003	0.066	0.095	0.132
GEO	0.007	0.011	0.015	0.044	0.064	0.088
AZE	0.002	0.004	0.005	0.010	0.015	0.019
MNG	-0.000	-0.000	-0.000	0.008	0.011	0.013
CHN	-0.002	-0.003	-0.004	-0.565	-0.802	-1.072
IND	-0.003	-0.005	-0.007	-0.119	-0.175	-0.303
USA	-0.001	-0.002	-0.002	0.110	0.158	0.219
CAN	-0.004	-0.006	-0.009	0.315	0.451	0.624
AUS	-0.011	-0.017	-0.023	0.166	0.233	0.328
FRA	-0.005	-0.007	-0.010	0.145	0.208	0.284
DEU	-0.001	-0.001	-0.001	0.044	0.063	0.087
ARG	-0.005	-0.008	-0.011	0.177	0.254	0.379
KOR	0.001	0.001	0.001	0.025	0.036	0.049
JPN	-0.001	-0.002	-0.002	0.078	0.113	0.154
RestSEAsia	0.001	0.002	0.002	0.047	0.068	0.090
RestAmer	-0.001	-0.001	-0.001	0.101	0.144	0.198
WestEurope	-0.001	-0.001	-0.001	0.066	0.095	0.132
MENA	0.000	-0.000	-0.000	0.043	0.061	0.086
SSA	0.000	0.001	0.001	0.077	0.111	0.155
ROW	-0.004	-0.006	-0.008	0.044	0.062	0.088

Source: Authors' simulation using GTAP Database Version 11 (Aguiar et al., 2023).

Table 8. Impact of the Russia-Ukraine War on Imports (%)

Region	Decrease in wheat production in Ukraine (S1) + wheat trade disruption (S2)			A decrease in wheat production Ukraine (S1) + wheat trade disruption (S2) + an increase in wheat production by third producers (S3)		
	Slight (SC1)	Moderate (SC2)	Severe (SC3)	Slight (SC1)	Moderate (SC2)	Severe (SC3)
UKR	-0.465	-0.746	-1.031	-0.791	-1.167	-1.611
RUS	0.016	0.026	0.036	-0.103	-0.146	-0.222
EGY	-0.034	-0.043	-0.053	-0.032	-0.040	-0.042
TUR	-0.002	-0.003	-0.004	-0.011	-0.015	-0.018
GEO	0.005	0.009	0.012	-0.008	-0.010	-0.012
AZE	0.002	0.004	0.006	0.001	0.002	0.007
MNG	-0.001	-0.001	-0.002	-0.012	-0.015	-0.015
CHN	-0.000	-0.000	-0.000	0.199	0.291	0.407
IND	-0.006	-0.009	-0.011	0.020	0.034	0.085
USA	0.001	0.002	0.003	-0.047	-0.067	-0.091
CAN	0.001	0.002	0.003	-0.075	-0.107	-0.146
AUS	0.016	0.026	0.036	-0.104	-0.146	-0.196
FRA	0.002	0.003	0.005	-0.022	-0.032	-0.040
DEU	0.000	0.000	0.001	0.006	0.009	0.012
ARG	0.003	0.004	0.006	-0.110	-0.157	-0.217
KOR	-0.001	-0.001	-0.001	0.014	0.020	0.029
JPN	0.000	0.000	0.000	-0.018	-0.026	-0.034
RestSEAsia	-0.003	-0.003	-0.004	0.006	0.009	0.015
RestAmer	-0.000	-0.000	-0.001	-0.028	-0.040	-0.052
WestEurope	0.000	0.001	0.001	-0.005	-0.007	-0.008
MENA	-0.005	-0.007	-0.009	-0.021	-0.030	-0.033
SSA	-0.004	-0.005	-0.006	-0.046	-0.062	-0.068
ROW	-0.005	-0.007	-0.010	-0.044	-0.063	-0.083

Source: Authors' simulation using GTAP Database Version 11 (Aguiar et al., 2023).

Table 9. Impact of an Increase in Wheat Production by Third Producers (S3) on Export and Import Volumes (%)

Region	Exports (%)			Imports (%)		
	Slight (SC1)	Moderate (SC2)	Severe (SC3)	Slight (SC1)	Moderate (SC2)	Severe (SC3)
Ukraine	0.134	0.190	0.279	-0.325	-0.421	-0.580
Russia	0.073	0.105	0.143	-0.119	-0.173	-0.259
Egypt	0.017	0.023	0.023	0.002	0.003	0.011
Turkey	0.068	0.097	0.135	-0.008	-0.012	-0.014
Georgia	0.037	0.053	0.073	-0.013	-0.019	-0.024
Azerbaijan	0.008	0.011	0.014	-0.001	-0.002	0.001
Mongolia	0.008	0.011	0.014	-0.011	-0.014	-0.013
China	-0.564	-0.800	-1.068	0.199	0.292	0.408
India	-0.116	-0.170	-0.296	0.026	0.043	0.096
USA	0.111	0.159	0.222	-0.048	-0.069	-0.093
Canada	0.319	0.457	0.632	-0.076	-0.109	-0.148
Australia	0.176	0.250	0.351	-0.120	-0.172	-0.232
France	0.150	0.215	0.294	-0.024	-0.035	-0.045
Germany	0.045	0.064	0.088	0.006	0.008	0.012
Argentina	0.182	0.263	0.390	-0.113	-0.161	-0.223
Korea	0.024	0.035	0.047	0.015	0.021	0.029
Japan	0.079	0.114	0.156	-0.018	-0.026	-0.034
RestSE Asia	0.046	0.066	0.088	0.009	0.013	0.019
RestAmer	0.101	0.145	0.199	-0.027	-0.039	-0.051
WestEurope	0.067	0.096	0.133	-0.005	-0.007	-0.009
MENA	0.043	0.061	0.087	-0.016	-0.023	-0.024
SSA	0.077	0.111	0.154	-0.042	-0.057	-0.062
ROW	0.047	0.068	0.096	-0.040	-0.056	-0.073

Source: Authors' simulation using GTAP Database Version 11 (Aguiar et al., 2023).

A comparison of changes in exports Table 9 in Columns 2 to 4 with changes in imports in Columns 5 to 7 of the same table is done. This is in consideration of changes in terms of trade, as explained in the changes in trade balance, as shown in Table 10. Table 9 shows the impact of an increase in wheat production by third producers on export and import volumes. China and India experienced declines of -0564% and -0.116%, respectively. If the war persists, it will affect the export trade of these countries deeper, as shown in SC3 for exports in Table 9. This would also lead to a decline in investment, as most countries would not want to invest in a chaotic environment. Reduced investment can lead to decreased export capacity, lower competitiveness, and limited access to global markets. This can result in a decline in exports and a widening trade deficit, thereby reducing participation in international trade.

Contrarily, the export volume of countries such as Russia, Japan, and Korea witnessed an increase due to a variety of factors other than those related to the conflict.

The impact of Russia's invasion of Ukraine on the import volumes of regions such as Ukraine, Russia, the US, Canada, and Japan, amongst others, experienced declines of -0.325%, -0.119%, -0.048%, -0.076%, and -0.018%, respectively. If the war continues, it will further dampen the import trade of these countries, as shown in Column 7 of Table 9. Contrarily, countries with positive import volumes include Egypt (0.002%), China (0.199%), India (0.026%), Germany (0.006), and Korea (0.015). With the disruption of agricultural activities in the conflict-affected regions, these countries may turn to alternative sources for wheat needs, potentially boosting imports from other nations. Comparatively, the decline in the import volumes of most regions is far heavier than its exports. This can be due to the increase in trade costs and border closures, which were a result of the war itself, or the economic sanctions some countries placed on Russia.

Regions that rely on Ukraine for wheat imports may face reduced supplies due to the conflict-induced drop in Ukraine's wheat production and trade. This could lead to increased demand for wheat from other exporting countries, potentially resulting in higher prices and logistical challenges. On the other hand, a rise in global wheat production by third producers might create additional export opportunities for countries with surplus wheat, which could partially offset the import disruptions faced by regions dependent on Ukrainian wheat.

The results in Columns 2 to 4 of Table 10 are based on shocks of wheat production in Ukraine and trade disruption (S1+S2), while in Columns 5 to 7, the shocks comprised of wheat production in Ukraine and trade disruption with an additional shock on wheat production by third producers (S1+S2+S3), as shown in Table 2. As shown in Table 10, the trade balances of China, Korea, and Japan are negative, as shown in Columns 2 to 4 (all scenarios). This is indicative of a trade deficit, while in Columns 5 to 7, China's trade balance suffers a significant decline, while those of Korea and Japan show significant surpluses. Further, though China and India have trade deficits, the rest of the regions experience trade surpluses. This is due to an increase in the production of wheat by third producers.

The impact of Russia's invasion on the trade balance is shown in Table 10. Most countries, including Russia (US$ 449.2 million), Ukraine (US$ 192.9 million), the US (US$ 3,221.7 million), Japan (US$ 912.8 million), and Korea (US$ 195.8 million), witnessed trade surpluses, while China (US$ -15,541.5 million) and India (US$ -538.7 million) recorded trade surpluses.

The trade balance of regions relying on Ukraine for wheat would largely depend on the overall reliance on Ukraine's imports and the ability to access alternative sources. If the conflict leads to significant disruptions in Ukraine's wheat trade, these regions may experience trade deficits due to higher import costs and limited availability. However, a rise in global wheat production by third producers might offer some relief by reducing the trade imbalance for countries that can access additional wheat exports from other regions.

Table 10. Impact of the Russia-Ukraine War on Trade Balance

(US$ Million)

Region	Decrease in wheat production in Ukraine (S1) + wheat trade disruption (S2)			A decrease in wheat production Ukraine (S1) + wheat trade disruption (S2) + an increase in wheat production by third producers (S3)		
	Slight (SC1)	Moderate (SC2)	Severe (SC3)	Slight (SC1)	Moderate (SC2)	Severe (SC3)
UKR	225.6	361.4	499.4	418.5	615.7	849.6
RUS	-18.0	-28.8	-39.8	431.1	617.6	871.3
EGY	5.5	8.8	12.0	25.6	37.5	49.5
TUR	0.4	0.7	0.9	157.3	226.4	309.6
GEO	0.2	0.4	0.5	4.0	5.8	8.1
AZE	-0.3	-0.5	-0.7	0.9	1.2	1.7
MNG	0.0	0.0	0.0	2.5	3.6	4.7
CHN	-29.9	-47.8	-65.8	-15,571.4	-22,303.4	-30,179.5
IND	12.3	19.3	26.3	-526.4	-798.6	-1,497.6
USA	-36.4	-58.0	-79.9	3,185.3	4,574.4	6,276.7
CAN	-11.8	-18.9	-26.0	1,540.9	2,207.0	3,027.2
AUS	-51.8	-82.5	-113.7	587.7	832.0	1,128.9
FRA	-36.5	-58.4	-80.7	1,095.2	1,565.9	2,107.4
DEU	-11.2	-18.0	-24.9	649.1	929.5	1,270.1
ARG	-1.8	-2.8	-3.8	144.9	207.4	287.4
KOR	-2.1	-3.3	-4.6	193.7	277.9	381.9
JPN	-8.3	-13.2	-18.2	904.5	1,299.9	1,782.9
RestSEAsia	8.2	13.0	17.7	845.6	1,216.1	1,647.8
RestAmer	-7.3	-11.6	-16.0	1,344.3	1,930.9	2,642.5
WestEurope	-41.4	-66.8	-92.6	3,384.4	4,856.6	6,696.7
MENA	2.9	4.5	6.2	541.2	776.9	1,055.5
SSA	-0.2	-0.3	-0.4	469.2	671.3	914.3
ROW	1.8	3.0	4.1	171.9	246.3	340.2

Source: Authors' simulation using GTAP Database Version 11 (Aguiar et al., 2023).

Table 11. Impact of an Increase in Wheat Production by Third Producers (S3) on Trade Balance

(US$ Million)

Region	Slight (SC1)	Moderate (SC2)	Severe (SC3)
UKR	192.9	254.3	350.2
RUS	449.2	646.5	911.0
EGY	20.1	28.7	37.5
TUR	156.8	225.8	308.7
GEO	3.8	5.4	7.5
AZE	1.2	1.7	2.4
MNG	2.5	3.5	4.7
CHN	-15,541.5	-22,255.5	-30,113.7
IND	-538.7	-818.0	-1,523.9
USA	3,221.7	4,632.4	6,356.7
CAN	1,552.7	2,225.9	3,053.2
AUS	639.5	914.5	1,242.6
FRA	1,131.8	1,624.3	2,188.1
DEU	660.3	947.5	1,295.0
ARG	146.7	210.2	291.2
KOR	195.8	281.3	386.5
JPN	912.8	1,313.1	1,801.2
RestSEAsia	837.4	1,203.1	1,630.1
RestAmer	1,351.6	1,942.6	2,658.5
WestEurope	3,425.8	4,923.4	6,789.3
MENA	538.3	772.3	1,049.3
SSA	469.4	671.7	914.7
ROW	170.0	243.3	336.1

Source: Authors' simulation using GTAP Database Version 11 (Aguiar et al., 2023).

Table 12. Impact of the Russia-Ukraine War on Output by Sector (%)

Region	UKR	RUS	EGY	TUR	GEO	AZE	MNG	CHN	IND	USA	CAN
Wheat	-14.39	-8.94	-0.80	-1.22	-2.48	-0.53	-0.69	5.02	4.64	3.71	2.81
OthGrains	0.15	0.17	0.05	-0.15	-0.06	-0.11	-0.37	0.45	0.29	-0.08	-0.04
VegOil	1.06	0.36	0.09	-0.11	-0.08	-0.11	0.47	0.33	0.30	-0.01	0.36
Crops	-0.09	0.14	0.03	-0.11	-0.08	-0.10	-0.47	0.45	0.25	-0.10	0.07
MeatLstk	-1.99	0.02	0.03	-0.01	-0.05	-0.01	-0.22	0.55	0.21	-0.06	0.19
Oil	0.20	0.06	-0.01	0.00	0.01	0.01	-0.02	-0.16	-0.09	0.01	0.08
Gas	0.12	0.03	-0.03	-0.02	-0.01	-0.02	-0.02	-0.19	-0.12	-0.03	0.03
Extraction	0.34	0.11	0.01	0.04	0.05	-0.00	0.04	0.04	-0.00	-0.06	0.20
ProcFood	0.02	-0.05	-0.01	-0.03	-0.12	-0.05	-0.38	0.79	0.49	-0.04	0.01
TextWapp	0.68	0.53	0.06	0.25	0.58	0.36	0.20	-0.23	0.08	0.26	0.94
WdPapPbl	0.70	0.38	-0.00	0.02	0.10	-0.03	-0.02	0.03	-0.03	0.02	0.42
PetroCoalPr	0.41	0.11	-0.01	-0.00	0.03	0.01	0.06	-0.04	-0.02	0.01	0.12
Chemicals	0.71	0.33	0.00	0.05	0.20	0.06	-0.08	-0.29	-0.12	0.10	0.56
Metals	1.12	0.56	0.03	0.08	0.24	0.11	-0.08	-0.25	-0.16	0.11	0.61
Electronics	2.02	0.53	0.17	0.35	0.34	0.15	0.22	-0.74	0.04	0.49	1.24
Machinery	1.54	0.37	0.06	0.12	0.19	0.12	0.10	-0.26	-0.05	0.04	0.70
Autos	0.35	0.05	-0.02	-0.01	0.08	0.09	0.03	0.16	0.10	0.01	0.31
OthMnfc	0.63	0.18	0.07	0.06	0.16	0.03	0.07	-0.14	-0.10	0.09	0.58
Util_Cons	-0.22	-0.05	-0.03	-0.08	-0.06	-0.03	-0.00	0.56	0.08	-0.09	-0.52
Trade	-0.01	0.01	-0.01	0.00	0.02	0.02	0.09	0.13	0.14	-0.01	0.01
TransportS	0.14	0.08	-0.00	0.01	0.03	0.02	0.03	0.05	0.05	0.00	0.12
Communcn	0.40	0.04	-0.01	-0.01	0.07	0.04	-0.01	0.12	-0.13	-0.02	0.05
FinanInsur	0.08	0.04	-0.00	0.01	0.02	0.00	0.02	0.13	0.07	-0.00	0.04
OthSvcs	-0.12	-0.02	0.00	0.00	0.01	0.01	0.02	0.22	0.16	-0.01	-0.04

Source: Authors' simulation using GTAP Database Version 11 (Aguiar et al., 2023).

Table 12. Impact of Russia's Invasion of Ukraine on Output by Sector (%) cont'd…

Region	AUS	FRA	DEU	ARG	KOR	JPN	Rest SEAsia	Rest Amer	West Europe	MENA	SSA	ROW
Wheat	2.08	4.01	4.02	3.93	-3.01	-11.96	-7.05	-10.07	-5.55	-4.09	-6.78	-6.11
OthGrains	-0.47	-0.20	-0.23	-0.04	-0.06	-0.08	-0.08	-0.03	-0.05	-0.11	0.00	-0.05
VegOil	0.29	-0.15	-0.24	0.10	-0.05	-0.16	-0.10	0.02	-0.08	-0.05	0.02	0.00
Crops	0.03	-0.09	-0.29	-0.02	-0.05	-0.07	-0.08	-0.05	-0.00	-0.06	-0.03	-0.00
MeatLstk	0.01	-0.05	-0.16	-0.04	-0.04	-0.10	-0.05	-0.04	-0.04	0.00	-0.01	-0.07
Oil	0.05	0.02	-0.01	0.03	-0.03	-0.02	-0.02	0.02	0.01	0.00	0.01	0.02
Gas	0.02	-0.01	-0.04	0.01	-0.04	-0.04	-0.05	-0.02	-0.02	-0.03	-0.02	0.00
Extraction	0.15	0.04	-0.02	0.01	-0.03	0.01	0.01	0.09	0.02	0.04	0.08	0.08
ProcFood	-0.10	-0.10	-0.12	-0.04	-0.18	-0.06	-0.14	-0.05	-0.10	-0.02	-0.06	-0.23
TextWapp	0.67	0.35	0.16	0.12	0.07	0.18	0.16	0.23	0.31	0.25	0.30	0.52
WdPapPbl	0.10	0.02	-0.05	0.00	-0.05	-0.00	0.01	0.08	0.03	0.05	0.08	0.10
PetroCoalPr	0.07	0.01	-0.01	0.01	-0.00	0.00	0.03	0.00	-0.01	0.05	0.03	-0.08
Chemicals	0.29	0.21	-0.00	0.16	-0.06	0.01	0.03	0.07	0.10	0.12	0.15	0.20
Metals	0.48	0.20	0.06	0.29	-0.01	0.09	0.10	0.23	0.19	0.12	0.34	0.32
Electronics	0.90	0.56	0.32	0.45	0.23	0.34	0.31	0.47	0.44	0.43	0.35	0.44
Machinery	0.47	0.22	0.08	0.33	0.01	0.06	0.07	0.13	0.17	0.13	0.15	0.25
Autos	0.18	0.10	0.02	0.22	-0.17	-0.05	-0.07	0.00	0.07	0.03	0.06	0.06
OthMnfc	0.25	0.33	0.06	0.13	-0.00	0.03	0.06	0.14	0.17	0.12	0.25	0.25
Util_Cons	-0.25	-0.23	-0.09	-0.18	-0.05	-0.09	-0.08	-0.17	-0.14	-0.09	-0.15	-0.07
Trade	0.01	0.01	-0.01	-0.00	-0.00	-0.00	0.02	0.00	-0.00	0.00	0.02	0.01
TransportS	0.03	0.02	-0.01	0.02	-0.02	-0.01	0.00	0.01	0.01	-0.01	0.03	0.03
Communcation	0.02	-0.08	-0.04	0.00	-0.02	-0.04	-0.01	0.01	-0.04	-0.00	0.02	0.03
FinanInsur	0.02	0.02	-0.02	-0.00	-0.01	-0.01	-0.00	0.01	0.01	0.01	0.01	0.02
	-0.01	-0.01	-0.01	-0.01	-0.01	-0.00	-0.00	-0.00	-0.01	-0.00	-0.00	-0.01

Source: Authors' simulation using GTAP Database Version 11 (Aguiar et al., 2023).

Table 12 presents the impact of the Russia-Ukraine war on output by sector. The results are based on calibration using SC3. It is important to note that the impact of Russia's invasion of Ukraine on output by sector varies across different countries and regions, as shown in Table 12. The conflict in Ukraine, known as the "breadbasket of Europe", has disrupted agricultural production and exports, leading to food shortages and higher prices in the region and elsewhere. Sanctions and trade restrictions imposed by other countries in response to the conflict can lead to reduced export opportunities and increased costs for both Russia and Ukraine. The actual outcome of output by sector would depend on the scale, duration, and intensity of the conflict, as well as the measures taken by the respective governments and the international community to mitigate the economic impact.

Overall, the impact of an increase in wheat production by third producers will depend on the scale of the increase and the extent of the disruption caused by Russia's invasion of Ukraine. It is important to note that the situation can be complex, and the interplay of various factors such as global demand, transportation logistics, and market dynamics will influence the outcomes for different economies.

Under the aforementioned varying scenarios, varying degrees of decrease in wheat production and trade disruptions are anticipated. For SC1, the potential impacts of this scenario are a decrease in wheat production that affects agricultural exports from Ukraine, leading to decreased revenues for the country's economy. SC2 focuses on supporting farmers in Ukraine and other wheat-producing regions to adopt sustainable agricultural practices to enhance resilience in the face of disruptions, and encourages research and development in agriculture to improve productivity and adaptability. The focus is also on international cooperation and aid; it is necessary to form international partnerships to provide humanitarian aid and support to regions heavily affected by reduced wheat production, and coordinate efforts to ensure the efficient distribution of food assistance during periods of scarcity.

The potential impacts of SC2 lead to further disruptions in Ukraine's agricultural exports and internal supply chains. Other countries dependent on Ukrainian wheat may face shortages and higher prices for imported agricultural products. Inflationary pressures could arise in some importing nations, impacting the economic welfare of citizens. The global trade balance could shift, with some countries experiencing deficits due to higher prices and reduced supplies.

The results of SC3 show significant disruptions in Ukraine's agricultural sector, with potential consequences for food security and domestic stability. Countries heavily reliant on Ukrainian wheat face acute shortages and soaring prices for essential food items. The global trade balance experienced substantial shifts, with countries facing trade deficits and struggling to secure alternative sources for wheat and other agricultural products. Increased volatility in commodity prices on the global market leads to widespread uncertainties for investors and businesses.

VI. Conclusion

Russia's assault on Ukraine, which became a full-scale conflict in 2022, has had a significant impact on food security globally. We designed three scenarios based on the duration of the conflict and quantified its potential impacts on real GDP, welfare, export volume, import volume, trade balance, and output by sector. The war has implications beyond the immediate regions, impacting various regions, including Turkey, Egypt, Georgia, and India.

The invasion of Ukraine has negatively affected the real GDP of countries such as France, Egypt, Mongolia, and Korea. This has also negatively affected countries such as Georgia, Azerbaijan, and Egypt that rely on Ukraine's agricultural produce. The conflict has disrupted economic activities, leading to a decline in production and investment. Infrastructure damage, displacement of people, and disruptions to supply chains have hindered economic growth.

The assault has caused a decline in welfare for the Ukrainian population. Regions such as Egypt, India, Turkey, and Korea are also affected negatively by the war. The conflict has led to increased poverty rates, limited access to basic services, and created humanitarian crises in affected regions. Also, it has negatively affected the trade volume of most countries. The conflict has disrupted trade routes, damaged infrastructure, and created barriers to international trade. As a result, both exports and imports have been significantly impacted, leading to a decline in trade volume. This has also affected the trade volume of other regions, directly or indirectly.

The war has had a mixed impact on Ukraine's trade balance. On the one hand, the disruption to exports and imports has led to a decrease in trade volume, which can negatively affect the trade balance. On the other hand, the conflict has also resulted in a decrease in imports, which could help improve the trade balance to some extent. The Russia-Ukraine conflict has the potential to lead to a trade surplus for Ukraine during a recession due to disruptions in trade relationships. With reduced imports caused by conflict-related factors, Ukraine could shift toward boosting domestic production to meet internal demand for essential goods. This surplus production might then be exported to countries facing challenges in accessing their usual sources of goods due to conflict-related disruptions, forming a trade surplus.

It is important to note that the precise magnitude of these impacts can vary over time, depending on the duration and intensity of the war, as well as other factors such as government policies and international support. Additionally, the ongoing nature of the conflict makes it difficult to fully assess the long-term consequences for Ukraine's economy. It is important to note that the specific impact on each country will depend on various factors, including economic ties, geopolitical considerations, and the duration and intensity of the conflict. Geopolitical dynamics and regional stability are crucial in understanding how the war may affect Korea, Japan, and China, both economically and strategically.

Policymakers must closely monitor the situation, implement measures to address potential disruptions, and foster international cooperation to mitigate the adverse effects on global trade, economies, and food security.

The uncertain duration of Russia's invasion of Ukraine complicates the assessment of its economic impact. The destruction of the Kakhovka dam will have far-reaching consequences beyond the loss of agricultural output. It is anticipated to disrupt the transportation of essential products to global markets, leading to reduced supply and increased prices internationally. The severity of these implications, along with others, hinges on the scale of the dam's destruction, the extent of agricultural areas impacted, and the effectiveness of the responses from governments and international organizations in addressing this critical situation.

On food security and agricultural diversification, regions dependent on Ukrainian wheat imports should explore diversification strategies to reduce reliance on a single source. Encouraging investment in domestic agriculture to strengthen food security and reduce vulnerability to external disruptions is recommended. On trade diversification, the essence is to explore alternative trading partners to mitigate the impact of reduced trade with Ukraine. Fostering trade agreements with other wheat-exporting regions to ensure a steady supply of wheat during periods of uncertainty is ideal.

References

Abay, K., Abdelfattah, L., Breisinger, C., Glauber, J., & Laborde, D., (2022). The Russia-Ukraine crisis poses a serious food security threat for Egypt. https://www.ifpri.org/blog/russia-ukraine-crisis-poses-

serious-food-security-threat-egypt

Aguiar, A., Chepeliev, M., Corong, E., & van der Mensbrugghe, D. (2023). The global trade analysis project (GTAP) data base: Version 11. *Journal of Global Economic Analysis*, *7*(2). https://doi.org/10.21642/JGEA.070201AF

Andrimont, R., Verhegghen, A., Lemoine, G., Kempeneers, P., Meroni, M., & Van der Velde, M. (2021). From parcel to continental scale: A first European crop type map based on Sentinel-1 and LUCAS Copernicus in-situ observations. *Remote Sensing of Environment*, *266*, 112708.

Armington, P. S. (1969). A theory of demand for products distinguished by place of production. *International Monetary Fund Staff Paper, 16*(1), 159-178. https://www.elibrary.imf.org/view/journals/024/1969/001/article-A007-en.xml

BBC News (2023a, July 18). *Ukraine grain deal expires after Russia pulls out*. https://www.bbc.co.uk/news/world-europe-66223280

BBC News (2023b, June 8). *Ukraine dam: Floods devastate tracts of rich farmland*. https://www.bbc.com/news/world-europe-65838771

Bhaskara Rao, B., & Rao, G., S. (2017). Economic impact of the conflict in Ukraine on the global grain market. *Post-Communist Economies*, *29*(1), 46-60.

Cheong, S. T. (2023). A study on the dispute settlement system of regional trade agreements as an alternative to the WTO dispute settlement system. *Journal of Global Business and Trade*, *19*(4), 15-35.

Choma, M., & Dobija, D. (2017). Ukrainian conflict consequences on wheat market in the world. *Agricultural Economics - Czech, 63*(3), 119-128.

CNN World News (2022, July 23). *Kyiv and Moscow agree deal to resume Ukraine grain exports from Black Sea ports.* https://edition.cnn.com/2022/07/22/europe/ukraine-russia-grain-deal-turkey-intl/index.html

Corong, E. T., Hertel, T. W., McDougall, R., Tsigas, M. E., & van der Mensbrugghe, D. (2017). The standard GTAP model, Version 7. *Journal of Global Economic Analysis, 2*(1), 1-119. http://dx.doi.org/10.21642/JGEA.020101AF

Crop Explorer (2023, July 12). *World agricultural production (WAP) briefs: Ukraine, Moldova and Belarus.* https://ipad.fas.usda.gov/cropexplorer/pecad_stories.aspx?regionid=umb&ftype=prodbriefs

FAO (2023). *Production: Value of agricultural production data*. https://www.fao.org/faostat/en/#compare

Fox Business (2023, June 6). *Ukrainian dam destruction sends global prices of wheat, corn soaring.* https://www.foxbusiness.com/markets/ukrainian-dam-destruction-sends-global-prices-wheat-corn-soaring

Glauber, J., Laborde, D., & Mamun, A. (2022). *From bad to worse: How Russia-Ukraine war related export restrictions exacerbate global food insecurity.* https://www.ifpri.org/blog/bad-worse-how-export-restrictions-exacerbate-global-food-security

Guerrieri, V., Lorenzoni, G., Straub, L., & Werning, I. (2022). Macroeconomic implications of COVID-19: Can negative supply shocks cause demand shortages? *American Economic Review*, *112*(5), 1437-1474.

Hertel, T. W. (1997). *Global trade analysis: Modeling and applications* (1st ed). Cambridge University Press. https://www.gtap.agecon.purdue.edu/resources/download/7684.pdf

Kang, H. S. (2022). The analysis for determinants of Korea's agricultural trade using gravity models. *Journal of International Trade & Commerce*, *18*(1), 245-265. http://dx.doi.org/10.16980/jitc.18.1.202202.245

Kim, B. C., Shin, E. C., & Park, K. E. (2023). Establishing EU norms as a Global actor: Application of new concepts in FTAs. *Journal of Global Business and Trade*, *19*(1), 75-89.

Kim, T. M., Huh, J. H., & Kim, Y. (2022). The influence of social crowdedness in retail stores on consumers' shopping satisfaction in the COVID-19 era: A focus on the moderating effects of happiness and time perspective. *Journal of Global Business and Trade*, *18*(2), 1-15.

Kitetu, G. M., & Ko, J. H. (2020). Climate change on agriculture in 2050: A CGE approach. *Journal of*

International Trade & Commerce, 16(4), 1-20

Ko, J. H. (2018). The opportunity cost of the US withdrawal from the TPP: A CGE approach. *Journal of International Trade & Commerce*, *14*(1), 23-43.

Kuzmenko, O., & Öztürk, B. (2020). The effects of the Russian–Ukrainian conflict on global agricultural commodity markets. *Eurasian Economic Review*, *10*(2), 245-269.

Li, X. Y., Li, X., Fan, Z., Mi, L., Kandakji, T., & Song, Z. et al. (2022). Civil war hinders crop production and threatens food security in Syria. *Nature Food, 3*(1), 38-46.

Martin-Shields, C. P., & Stojetz, W. (2019). Food security and conflict: Empirical challenges and future opportunities for research and policy making on food security and conflict. *World Development*, *119* (C), 150-164.

PBS NewsHour (2023, June 6). *Global wheat prices jump following collapse of major dam in southern Ukraine.* https://www.pbs.org/newshour/world/global-wheat-prices-jump-following-collapse-of-major-dam-in-southern-ukraine

Reuters (2023, June 7). *Ukraine warns over impact of Kakhovka dam collapse on farmland.* https://www.agriculture.com/markets/newswire/update-1-ukraine-warns-over-impact-of-kakhovka-dam-collapse-on-farmland

Song, J., & Kim, Y. G. (2022). A study on the impact of RCEP tariff reduction on Korea's agricultural trade: Simulation analysis based on the GTAP model. *Journal of International Trade & Commerce, 18*(1), 41-57.

Statista (2023a, April 25). *Wheat production in Ukraine from 2016/2017 to 2022/2023.* https://www.statista.com/statistics/1379509/ukraine-wheat-production/

Statista (2023b, March 28). *Value of wheat exports from Ukraine in 2022, by country* https://www.statista.com/statistics/877201/ukraine-wheat-export-value-by-country/

Stephens, A. R., Robb, C. A., & Kang, M. (2022). A comparative study of Korean and US firms amid COVID-19 supply chain disruptions: The role of relational capital for improving ambidextrous innovation and firm performance. *Journal of Global Business and Trade*, *18*(5), 77-99.

The Guardian (2023, June 6). *Maps show how Kakhovka dam collapse threatens Ukraine's bread basket.* https://www.theguardian.com/world/2023/jun/08/maps-kakhovka-dam-collapse-threatens-ukraine-bread-basket

The United Nations (2022, May 19). *Lack of grain exports driving global hunger to famine levels, as war in Ukraine continues, speakers warn security council.* https://press.un.org/en/2022/sc14894.doc.htm#

World Bank (2022). *The impact of the war in Ukraine on global trade and investment (English).* https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099750104252216595/idu0008eed66007300452c0beb208e8903183c39

World Food Programme (2023). *A global food crisis.* https://www.wfp.org/global-hunger-crisis

World Trade Organization (2023). One year of war in Ukraine. https://www.wto.org/english/res_e/booksp_e/oneyukr_e.pdf

Yan, W., Cai, Y., Lin, F., & Ambaw, D.T. (2021). The impacts of trade restrictions on world agricultural price volatility during the COVID-19 pandemic. *China World Economy, 29*(6), 139-158.

Yang, H., & Li, Y. H. (2021). Analysis of factors affecting grain futures price in china and implications for Korea. *Journal of International Trade & Commerce*, *17*(4), 241-259. http://dx.doi.org/10.16980/jitc.17.4.202108.241

Yoon, S. H., & Ko, J. H. (2022). The impact of COVID-19 on the world economy. *Journal of Global Business and Trade*, *18*(2), 79-98.