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A Review of MEAs and WTO Agreements: Are Trade and Environment Policies Compatible?

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ABSTRACT

The relationship between international trade and environment has been on the agenda of both academicians and policy makers in recent years. Multilateral Trade Environment Agreements such as The Montreal Protocol, The Basel Convention, The Convention on International Trade in Endangered Species (CITES), and the Framework Convention on Climate Change were established. In addition to General Exceptions of GATT Article XX, the WTO is dealing with trade-related environment measures (TREMS) under SPS, GATS, TBT, and TRIPS Agreements. The need to ensure that trade and environment policies are mutually supportive is more pressing today than ever before. Therefore, successful integration of these policies can only be achieved through a constructive dialogue based on far broader awareness and understanding of the complex inter-linkages between trade and our environment.

Keywords: multilateral environmental agreements (MEAs), GATS, SPS, TBT, TRIPS, WTO

Ⅰ. Introduction

There have been heated debates over the environmental consequences of liberalized trade. It has been intensified by the creation of the World Trade Organization and proposals for future rounds of trade negotiations. World trade expansion has raised the issue of the relationship between trade and the environment. The production of goods that are imported and exported, like other production, will often have environmental effects. In the last few decades, many multilateral environmental agreements have entered into force dealing with such issues as ozone depletion, transport of hazardous waste, and migratory species.

Much environmental damage is due to the increased scale of global economic activity. International trade constitutes a growing portion of that growing scale, making it increasingly important as a driver of environmental change. As economic globalization proceeds and the global nature of many environmental problems becomes more evident, there is bound to be friction between the multilateral systems of law governing both.

The relationship between trade and the environment has evolved over time. The inclusion of environmental issues in the negotiating agenda of the World Trade Organization (WTO) at the Doha Ministerial in 2001 moved this relationship into the spotlight. However, this is by no means a new relationship; indeed, this is a relationship that has gone through many phases and will continue to evolve in the future.

The trade and environment relationship is, in fact, imbedded within the original text of the General Agreement on Tariffs and Trade (GATT), which was adopted in 1947 as the basis for the post-war global trading system. Among the exceptions to the GATT's core principles were provisions stating that nothing in the GATT would prevent member countries from adopting or enforcing measures either "necessary to protect human, animal or plant life or health" or "relating to the conservation of exhaustible natural resources"(Article XX, paragraphs (b) and (g), respectively). However, Article XX also says that such measures cannot be disguised restrictions on trade applied for protectionist intent.

At the 1972 UN Conference on the Human Environment in Stockholm, the GATT Secretariat presented a paper on the implications of environmental protection policies and how these could become obstacles to trade. Further, discussions during the Tokyo Round of the GATT over trade related technical regulations and standards implemented for environmental purposes led to the adoption of the Agreement on Technical Barriers to Trade (TBT. The TBT Agreement called for transparency in the application of technical regulations and standards and marked the first reference to the environment in a GATT agreement.

This purpose of this article is twofold: (1) to provide a brief survey of the trade and environment policies under the WTO/GATT and multilateral trade agreements; and (2) to present some compatible strategies of mutual cooperation on trade and environment between the WTO and MEAs.

Ⅱ. Multilateral Environment Agreements (MEAs)

The modern system of international environmental management dates to the 1972 United Nations Conference on the Human Environment, held in Stockholm. The Stockholm Conference led to the establishment of the United Nations Environment Programme (UNEP). UNEP has launched a significant number of international agreements. The Rio Conference helped establish the United Nations Commission on sustainable development and reaffirmed the role of the global environment facility, thus widening the organizational basis for the environment and sustainable development within the United Nations system.

2.1. The Montreal Protocol

The Montreal Protocol establishes a regime of control for several classes of industrial chemicals now known to harm the stratospheric ozone layer. The result has been a ban on the production and use of several of them, together with severe limitations on others. It has successfully implemented the principle of precaution by acting before the availability of clear scientific evidence, and that of common and differentiated responsibility by establishing a fund to assist developing countries in their transition away from dependency on controlled substances. Its principal enforcement tool is the control of trade in ozone depleting substances and trade in products containing controlled substances. It included the possibility of imposing controls on trade in products produced with controlled substances, but the parties have not considered it necessary to implement such controls.

The Protocol lists certain substances as ozone depleting and bans all trade in those substances between parties and non-parties. Similar bans may be implemented against parties as part of the Protocol's non-compliance procedure. The Protocol also contemplates allowing import bans on products made with, but not containing, ozone-depleting substances—a ban based on process and production methods.

2.2. The Basel Convention

The Basel Convention resulted from the concern of developing countries, particularly in Africa, in that they could become the dumping ground for hazardous wastes that could no longer be disposed of in the developed world. Developing countries and non-governmental organizations have continued to play a significant role in developing the regime. The Basel Convention has been marked by disputes over the most appropriate strategy for controlling the movement of hazardous waste and the technical difficulty in establishing unambiguous distinctions between wastes and materials for recycling. Parties have adopted amendments banning the export of hazardous waste for the Environment and Trade from mainly OECD to non-OECD countries.

Parties may only export a hazardous waste to another party that has not banned its import and that consents to the import in writing. Parties may not import from or export to a non-party. They are also obliged to prevent the import or export of hazardous wastes if they have reason to believe that the wastes will not be treated in an environmentally sound manner at their destination.

2.3. Convention on Biological Diversity

The Convention's objective is conserving biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising from the use of genetic resources. The Convention has not been easy to operationalize. The very concept of "biodiversity" is a research construct developed in the past 20 years to better help us understand the natural environment. Protecting a research construct, as opposed to something tangible, such as a species or specific habitat, is not a straightforward exercise.

2.4. The Convention on International Trade in Endangered Species (CITES)

The Convention on International Trade in Endangered Species (CITES) was drawn up in 1973 and entered into force two years later. CITES seeks to control trade in endangered species and their parts, as well as products made from such species. Three annexes list species identified by the Conference of Parties as being endangered to various extents. It establishes trade controls, ranging from a complete ban to a partial licensing system. CITES has long been known for the unusually active participation of non-governmental organizations in its deliberations. CITES bans commercial international trade in an agreed list of endangered species. It also regulates and monitors trade in other species that might become endangered. CITES is one of the largest and oldest conservation and sustainable use agreements in existence. Every year, international wildlife trade is gauged to be worth billions of dollars and to include hundreds of millions of plant and animal specimens. Nowadays, a number of species are quoted as "endangered" and may know extinction if no attention is granted to them.

2.5. Framework Convention on Climate Change

Framework Convention on Climate Change (FCCC) is grappling with the most complex of all environmental issues, and the one with greatest potential for economic impacts. Since greenhouse gas emissions can rarely be limited with technical, "end-of-pipe" technologies, the principal strategy of the FCCC must be to change the pattern of future investment in favor of activities that generate less greenhouse gases. In December 1997 the Kyoto Protocol was adopted. It created two classes of countries—those with greenhouse gas limitation commitments and those without—as well as several institutions governing their relations. Although neither the FCCC nor the Kyoto Protocol includes trade measures, it is highly likely that the parties, in fulfilling their Kyoto obligations, will adopt trade-restrictive policies and measures.

Ⅲ. WTO and the Environment

3.1. WTO and Environment

Environmental provisions under the WTO are limited to the adoption of product-related measures as "necessary to protect human, animal or plant life or health," or "relating to the conservation of exhaustible natural resources." Process-related requirements continue to remain outside the scope of the WTO. The "Standards Code" had undergone modifications, and certain environmental issues were addressed in the General Agreement on Trade in Services (GATS), the Agreements on Agriculture, Sanitary and Phytosanitary Measures10

(SPS), Subsidies and Countervailing Measures (SCM), and Trade-Related Aspects of Intellectual Property Rights (TRIPS).

All agreements in the WTO system supervise trade-related environmental measures (TREMs), but within these agreements, there are a number of provisions that specifically address the environment. Most of them were not part of the pre-WTO system. A brief catalogue follows. First, the Agreement on Agriculture provides that certain payments for government environment programs may have a qualified exemption from the Agreement's required subsidy reduction commitments. Second, the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) includes 'ecological and environmental conditions' within its criteria for a risk assessment, and requires governments to consider 'ecosystems' as one factor in determining pest or disease free areas. Third, the Agreement on Technical Barriers to Trade (TBT) recognizes the protection of the environment as a legitimate objective. Fourth, the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) contains an environmental exception with regard to patents. Members may exclude an invention from patent ability when the prevention of domestic commercial exploitation is necessary to protect human, animal or plant life or health or to avoid serious prejudice to the environment. Fifth, the Agreement on Subsidies and Countervailing Measures provided non-actionable status for financial assistance from government to industry promotes adaptation to new environmental requirements. Unfortunately, this provision lapsed after five years, and the WTO failed to reinstitute this safe harbor. As a result, TREM subsidies are now potentially outlawed by the WTO, including those which may be called for in other WTO agreements. The General Agreement on Trade in Services (GATS) contains an exception for measures 'necessary to protect human, animal or plant life or health.'

The most important provisions governing the operations of the WTO affecting the environment are in Article XX of GATT, the Agreement on Sanitary and Phytosanitary (SPS) Measures and the Agreement on Technical Barriers to Trade (TBT). For example, restrictions can be applied to the trading of toxic and hazardous substances or potential disease vectors, among others. Any tendency to use the provisions as a means of securing economic advantages rather than environmental or health benefits is protected through two subsidiary agreements.

The SPS provides that when restrictions on trade are applied they must be consistent with recognized international standards. Any other standards applied must be based on solid scientific evidence and supported by a risk assessment process and provisions created for affected parties to require presentation of the supporting justification. The TBT is intended to reduce the potential for countries to use technical standards as hidden barriers to trade. Technical standards which are restrictive to trade may only be applied subject to some caveats for certain legitimate purposes such as protecting the environment; national security and protecting human health and safety and animal and plant health and life.

3.2. Doha Round and Environment

The Doha Agenda contains several environmental elements. It seems very likely that if the Doha Round is successfully brought to conclusion, the results will include new environmental provisions. Among them may be needed disciplines for fishery subsidies. This Declaration provides a negotiating agenda and a forward work program for the WTO. It should be noted, however, that the negotiating process is not being conducted with sufficient transparency, and therefore, the interested public is not always able to appreciate what is going on so that public opinion can be injected.

In order to benefit the environment, members work on trade liberalization in goods and services as well as discuss ways to maintain a harmonious co-existence between WTO rules and MEAs environmental policies. The Committee on Trade and Environment Special Session (CTESS) was established to conduct negotiations on (i) the relationship between existing WTO rules and specific trade obligations set out in MEAs; (ii) procedures for regular information exchange between

WOT and MEAs; (iii) reduction or elimination of tariffs and non-tariff barriers to environmental goods and services.

The CTE has received a new request assigned to focus on three items of its work program: (i) the effect of environmental measures on market access; (ii) the links between TRIPS Agreement and the environment; (iii) environmental labeling.

The Ministerial Conference in Cancun, Mexico, reaffirmed the decisions made during the Doha Round. It took note of the progress made by the Special Session of the Committee on Trade and Environment in developing a common understanding of the concepts contained in its mandate in paragraph 31 of the Doha Ministerial Declaration, reaffirming the commitment to these negotiations. At the same time, it was agreed that the secretariats of the MEAs, the United Nations Environment Program (UNEP) and the United Nations Conference on Trade and Development (UNCTAD) to participate in the meetings of the CTESS. The Doha round of negotiation about environmental questions and its implication in international trades have not been concluded.

The Doha Round provides the scope for expanding environmental provisions in the context of WTO negotiations. There are, however, a number of unresolved issues with respect to the Doha Mandate on trade and the environment.

3.2.1. Fisheries Subsidies

For several years, WTO Members have pursued the issue of fisheries subsidies in the WTO Committee on Trade and Environment (CTE), which has the power only to make recommendations. However, current negotiations on fisheries subsidies are taking place in the WTO Negotiating Group on Rules

Many countries seem to favor prohibition of all subsidies causing overcapacity and overfishing, as well as other trade distortions with certain exceptions. As opposed to this "top down" approach, some countries such as Japan and South Korea are in favor of a "bottom up" approach in which only particular harmful subsidies would be prohibited.

3.2.2. Eco-labeling

The discussions on labeling requirements for environmental purposes show some areas of consensus and several areas of divergence. There appears to be consensus that voluntary, participatory, market-based and transparent environmental labeling schemes are potentially efficient economic instruments in order to inform consumers about environmentally friendly products. Almost all members agree on the need for transparency in developing and implementing eco-labeling schemes so as to avoid causing a disadvantage to foreign producers. There is still, however, considerable divergence which relates to the issue of non-product PPMs and their compatibility with the multilateral trading system. It is argued that the labeling criteria used should be non-discriminatory and based on measurable scientific criteria. For developing countries, the recognition of the equivalency of their own certification systems is especially of particular concern.

3.3. Environmental Goods and Services

There are still a number of issues to be resolved regarding definition of environmental goods while referring the issues of reducing or eliminating tariffs on environmental goods to the tariff negotiating group. Definitional issues involve how to define the goods, a general definition or lists of goods to be included. The latter revolves around whether environmental goods should include "environmentally friendly," i.e., "green goods" including consumer goods or goods specifically aimed at improving the environment such as pollution control equipment. A number of bilateral agreements have gone beyond the WTO to give attention to environmental protection aspects. Agreements such as the North American Free Trade Agreement (NAFTA) and the US-Singapore FTA directly address environmental concerns, and Regional Economic Integration

Organizations (e.g. MERCOSUR) deal with trade-environment issues both in relations between their members and in global policy activities.

Ⅳ. Conflicts and Supporting Measures between the WTO and MEAs

4.1. Conflicts

4.1.1. Border Tax/Environmental Tariff

Unlike some other multilateral environmental agreements (e.g. Montreal Protocol), the Kyoto Protocol does not trigger trade sanctions against non-participating countries. In fact, it could conceivably have been more effective had trade sanctions been used either to encourage participation or to enforce compliance by members. It would still not be in violation of WTO provisions (Frankel, 2004) as a number of other MEAs (e.g. Montreal Protocol) have such provisions. However, even without trade sanctions or controls, complaints about violations of the WTO non-discrimination rules are likely to arise if a member country seeks to impose border tax adjustments to offset the effects of specific domestic GHG taxes on the competitiveness of its own industry vis-à-vis foreigners. Although nothing is being contemplated at present, pressure from industry groups worried about higher energy costs that burden them domestically, and that give competitors in non-member countries an unfair advantage could tilt the political balance. So far no such regime exists anywhere in the world. However, one can argue that barriers against the import of dirty products or any product resulting from a dirty production process (e.g. greenhouse gases) on welfare grounds would be justified.

4.1.2. Leakage of Emissions

The main goal of the Kyoto Protocol will be subverted if all carbon-producing activities such as coal-burning and aluminum smelting simply relocate to non-member countries, thus offsetting the reduction in emission among members. Under the WTO it is still much less clear that a country can, in the name of the environment, target others' PPM than others' export products. However, the precedent set by 'shrimp-turtle' case could change things. One can make a case for PPMs that create global externalities such as ozone-depleting chemicals or greenhouse gases. Thus, discouraging leakage of emissions to non-members is essential to the goals of the Protocol, and the WTO could recognize the legitimacy of such goals. As of now, there is no clear cut dispute settlement mechanism in case of a conflict between the two treaties.

4.1.3. Technical Barriers to Trade

There could be an intersection with WTO Technical Barriers to Trade (TBT) if eco-labeling issues were to arise in the context of greenhouse gas content in production processes. In addition, trade in emission permits are currently classified neither as goods nor as services. However, if emission permits/credits are defined as services to which the General Agreement on Trade in Services (GATS) applies, then there is a question about whether the most favored nation (MFN) principle of non-discrimination would be violated. Limiting the trading of emission permits to Kyoto Protocol parties would be in violation of GATS.

4.2. Supporting Measures

4.2.1. Within the WTO

The proposals on exemptions under GATT Article XX can be divided in two main ideas:

4.2.1.1. An Amendment of Article XX.

The fact that this Article could be subject to modification may reinforce the position of the WTO with respect to the environmental issues. To facilitate the cooperation among trading partners as embodied within the Multilateral Environmental Agreements, this article could offer a special treatment regarding the trade measures in the MEAs to make them justifiable. The chapeau of this article could be ignored in a precise case of protecting the environment without taking in account the importance of national law or international law. In the Tuna/Dolphin case, the dispute settlement body did not accept the US request, even if it was concerning endangered species. It was a national law which could not apply to the other Party's territory. In this case, the WTO could have promoted the US demand over the dolphins.[2]

4.2.1.2. A Clause of Interpretation

Sometimes an interpretation of certain terms of the article can be interpreted differently by the Parties. It could be important, for example, to know what measure is considered "necessary" from the point of view of the WTO, or what deserves to be noted as "exhaustible." An official interpretation could avoid such a conflict of issues as this could help in promoting the idea that environmental trade-related measures are complementary with the multilateral trading system.

Another solution could be the implementation of a new Agreement inside the World Trade Organization that would have the same status as the other agreement, such as the Agreement on Technical Barriers to Trade or the Agreement on Application of Sanitary and Phytosanitary Measures. By doing so, the WTO could create a number of rules which would only apply to MEA trade measures, and at the same time, it would avoid any attempt of amendment. The creation of this kind of agreement would create a scope where trade related measures would not have to answer to GATT rules and thereby would be exempted of its requirements. It could be the case for prohibited or restricted exportation or importation of the Article XI of the amended; it could create a rule which would approve prohibitions or restrictions on certain products in accordance with an MEA measure and under strict conditions. In order to create such an agreement, it would be necessary to define an "MEA" and important key points related to it, and to describe the scope and include criteria on the participation to this agreement. It would also be necessary to give a precise explanation on the burdens and offsets in order to not force countries to accept an agreement that would not be beneficial to their development.

[2] According to the WTO rules, an amendment would require approval by all or by two-third of the majority and would only apply to those who accepted it.

4.2.2. Outside the WTO

If the modification of the WTO rules requires a long process and seems to be a difficult achievement, reinforcing the MEAs could be considered. The creation of a World Environment Organization could be a response to fix the issues between the WTO and the MEAs. Many countries, especially European Nations and Switzerland, found it important to strengthen the dispute settlement system within the MEAs themselves. This approach addresses the environmental issues under environmental forums. Such an approach would create a unique system that covers the different scopes of the current MEAs by being responsible for the coordination between environmental policies, thereby protecting the WTO from unprepared responsibilities.

In order to solve the latent problems between the WTO and the MEAs, an approach of national scope-relative to the nation within which the international trade companies operate is suggested. Every company would have the will to trade while incorporating the ideology of environment protection. To do so, the government of each country participating in the WTO and MEAs would have an important role to play. It would adopt policies inclusive of environmental measures by implementing a system of sanction and reward. If any government is able to make trade and environmental protection policies compatible at the national scope, it could establish a national law related to it. This in turn may, in the future, help the WTO to conceptualize unique international law which addresses both trade and environmental policies and covers all possible issues that may possibly arise.

Ⅴ. Conclusions

The World Trade Organization has always been aware of the difficulties in building a complete multilateral trade system. Facing trade barriers, it implemented a constructive and rigorous regime in order to facilitate trade between countries. To show its versatility, it has tried to adapt to evolving world events and help member-countries face threats such as environmental issues by adopting regulations or holding conferences in order to discuss diverse solutions.

Environmentalists and people fighting to protect the environment are not satisfied by the trade liberalization system and this has a bad influence on nature. Since environmental issues were not really treated as equals to trade issues, the need of a system, which could cover a more wide scope regarding the environment and protect it more efficiently, was important. Thus, Multilateral Environmental Agreements were created in parallel to the WTO. The WTO would be able to deal with trade, while MEAs would protect and work in favor of the environment. MEAs were implemented to include measures dealing with the environmental protection, but some of these MEAs, though these included trade-related environmental measures, were in opposition with the trade measures established in the WTO. Some MEAs prohibited or regulated the trade of animals, plants or even waste products. Other MEAs prohibited trade with non-members or did not allow conferring different rights to Party members. Therefore, the WTO system and the MEAs had various areas of conflict. Even though the WTO dispute settlement body was able to manage such conflict relative to environmental issues, this was not always the case. The fact that these problems are still present shows the importance of having a better coordination between the WTO and MEAs.

Since the 1970s, these two systems have not been able to find a consensus. The countries involved in the MEAs tried to encourage other countries to participate in such agreements in order to facilitate the trade under their jurisdiction. The WTO has attempted to veer towards environmental protection by implementing a committee in its system that would be able to address environmental negotiations. It likewise initiated the Doha Development Agenda, which was tasked with trying to find a solution to the conflicts arising between the WTO and MEAs. This agenda has not been concluded yet. Some were in favor to amend rules inside the WTO, create an agreement that will be responsible for the MEAs or reinforce the dispute settlement body with more expertise regarding the environment. Others envisioned instead a new system such as a World Environment Organization that would be able to rebuild and reorganize the MEA system. The latter calls for a more important brand of involvement from the government of each country as well as the companies operating with national boundaries. Such a move may be seen as a perfect situation in which countries would like to protect the environment by implementing rules through their own will.

Multilateral Environmental Agreements address specific environmental issues which are trans-boundary or global. Conflicts between MEAs and World Trade Organization rules are possible, but have so far been avoided. Proposals have been made for a World Environmental Organization to oversee global environmental policy, and to serve as an advocate for environmental interests in the world trade system. Where effective environmental protection policies are lacking at the regional or global level, national policies are needed to address trade-related environmental issues. Certification and labeling requirements can help to promote consumer awareness and "greener" corporate practices in international trade.

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Estimates of Interfuel Elasticities of Substitution for the Philippine Transport Sector

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ABSTRACT

This study attempted to generate interfuel elasticities of substitution for the Philippine transport sector through a translog production function approach. Ridge regression was used to estimate the parameters of the function with the use of data from the United Nations' Energy Statistics Database and the Philippines' National Statistics Office. All energy inputs considered in the study (i.e., diesel oil, kerosene and gasoline) were found to be highly substitutable, with most elasticities being close to unity. This suggests that price-based policies, coupled with capital subsidy programs, can be used to redirect technology use towards cleaner and more efficient sources of energy.

Keywords: elasticity of substitution, energy, translog production function

Ⅰ. Introduction

Among all the sectors in the economy, the transport sector is one of those with the highest intensity of energy use (e.g., diesel, gasoline, kerosene). As this sector grows vis-à-vis the growth of the economy, the use of these inputs is also expected to increase. From 1972 to 2008, the consumption of diesel and gasoline products in the transport sector had generally increased, though the rate of increase had slowed down following the enactment of the Oil Deregulation Act in 1997 (Fig. 1). Consumption of kerosene, used mainly as jet fuel, had been steady over time.

In terms of percentage shares (Fig. 2), it can be seen from the graph that the share of gasoline in total fossil fuel use had decreased in the 1980s, while that of diesel had been increasing. This could be due to the fact that diesel is generally cheaper than gasoline and most land-based public utility vehicles run on diesel engines. These observations could imply fuel switching from one type of oil product to another. With increasing demand for these fuels, forecasts need to be done so as to match this demand with the necessary supply. These forecasts should be based not only on the trend of total energy input consumption alone but also on the degree of interfuel substitution happening across time.

The degree of substitutability between these energy inputs can be measured by the elasticity of substitution. The concept of the elasticity of substitution started with Hicks' work in 1932 entitled "Theory of Wages" (Stiroh, 1999). In the traditional production function where output is a function of two inputs (e.g., labor and capital), the elasticity of substitution measures the percent change in the ratio of input quantities for a one percent increase in the relative price of the inputs. The sign of the said statistic determines whether the inputs are substitutes or complements, and the magnitude determines the degree of substitutability or complementarity between the two inputs.

Fig. 1. Total Consumption of Energy Inputs (in terajoules), Philippine Transport Sector, 1972-2008

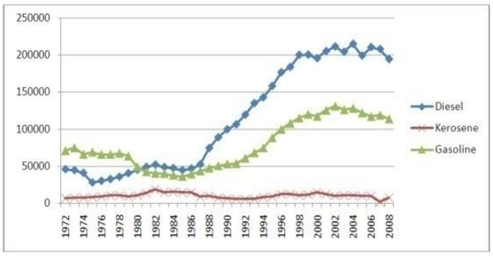
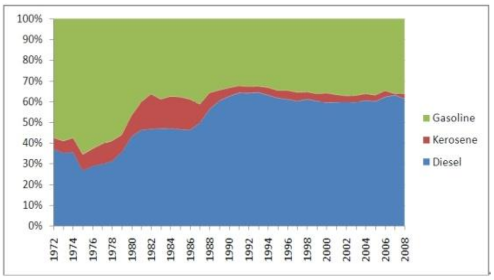


Fig. 2. Percent Shares in Consumption of Different Energy Inputs, Philippine Transport Sector, 1972-2008



Estimates of the elasticity of substitution among different energy sources, also known as the "interfuel elasticities of substitution" can help researchers and policy makers in a number of ways. As mentioned, earlier forecasts on future energy demand using demand models can be more reliable if the elasticities of substitution are taken into account. Also, if policy makers know which energy sources are highly substitutable, the information can be used to assess whether the promotion of the use of relatively "cleaner" energy sources as opposed to oil and other traditional sources would be successful.

Interfuel elasticities of substitution have not been computed for the Philippines, more specifically for its transport sector. Hence, the goal of this study is to obtain elasticities of substitution for the Philippine transport among three types of oil products: gasoline, diesel and kerosene. Section 2 of this paper discusses the framework used in this study, Section 3 discusses the different methods of obtaining the said elasticities in literature, and Section 4 discusses the chosen method for this study. Results of the study are presented in the fifth section. Lastly, Section 6 discusses the conclusions and implications of the results of the study.

Ⅱ. Framework

The concept of the elasticity of substitution first appeared in John R. Hicks' "A Theory of Wages" in 1932. Stiroh (1999) presents a simplified discussion on the contemporary definition of the said parameter. Given a production function with two inputs, say capital (K) and labor (L) given by:

$$Q = f(K, L) \tag{1}$$

The elasticity of substitution (σ) measures the percent change in the ratio of the quantity of inputs used per unit percent change in the ratio of the inputs' prices. The formula for σ is defined as follows;

$$\sigma = \frac{\%\Delta(K/L)}{\%\Delta(P_L/P_K)} \tag{2}$$

The parameter σ measures the elasticity of the inputs' quantity ratio with respect to the inputs' price ratio. A value greater than unity implies that the two inputs are easily substitutable with each other. However, if the value of σ is less than one, this implies limited substitution possibilities between the two inputs. A zero value signifies that the two inputs are not substitutable. Finally, when σ is equal to one, the two inputs are considered perfect substitutes. The estimated σ can be used to derive the implicit parameters for some types of production functions such as the Constant Elasticity of Substitution (CES) production function proposed by Arrow et al. (1961) with the following form:

$$Q = \gamma\{\delta K^{-\rho} + (1-\delta)L^{-\rho}\}^{-1/\rho} \quad (3)$$

where:

γ = efficiency parameter, an indicator of the state of technology ($\gamma > 0$)

δ = distribution parameter, indicator of the relative factor shares ($0 < \delta < 1$)

ρ = substitution parameter, from which the constant elasticity of substitution can be determined such that $\sigma = \frac{1}{1+\rho}$ for $-1 < \rho \neq 0$

Ⅲ. Review of Literature

Various empirical methods have been used to extract the elasticity of substitution among different inputs from data collected by researchers. Perhaps the most popular method of estimating these elasticities in the field of energy economics studies is through the use of transcendental logarithmic (translog) cost functions. One of the earliest of these studies was conducted by Pindyck (1979) on the estimation of interfactor substitution elasticities across 10 developed countries. Pindyck's estimates show a positive elasticity of substitution between capital and energy; hence, these two inputs may be considered substitutes, a contradiction to what has been found in earlier studies (e.g., Halvorsen, 1977). Moreover, labor and energy inputs were found to be substitutes in the study.

Shankar and Pachauri (1983) went further by analyzing not just interfactor substitution, but also interfuel substitution possibilities in the context of India's industrial energy demand patterns. In general, the estimates of these parameters among different fuels are low. This implies weak substi-tution or comple-mentary possibilities among fuels, with oil and coal showing the highest degree of potential substitutability in several industries, parti-cularly in the iron and steel industry. Electricity and coal were also found to be substitutable but to a lesser extent. Another significant result was derived from the estimates of the elasticity of substitution between capital and energy. These two inputs were found to be complements, a result contradictory with the findings of Pindyck (1979).

The translog cost function was also utilized by Bataille (1998) in an attempt to estimate capital for energy and interfuel substitution elasticities through the Intra Sectoral Technology Use Model (ISTUM) developed for Canada. Among all the fuel types included, oil was found to be the most substitutable with capital and the pulp and paper sector showed the largest potential for such substitution. Among different fuel types, interfuel substitution elasticities that were found to be most significant were electricity for natural gas, electricity for oil, and natural gas for oil, all of which are substitutes. Bataille points out that these results have significant impacts on policies regarding the abatement of CO_2 and GHG emissions as the move to cleaner sources of energy (e.g., natural gas) is found to be easier.

Soderholm (2001) studied short run interfuel substitution in the west European electricity generation industry through a restricted translog cost function. Estimation was done by pooling annual data from 1984 to 1994 across six west European countries. Most notably, oil and gas were found to be highly substi-tutable and other fuel combinations were also found to exhibit relative ease in substitution. Soderholm concludes that short-run fuel substitution is most imminent in multi-fuel fired plants, by switching loads between different single-fuel fired plants and the conversion of present electric plants to plants which can burn alternative fuels.

Bjornerl and Jensen (2001) analyzed interfuel substitution among electricity, district heating, and other fuels in Denmark from 1983 to 1997. A micro panel data set from Danish industrial companies was used and the translog cost function was one of the functional forms used in the study. The authors found low substitutability between electricity and other fuels with an estimate of 0.1 elasticity of substitution. Substitution elasticities of electricity for heating and other fuels for heating were also relatively low. The authors state that the results may have been affected by derived demand effects and aggregation bias.

Some studies utilize the translog cost function but modify the estimation procedures in order to accommodate assumptions regarding production technologies. An example was the one conducted by Bousquet and Ladoux (2006) where two alternative assumptions form the basis of the study: (1) fixed technology that allows one or more of the potential energy inputs to be excluded as part of the actual input, and; (2) flexible fuel technology which assumes that the absence of a type of fuel in production is a result of cost minimizing exercises of a firm (i.e., fuel not consumed in practice could have been consumed in principle). Through maximum likelihood estimation, the authors found a higher degree of interfuel substitution among firms with the option of using three fuels compared to those who use only two types of fuels. Higher demand responses were also found in the estimates of the model accommodating the first technological assumption.

In an effort to promote abundant coal resources and reduce imported liquid fuel in Zimbabwe, Nkomo, and Goldstein (2006) estimated the degree of substitution in different energy types. Elasticity estimates were derived from a disaggregation of different industries, also through the use of the translog cost function. The study found that coal and liquid fuels are substitutes, as well as electricity and liquid fuels. An increase in the price of liquid fuels increases the demand for the two alternative energy sources.

Adeyemo, Mabugu, and Hassan (2007) conducted a study in another African country with regards to interfuel substitution. The study focused on the investigation of potential energy substitution in the Nigerian industrial sector. Data used were disaggregated based on different subsectors of the manufacturing sector and the translog cost function was also used. In most of the subsectors analyzed, substitution possibilities were found between oil and electricity, oil and coal, and oil and gas. Complementarities were also found in most industries between electricity and coal, and gas and electricity. On the aggregate, energy was found to be substitutable with both capital and labor.

The translog cost function was utilized by Penphanussak and Wongsapai (2008) in analyzing energy demand in Thailand. A modification was introduced to derive both static and dynamic (long run) estimates for the elasticity of substitution. Both models showed that oil, gas, and electricity are substitutable energy inputs. However, oil was found to be strongly complementary with coal in the context of Thailand's manufacturing sector. Though results were similar, Penphanussak and Wongsapai stated that the dynamic model presents more accurate estimates of interfuel elasticities of substitution.

Hengyun et al. (2009) also used the translog cost function to derive elasticities of substitution among different fuel types and factors of production in China. The methodology used was heavily based on the technique used by Pindyck in estimating these elasticities. On the aggregate, the authors' results were in agreement with Pindyck's findings that energy and capital are substitutes. Labor and energy were also found to be substitutes. Coal and electricity are substitutes, as well as gasoline and diesel, and electricity and diesel. Diesel and coal were found to be complements.

The studies presented are among the several studies which use the translog cost function in estimating elasticities of substitution. The flexibility of the specification, satisfaction of desired properties of production and cost functions, a tractable methodology, and the model itself being easy to understand makes the translog cost function a popular method of specification in energy economics literature. However, there exist other methods which have been used to estimate interfuel elasticities of substitution. Bjornerl and Jensen (2001), aside from the translog function, also utilized a generalized Leontief (GL) specification. Estimates from the GL model were slightly smaller than those of the translog model. However, the qualitative conclusions were similar for both models. The authors state, however, that the GL model is more appropriate when the elasticity of substitution estimates are small.

Chakir and Thomas (2003) estimated Morishima elasticities of substitution for five fuel types (i.e., gas, heavy fuel, oil fuel, butane-propane, and electricity) in the French pulp and paper sector from 1983 to 1996. The Simulated Maximum Likelihood (SML) estimation technique was used in the study. The authors noted that this method allows the estimation of an energy demand system dealing with the zero expenditures problem while simultaneously allowing for unobserved heterogeneity in the data set. All estimates were positive and significant, implying that all five fuel types were substitutes for one another. These, along with other estimated elasticities were used in simulating potential environmental effects of reducing CO_2 emissions in the pulp and paper sector of France.

A normalized quadratic (NQ) cost function specification was utilized by Serletis and Timilsina (2009) in estimating interfuel substitution elasticities in both developing and industrialized countries. The analysis was done at both national and sectoral levels. The NQ cost function is also a well-known flexible functional form. However, the authors of the study point out that the NQ specification is superior to the translog cost function as the results from the latter model are prone to violating theoretical regularity conditions in neoclassical microeconomic theory. Estimates of the elasticities of substitution are generally low (below unity), suggesting limited ability to substitute one fuel/energy source with another. Interfuel substitution was found to be easier in the industrial and transportation sectors of high-income economies as compared to middle and low-income economies. This was not true for the other sectors, implying that the structure of the economy, and not the level of economic development, affects the ease of substitutability and fuel switching in countries.

A recent study by Smyth, Narayan, and Shi (2010) utilized a translog production function, instead of a translog cost function, in estimating interfuel elasticities of substitution. The study determined the degree of interfuel substitution among coal, natural gas, electricity, and oil in the Chinese iron and steel sector from 1978 to 2007. The production function was assumed to exhibit constant returns to scale and Hicks-neutral technical change. The different energy inputs considered were found to be substitutes. The results suggest that China can move from coal to other cleaner energy sources to fuel its iron and steel sector while also mitigating GHGs emitted in production.

Differences in the estimates of interfactor and interfuel elasticities of substitution arise from several factors. Stern (2009) notes that the methodology used in the study is an important factor in the variety of substitution elasticities in literature. Other factors include the country or economy of study, level of aggregation (e.g., national, regional, sectoral), data used (i.e., cross section, time series, pooled data), and sample size. A meta-analysis of interfuel elasticities of substitution was conducted by Stern to address these issues and uncover true values of these elasticities and analyze the impact of the different factors on the elasticity estimates.

Stern found that in the industrial sector, different energy types are highly substitutable with the exception of gas and electricity. In general, oil and coal were found to exhibit the highest degree of substitution possibility in literature. The elasticity estimates were found to decrease with increasing levels of aggregation, with elasticity estimates highest at the sub-industry levels. Estimates from high income countries were found to be generally lower than those in high income countries. In terms of sample size, the author found a positive relationship between sample size and the size of the elasticity of substitution estimates. In terms of methodology, Stern notes that studies which use linear logit (LL) models tend to produce higher elasticity estimates as compared with other models. Jones (1995) and Steinbuks (2010) are some of the studies which used the said model specification.

Very few studies have been conducted in the Philippines in relation to the estimation of elasticities of substitution in input use and trade. A few have estimated interfactor elasticities of substitution. Sicat (1969) computed elasticities of substitution between labor and capital in the Philippine manufacturing sector. A CES function was used in the econometric estimation of these elasticities through a cross section of 1,688 manufacturing firms using 1960 data. Mendoza (1992) computed the elasticities of substitution among buildings, machinery, skilled labor, and unskilled labor for non-agricultural sectors of the country. The author used the CES production function, translog cost function, and the NQ function in deriving these elasticities. However, substitution elasticities for different energy sources have not yet been computed for the Philippines.

Ⅳ. Methodology

Most studies in energy economics literature employ a translog cost function in the estimation of interfuel elasticities of substitution. However, estimation through this method requires data on input prices (e.g., wages, rent, and energy prices), most of which are not available in the existing statistical bulletins of the country for most of the years covered in this study. Whenever price data are available, the number of observations does not warrant a sufficiently large sample to conduct statistical analysis. Hence, this study used a translog production function in lieu of a translog cost function for the estimation of interfuel elasticities of substitution, similar to what was proposed by Smyth, Narayan, and Shi (2010).

The translog production function is a second order Taylor Series approximation of an unknown aggregate production function (Pavelescu, 2011). The twice differentiable translog production function (Christensen, Jorgenson, and Lau, 1973) can be expressed in general form as follows;

$$\ln Y_t = \ln \beta_0 + \sum_i \beta_i \ln X_{it} + \frac{1}{2}\sum_i \sum_j \beta_{ij} \ln X_{it} X_{jt} \tag{4}$$

where ln$Y$ denotes the growth in output of the economy/industry, t is a time index, lnβ_0 is the technological coefficient, and lnX_i and lnX_j are respective growths in the use of inputs i and j. β_i and β_{ij} are technologically determined parameters. The use of this functional form permits one to avoid the imposition of assumptions such as perfect competition or perfect substitution among inputs. The presence of quadratic terms also allow for nonlinear relationships between the output and the inputs. These characteristics make the translog production function attracttive to researchers due to its flexibility relative to other functional forms (Pavelescu, 2011). From Equation 4, the output elasticity (η_{it}) of the ith input can be computed as:

$$\eta_{it} = \frac{\partial \ln Y_t}{\partial \ln X_{it}} = \beta_i + \sum_j \beta_{ij} \ln X_{jt} \tag{5}$$

Output elasticities are expected to vary across the period since these are functions of energy consumption per period. Between two energy inputs, the elasticity of substitution can be defined as:

$$\sigma_{ij} = \frac{\%\Delta(X_{it} / X_{jt})}{\%\Delta(P_{jt} / P_{it})} \tag{6}$$

However, on the assumption that firms in the economy/industry are cost minimizing, Equation 6 can be rewritten as:

$$\sigma_{ij} = \frac{\%\Delta(X_{it} / X_{jt})}{\%\Delta(MP_{jt} / MP_{it})} = \left(\frac{d\,\frac{X_{it}}{X_{jt}}}{d\,\frac{MP_{jt}}{MP_{it}}} \right) \left(\frac{\frac{MP_{jt}}{MP_{it}}}{\frac{X_{it}}{X_{jt}}} \right) \tag{7}$$

Appendix A shows the full derivation of the substitution elasticity formula from Equation 7 to Equation 8, which is the final formula used in this study.

$$\sigma_{ij} = \left[1 + \frac{-\beta_{ij} + \frac{\eta_i}{\eta_j}\beta_{jj}}{-\eta_i + \eta_j} \right]^{-1} \tag{8}$$

Interfuel elasticities of substitution were computed at the national level, as well as for its industrial, transport and agricultural sectors. Factors of production included in the model were labor (L), capital stock (K) and various energy inputs used in each sector. However, Pavelescu (2011) noted that the number of parameters “explodes” with the number of inputs included in the model leading to overparametrization. Given n inputs, the number of parameters that need to be estimated totaled to n(n+3)/2 if all inputs have translog components in the model. The problem is further aggravated by the tendency of the model to suffer from severe multicollinearity due to interaction and squared terms of the input variables. In the model proposed by Smyth, Narayan, and Shi (2010), the translog components for capital and labor and the substitution elasticities between these factors and energy inputs were not computed. This was done to lower the number of parameters to be estimated in the model and to focus only on interfuel elasticities of substitution. The same approach was employed in this study.

For this study, the energy inputs considered were diesel and heavy fuels (D_t); kerosene and kerosene – type jet fuels (Kr_t); and gasoline and other oil products (G_t). The production function model used for these sectors is specified as follows:

$$\begin{aligned}\ln Y_t &= \beta_0 + \beta_L \ln L + \beta_K \ln K + \beta_D \ln D_t + \beta_{Kr} \ln Kr_t + \beta_G \ln G_t \\ &+ \beta_{DKrO} \ln D_t \ln Kr_t + \beta_{DG} \ln D_t \ln G_t + \beta_{KrG} \ln Kr_t \ln G_t \\ &+ \beta_{DD}\left(\frac{1}{2}(\ln D_t)^2\right) + \beta_{KrKr}\left(\frac{1}{2}(\ln Kr_t)^2\right) + \beta_{GG}\left(\frac{1}{2}(\ln G_t)^2\right) + \mu_t\end{aligned} \tag{9}$$

Given the number of interaction terms and squared terms in Equation 9, the problem of severe multicollinearity is expected in estimating these models. In order to avoid omission of important variables in the model, the ridge regression method was used. Proposed by Hoerl and Kennard in 1970, the ridge regression is used to estimate models suffering from severe multicollinearity by accommodating some degree of bias in estimating the regression parameters. As cited in Al-Hassan and Al-Kassab (2009), the ridge regression parameters $\beta_i^{\wedge}$'s are estimated as follows:

$$\beta^{\wedge} = (X'X + kI)^{-1} X'Y \tag{10}$$

where k is the ridge parameter or the biasing parameter. In econometric literature, many ways have been proposed in order to search for the optimal value of the ridge parameter. This study used the ridge trace plot method, wherein coefficients are estimated with various levels of k from zero to one. $\beta_i^{\wedge}$ coefficients are then plotted with respect to the values of k where the optimal value being chosen at the point where $\beta_i^{\wedge}$ coefficients seem to have stabilized.

Annual time series data from various sources were used for estimating interfuel elasticities of substitution for the Philippine transport sector. Data on energy input use were taken from the United Nations’ (UN) Energy Statistics Database. All values were converted and expressed in terajoules (TJ) as the database provides a conversion factor from original units to TJ. The joule is an energy unit which is defined as the amount of “work done when a constant force of 1 Newton is exerted on a body with a mass of 1 gram to move it in a distance of 1 meter” (UN, 1987). One terajoule is equivalent to 10^{12} joules. The measure has been adopted by the UN Statistical Office.

Time series data for labor inputs were obtained from the Labor Statistics database of the International Labor Organization (ILO). Capital stock was estimated through the perpetual inventory method. Capital stock is estimated as follows:

$$K_t = K_{t-1} + (1-\delta)I_t \tag{11}$$

where I_t represents capital expenditures for the industry for the year or gross fixed capital formation in the case of the whole economy. The depreciation rate of capital is 0.1011 which was obtained from Cororaton and Cuenca (2001). Initial capital stock (K_0) was computed as follows:

$$K_0 = I_0 / (g + \delta) \tag{12}$$

where g represents the average growth rate of capital expenditures over the period of study. Data on capital expenditures were taken from the Annual Survey of Establishments (ASE), Annual Survey of Philippine Business and Industry (ASPBI), and Census of Philippine Business and Industry (CPBI) conducted by the National Statistics Office (NSO) for the manufacturing sector and the transport, storage, and communication sector. These were expressed in real 2005 prices by using the implicit price deflator index (2005=100) obtained from the International Monetary Fund (IMF). Total output of the transport sector is represented by its Gross Value Added expressed in 2005 prices and were also obtained from the National Accounts of Main Aggregates Database of the UN. The inclusive years for the data used in this study were from 1972-2008.

V. Results and Discussion

As discussed in Chapter 3, ridge regression is used due to the problem of severe multicollinearity in the translog production function models. The ridge parameters used were based on constructed ridge trace plots shown in Fig. 3. The ridge parameter (or ridge k-value) chosen was 0.25, the value where the coefficients have appeared to stabilize. Table 2 shows the results of the Ridge regression run.

Fig. 3. Ridge Trace Plot, Transport Sector Model

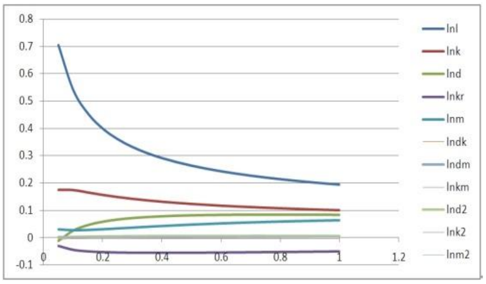


Table 3 shows the output elasticities for each energy input computed from the ridge regression. Negative output elasticities were obtained for diesel and kerosene due to the decreasing trend in the shares of these energy inputs over time as the output of the transport sector is increasing. This can also be explained by the phenomenon of fuel substitution seen in the trends in energy consumption (e.g., diesel replacing gasoline). Computed output elasticities were relatively stable for the years considered in the study.

Table 2. Ridge Regression Estimates

	TRANSPORT
lnL	0.3610978**
lnK	0.1491386**
lnD	0.0667299**
lnKr	-0.0532199*
lnG	0.033081
lnD*lnK	0.0026047
lnD*lnM	0.0034129**
lnK*lnM	-0.0032255
lnD2	0.0061662**
lnK2	-0.0037894
lnG2	0.0039359
Constant	12.03796**
Ridge k value	0.25
Adjusted R-squared	0.8755
F-value	24.0224**

Notes: 1. *significant at 5%.
2. **significant at 1%.

From the computed parameters and output elasticities, interfuel elasticities of substitution among the different oil products were obtained. Table 4 shows the estimated interfuel elasticities of substitution for each pair of energy inputs. All elasticity estimates are positive, implying that all oil products considered in the study are substitutes.

Most of the estimates were close to unity; hence, test of means was conducted to show if the mean estimates of the elasticities of substitution were similar or different from one. All of the tests reject the null hypothesis that the mean elasticity is equal to one at the 1% level of significance. Hence, strictly speaking, elasticities greater than unity imply relatively easy substitution between the pair of energy inputs.

On the average, the results imply relative ease in substituting; (1) diesel to kerosene (1.019); (2) diesel to gasoline (1.078) and; (3) kerosene to gasoline (1.022). The results seem to be consistent with the patterns of fuel switching/substitution found in the trends of energy input shares across the time period of study. Also, the study found no complementarities between the pairs of energy inputs considered.

Table 3. Output Elasticities, Transport Sector

p	Diesel	Kerosene	Gasoline
1972	0.194	-0.094	0.056
1973	0.194	-0.095	0.056
1974	0.193	-0.095	0.055
1975	0.191	-0.096	0.054
1976	0.192	-0.096	0.054
1977	0.193	-0.097	0.053
1978	0.194	-0.097	0.053
1979	0.194	-0.096	0.054
1980	0.194	-0.095	0.053
1981	0.195	-0.095	0.052
1982	0.196	-0.096	0.051
1983	0.194	-0.095	0.052
1984	0.194	-0.095	0.051
1985	0.194	-0.095	0.051
1986	0.194	-0.095	0.051
1987	0.194	-0.094	0.054
1988	0.197	-0.093	0.055
1989	0.197	-0.092	0.057
1990	0.198	-0.091	0.058
1991	0.198	-0.090	0.059
1992	0.199	-0.091	0.059
1993	0.200	-0.091	0.060
1994	0.202	-0.092	0.060
1995	0.203	-0.093	0.060
1996	0.205	-0.094	0.060
1997	0.206	-0.094	0.060
1998	0.206	-0.094	0.061
1999	0.206	-0.094	0.062
2000	0.207	-0.095	0.060
2001	0.207	-0.094	0.062
2002	0.207	-0.094	0.062
2003	0.206	-0.094	0.062
2004	0.207	-0.094	0.062
2005	0.206	-0.094	0.062
2006	0.206	-0.093	0.062
2007	0.202	-0.087	0.067
2008	0.205	-0.092	0.063
Average	0.199	-0.094	0.057

Ⅵ. Conclusions and Policy Implications

This study was conducted to estimate interfuel elasticities of substitution for the Philippine transport sector. Through the use of translog production functions and Ridge regression estimation, elasti-cities of substitution were obtained for different energy input pairs composed of diesel, gasoline and kerosene. All energy inputs included in the study were found to be substitutes with positive estimates of elasticities of substitution. Therefore, policies intended to promote increased use of alternative sources of energy can present opportunities, most especially with regards to the energy input pairs that were found to be highly substitutable.

Table 4. Interfuel Elasticities of Substitution, Transport Sector

YEAR	σDK	σDG	σKG
1972	1.018	1.080	1.023
1973	1.018	1.080	1.023
1974	1.018	1.082	1.024
1975	1.017	1.084	1.026
1976	1.018	1.084	1.026
1977	1.017	1.084	1.027
1978	1.017	1.084	1.027
1979	1.018	1.083	1.025
1980	1.018	1.084	1.026
1981	1.018	1.086	1.028
1982	1.018	1.088	1.029
1983	1.018	1.087	1.028
1984	1.018	1.088	1.029
1985	1.018	1.088	1.029
1986	1.018	1.087	1.029
1987	1.019	1.084	1.025
1988	1.019	1.082	1.024
1989	1.020	1.079	1.022
1990	1.020	1.077	1.020
1991	1.020	1.076	1.020
1992	1.020	1.075	1.019
1993	1.020	1.074	1.018
1994	1.020	1.075	1.019
1995	1.020	1.074	1.019
1996	1.019	1.074	1.019
1997	1.019	1.074	1.019
1998	1.019	1.073	1.018
1999	1.019	1.072	1.018
2000	1.019	1.074	1.019
2001	1.019	1.072	1.018
2002	1.019	1.072	1.018
2003	1.019	1.072	1.018
2004	1.019	1.072	1.018
2005	1.020	1.072	1.018
2006	1.020	1.072	1.018
2007	1.022	1.066	1.012
2008	1.020	1.071	1.017
Average	**1.019**	**1.078**	**1.022**

For example, diesel is considered to be more harmful to the environment when compared to gasoline and kerosene; hence, a tax on diesel could be an effective way of encouraging substitution away from diesel to other oil products in the transport and agricultural sectors. However, with the development of biodiesel, the policy could be reversed (i.e., subsidy provision for biodiesel) in order to promote the use of the more eco-friendly fuel. However, a switch from one energy source to another also requires a change in technology. This will entail higher capital expenditures on new machineries, engine upgrades, or new production equipment, among others, in order to accommodate the change in energy usage. Given the costs associated with this change, price-based or regulation policies alone may not be fully effective. Hence, strategies intended to minimize capital expenditures related to energy switching (e.g., capital subsidies, lower taxes on capital expenditures) should also be implemented in line with price-based policies.

As with most studies in developing countries, the unavailability of relevant data limits the scope and the methodology used in this study. The use of other approaches in estimating elasticities of substitution for energy inputs (e.g., translog cost function) could be done if price data for these inputs were available. However, time series data for energy prices seemed to be missing in the statistical accounts of the Philippines.

This study resorted to the use of ridge regression in estimating a translog production function in order to estimate interfuel elasticities of substitution. However, this method suffers from the fact that some degree of bias needs to be accepted in order to eliminate the problem of multicollinearity and the loss in efficiency in estimation due to the sheer number of parameters of the model. This also forced the author to lump energy inputs into groupings to lessen the number of parameters to be estimated. Hence, the estimates of this study need to be used with caution and should not be interpreted as absolute estimates of interfuel substitution elasticities.

The author recommends the use of other methods in estimating the elasticities of energy products considered in this study. For instance, one may opt to conduct a cross-section analysis of firms in estimating interfuel elasticities. Hence, time series data on prices would not be required. More studies concerning interfuel elasticities of substitution should be conducted to give policy makers, economic modelers and researchers more options and better estimates of these elasticities.

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Appendices

Derivation of the Elasticity of Substitution Formula

Equation 4 presents the translog production function as follows (Christensen, Jorgenson, and Lau 1973);

$$\ln Y_t = \ln \beta_0 + \sum_i \beta_i \ln X_{it} + \frac{1}{2} \sum_i \sum_j \beta_{ij} \ln X_{it} X_{jt} \tag{4}$$

from which output elasticities can be computed as follows;

$$\eta_{it} = \frac{\partial \ln Y_t}{\partial \ln X_{it}} = \beta_i + \sum_j \beta_{ij} \ln X_{jt} \tag{5}$$

It can also be shown that the formula for elasticity of substitution can be expressed in terms of marginal products assuming cost minimization among firms;

$$\sigma_{ij} = \frac{\%\Delta(X_{it} / X_{jt})}{\%\Delta(MP_{jt} / MP_{it})} = \left(\frac{d \dfrac{X_{it}}{X_{jt}}}{d \dfrac{MP_{jt}}{MP_{it}}} \right) \left(\frac{\dfrac{MP_{jt}}{MP_{it}}}{\dfrac{X_{it}}{X_{jt}}} \right) \tag{7}$$

One can also show that:

$$\frac{MP_{jt}}{MP_{it}} = \frac{\dfrac{\partial Y_t}{\partial X_{jt}}}{\dfrac{\partial Y_t}{\partial X_{it}}} = \frac{\eta_{jt}}{\eta_{it}} \frac{X_{it}}{X_{jt}} \tag{13}$$

Substituting Equation 13 into Equation 7, one can derive the following:

$$\sigma_{ij} = \frac{d\left(\dfrac{X_{it}}{X_{jt}}\right)}{d\left(\dfrac{MP_{jt}}{MP_{it}}\right)} \frac{\eta_{jt}}{\eta_{it}} = \frac{\eta_{jt}}{\eta_{it}} \left[\frac{d\left(\dfrac{\eta_{jt}}{\eta_{it}} \dfrac{X_{it}}{X_{jt}}\right)}{d\left(\dfrac{X_{it}}{X_{jt}}\right)} \right]^{-1} \tag{14}$$

One can also solve for the following derivatives and differentials:

$$\left[\frac{d\left(\dfrac{\eta_{jt}}{\eta_{it}} \dfrac{X_{it}}{X_{jt}}\right)}{d\left(\dfrac{X_{it}}{X_{jt}}\right)} \right] = \frac{\eta_{jt}}{\eta_{it}} + \frac{X_{it}}{X_{jt}} \left[\frac{d\left(\dfrac{\eta_{jt}}{\eta_{it}}\right)}{d\left(\dfrac{X_{it}}{X_{jt}}\right)} \right] \tag{15}$$

$$d\left(\frac{\eta_{jt}}{\eta_{it}}\right) = -\frac{\eta_{jt}}{\eta_{it}^{2}} d\eta_{it} + \frac{1}{\eta_{it}} d\eta_{jt} \tag{16}$$

$$d\left(\frac{X_{it}}{X_{jt}}\right) = -\frac{X_{it}}{X_{jt}^{2}} dX_{jt} + \frac{1}{X_{jt}} dX_{it} \tag{17}$$

$$\frac{d\left(\frac{\eta_{jt}}{\eta_{it}}\right)}{d\left(\frac{X_{it}}{X_{jt}}\right)} = \frac{-\frac{\eta_{jt}}{\eta_{it}^{2}} d\eta_{it} + \frac{1}{\eta_{it}} d\eta_{jt}}{-\frac{X_{it}}{X_{jt}^{2}} dX_{jt} + \frac{1}{X_{jt}} dX_{it}} = \frac{-\frac{\eta_{jt}}{\eta_{it}^{2}} \frac{d\eta_{it}}{dX_{jt}} + \frac{1}{\eta_{it}} \frac{d\eta_{jt}}{dX_{jt}}}{-\frac{X_{it}}{X_{jt}^{2}} + \frac{1}{X_{jt}} \frac{dX_{it}}{dX_{jt}}} \tag{18}$$

Combining Equations 14, 15, and 18 and solving for Equation 8;

$$\sigma_{ij} = \frac{d\left(\frac{X_{it}}{X_{jt}}\right)}{d\left(\frac{MP_{jt}}{MP_{it}}\right)} \frac{\eta_{jt}}{\eta_{it}} = \frac{\eta_{jt}}{\eta_{it}} \left[\frac{\eta_{jt}}{\eta_{it}} + \frac{X_{it}}{X_{jt}} \left[\frac{d\left(\frac{\eta_{jt}}{\eta_{it}}\right)}{d\left(\frac{X_{it}}{X_{jt}}\right)}\right]\right]^{-1} = \left[1 + \frac{\frac{X_{it}}{X_{jt}}}{\frac{\eta_{jt}}{\eta_{it}}} \left[\frac{d\left(\frac{\eta_{jt}}{\eta_{it}}\right)}{d\left(\frac{X_{it}}{X_{jt}}\right)}\right]\right]^{-1}$$

$$= \left[1 + \frac{\frac{X_{it}}{X_{jt}}}{\frac{\eta_{jt}}{\eta_{it}}} \left(\frac{-\frac{\eta_{jt}}{\eta_{it}^{2}} \frac{d\eta_{it}}{dX_{jt}} + \frac{1}{\eta_{it}} \frac{d\eta_{jt}}{dX_{jt}}}{-\frac{X_{it}}{X_{jt}^{2}} + \frac{1}{X_{jt}} \frac{dX_{it}}{dX_{jt}}}\right)\right]^{-1} = \left[1 + \left(\frac{-\frac{1}{\eta_{it}} \frac{d\eta_{it}}{dX_{jt}} + \frac{1}{\eta_{jt}} \frac{d\eta_{jt}}{dX_{jt}}}{-\frac{1}{X_{jt}} + \frac{1}{X_{it}} \frac{dX_{it}}{dX_{jt}}}\right)\right]^{-1}$$

from Equation 5, $\frac{d\eta_{it}}{dX_{jt}} = \beta_{ij} \frac{1}{X_{jt}}$ and $\frac{d\eta_{jt}}{dX_{jt}} = \beta_{jj} \frac{1}{X_{jt}}$, hence;

$$\sigma_{ij} = \left[1 + \left(\frac{-\frac{1}{\eta_{it}} \beta_{ij} \frac{1}{X_{jt}} + \frac{1}{\eta_{jt}} \beta_{jj} \frac{1}{X_{jt}}}{-\frac{1}{X_{jt}} + \frac{1}{X_{it}} \frac{dX_{it}}{dX_{jt}}}\right)\right]^{-1} = \left[1 + \frac{\frac{1}{X_{jt}}}{\frac{1}{X_{jt}}} \left(\frac{-\frac{1}{\eta_{it}} \beta_{ij} + \frac{1}{\eta_{jt}} \beta_{jj}}{-1 + \frac{X_{jt}}{X_{it}} \frac{dX_{it}}{dX_{jt}}}\right)\right]^{-1}$$

Since $\frac{dX_{it}}{dX_{jt}} = \frac{\frac{dY_t}{dX_{jt}}}{\frac{dY_t}{dX_{it}}} = \frac{MP_{jt}}{MP_{it}}$, then $\frac{X_{jt}}{X_{it}} \frac{dX_{it}}{dX_{jt}} = \frac{X_{jt}}{X_{it}} \frac{MP_{jt}}{MP_{it}} = \frac{\eta_{jt}}{\eta_{it}}$ from Equation 22. Hence;

$$\sigma_{ij} = \left[1 + \left(\frac{-\frac{1}{\eta_{it}} \beta_{ij} + \frac{1}{\eta_{jt}} \beta_{jj}}{-1 + \frac{\eta_{jt}}{\eta_{it}}}\right)\right]^{-1} = \left[1 + \left(\frac{-\frac{1}{\eta_{it}} \beta_{ij} + \frac{1}{\eta_{jt}} \beta_{jj}}{\frac{-\eta_{it} + \eta_{jt}}{\eta_{it}}}\right)\right]^{-1} = \left[1 + \left(\frac{-\frac{\eta_{it}}{\eta_{it}} \beta_{ij} + \frac{\eta_{it}}{\eta_{jt}} \beta_{jj}}{-\eta_{it} + \eta_{jt}}\right)\right]^{-1}$$

From here, the formula for elasticity of substitution used in this study (Equation 8) is:

$$\sigma_{ij} = \left[1 + \frac{-\beta_{ij} + \frac{\eta_{it}}{\eta_{jt}} \beta_{jj}}{-\eta_{it} + \eta_{jt}}\right]^{-1} \tag{8}$$

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An Attempt to Demonstrate Business Domain Extension through Extension of Technology Usage

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ABSTRACT

Firms try to acquire new sources of revenue to operate sustainable management of the company. On occasion, there is a proposal that is not consistent with the existing business domain. This makes it possible to match it to the business by making a company decision to extend the business domain. This is obtained by searching for factors for configuring hypotheses on the basis of this consideration and then demonstrated.

Keywords: business domain extension, FUJIFILM Holdings, KODAK, strategy- behavior, technology-usage, uncertainty of technology

Ⅰ. Introduction

In recent years, the business environment surrounding companies has been rapidly changing through diversification and globalization of markets and the development of science. This change can be an increasing threat in existing businesses that firms can enter from different industry, an axis of competition will change product advantage. On the other hand, a firm's business will decline in any period according to the product life cycle. Creation of new products and services is essential for companies to have sustainability in this environment. Firms invest in R & D in order to build new products and services. Firms also improve the performance of existing products through this R & D investment and become more competitive (Cristensen, 1997). This competition is intense, and not be able to recover the R & D investment. Therefore, firms take action to try to shape the market or find a market wherein competition is not relatively violent. If used in other departments, "technology developed" and "experience gained in operation of existing business", it is possible for firms to reduce the burden of investment in R & D development. However, this "experience", and "usage of Technology (Usage)", although it is possible to widen the operating range, it is not possible to divert technology without the firm using it. Decision-making may be required for firm to use. This decision is necessary to create new revenue streams, not only the performance of existing businesses.

Ⅱ. Environmental Changes in the Film Industry

Photographic film is one of the products in a decline stage due to changes in technology in recent years. The digital camera is more convenient than the film camera. With the advent of the digital camera, film camera market was reduced. Along with this, photographic film market, which is the storage medium of film camera, was also was reduced. Photographic film manufacturers tried to react to changes in the predicted decline in the market. However, response to change is often divided into impossible firm and possible firm. Therefore, it is possible to consider a comparison with Kodak and FUJI, both leading in photographic film. In this study, we present a hypothesis on the basis of this discussion.

Ⅲ. Case of Fujifilm

In an environment of technological change, Fujifilm changed the firm’s business structure. Fujifilm decided to redefine its business domain at this time. Fujifilm has redefined the business domain to “Science for life” from “Information and video” for the existing business domain. This redefinition proposed R & D departments and a relationship with life’s science have a significant impact. Proposed R & D department technology was to be used in other markets. It was proposed to use the technology in other markets that the R & D departments of Fujifilm had cultivated as net sales of photographic films reduced since 2000 (Nagai, 2010: p.199). This was proposed for use in cosmetics business techniques to develop photographic film.

Further, Fujifilm has points of contact with the healthcare industry (Shinohara, 2013: p.114). Fujifilm had been producing a medical film and medical instruments. This had relevance to the healthcare industry. This was taken into account when the point of contact with the medical industry and proposals for this cosmetics business to redefine its business domain; diversification could be the “life” relationship. Because there was point of contact with the medical industry and proposals for this cosmetics business, it was possible for diversification in “Life” relevant to be able to be considered when redefining the business domain.

Ⅳ. Case of KODAK

When Fujifilm did the redefinition of the domain, Kodak made a selection and focus. Kodak made a selection and focus of business in the printing-related business. Kodak also had relevance to the healthcare industry; it was impossible to redefine of the business domain. Kodak was invested in R & D and markets for professional business and the market of solutions for system improvement. It was not possible to demonstrate the competitive advantage in the product, because there were a lot of competitors already in the market. As a result, Kodak, went bankrupt in 2012, and it presented a disclosure statement and restructure plan in 2013.

Table 1. Compare Sales Figs. of Kodak and Fujifilm

(Unit: Billions of Yen)

KODAK (year) Business Segment	2001	2005	2010	2012
Photography	9403			
D&FIS		8460		
Consumer Digital Imaging Group			2739	
Film, Photofinishing and Entertainment Group			1767	※
Graphic Communications Group		2990	2681	
Commercial Imaging	1459			
Health imaging	2262	2655		
All Other	110	163		
Fujifilm (year) Business Segment	**2001**	**2005**	**2010**	**2012**
Imaging Solutions	7846	6895	3258	2948
Information Solutions	6853	8774	9174	9077
Document Solutions	9312	11007	9739	10121

Note: It is submission of disclosure statement and restructuring plan.

Table 2. R & D Cost Ratio Sales by Business Segment in Fujifilm

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Imaging Solutions	5.34	5.37	5.64	4.74	3.56	3.10	3.49	3.93	2.32	2.22	2.37
Information Solutions	5.69	6.03	7.08	7.74	7.50	8.43	10.18	9.74	7.60	8.66	7.82
Document Solutions	7.74	8.49	7.06	7.41	6.82	6.48	7.46	7.89	6.72	6.51	6.26
All businesssales & All businessR & Dcost ratio	6.35	6.77	6.65	6.83	6.36	6.59	7.85	8.03	6.43	6.75	6.38

Notes: 1. Created report from author retouched securities of Fujifilm Holdings.
2. R & D cost ratio sales by Business Segment = R&D costs for each business sector÷sales for each business sector×100.
3. Ratio of sales of each business sector = sales of each business sector÷sales of all business sector×100.
4. Innovation Solutions, Information Solutions, Document Solutions is a business segment since 2001, Fuji Film.

Each business product is as follows:

a. Imaging Solutions: Color films, digital cameras, photofinishing equipment, Color paper for printing Photography, Chemical, Services, etc.

b. Information Solutions: Medical Systems and Life Sciences materials, Graphics system equipment, Flat panel display materials, Media, Optical devices, Electronic materials, Inkjet Materials, etc.

c. Document Solutions: Office copiers and MFP, Printer, Related Products Production Services, The paper, Consumables, Office Services, etc.

Ⅴ. Differences in Strategy for the Two Firms

Differences in corporate strategy of the two firms are due to redefinition of the business domain. Due to differences in business domain, Fujifilm performed diversification; Kodak performed selection and focus. As a result, as seen in Table 1, net sales decreased in 2010 and Kodak, went bankrupt in 2012. On the other hand, Fujifilm net sales were concentrated in imaging solution upon transition to Information Solutions. Fujifilm invested in the R & D Information Solutions department at this time. From the time it announced a medium-term management plan in 2004, R & D investment ratio was above the average ratio of a firm (Table 2). It is necessary to consider the factors that determine business domain.

Ⅵ. Definition of Business Domain

According to Levitt (1960), corporate domain definition is to be defined by customer applications. In addition, according to Abell (1980), business domain is conFig.d by customer segment, customer function, and alternative technology. It is possible to grasp the degree differentiated by this component. According to Sakakibara (1992), a spread of “Business areas”, “business development” and “meaning of business subject” are required. Other words, it is possible to set up a business domain based on customer usage, though the spread is important. Further, there is a need to be redefined as necessary business domain is discussed. However, any research on business domain these about what the spread of business domain is is not discussed.

Ⅶ. Empirical Studies on the Definition of a Business Domain

In addition to this, empirical studies have also been carried out a number of times on the definition of the business domain. First, according to Jatinder (2004), on the definition of business domain, direct development of innovative products, a strategic long-term plan and expressing a business domain correlated with results of company that have been recognized. In addition, according to Wakabayashi & Osada (2007a), there has been a confirmed correlation between

"Definition of the business domain by customer applications" and "Corporate performance".

In addition, according to Wakabayashi & Osada (2007b), high growth potential has a high matching degree between "business domain and products and services" and "definition of business domain and customer usage". However, the cause of change in definition of business domain has not been studied. Wakabayashi & Osada (2007a) above is empirical research, and we have discussed Sakakibara's (1992) business domain definition axis, but there are not not results to demonstrate.

Ⅷ. Factors Involved in Redefinition of Business Domain

In this paper, we try to build a hypothesis on the basis of following discussion and arrangement of these previous studies. There are two affecting redefinition of the business domain. The first is a proposal for R & D departments. There was a suggestion for R & D departments during the launch of the cosmetics business in Fujifilm, but it could not be commercialized (Nagai, 2010). Then, the cosmetics business unit became possible by redefinition of business domain. Therefore, it is considered that redefinition of a business domain is necessary to consider proposals from R & D. The second is a request for business departments. Business units must request a new earnings base different from existing business operations. Demand for a new earnings base has been a sense of crisis business sector which is increasing in Fujifilm due to lower performance.

Accordingly, it is intended to redefine the definition of a business domain in an existing business. Therefore, proposals for R & D departments and requests for business departments are performed. For example, proposals for R & D department should have profitability, or firms will reject a proposal if there is no redefinition of business domain. On the other hand, if it is not possible to commercialize a request from the business department if there is no suggestion in the R & D department. Therefore, proposals for R & D departments and requests for business departments are required at the same time when redefining of business domain.

A business is able to respond to changes in the environment by performing a redefinition of business domain, but taking into account all of the environmental changes that may occur in the future is a difficult business. Furthermore, even if there is a proposal from an R & D department and a business unit that produces a need for the redefinition of business domain, it must be performed at the corporate level. When redefining the actual business domain, it is necessary to factor in involvement of top management, the involvement of officer, and funds necessary to reform.

Ⅸ. Involvement of "Top", "Directors" and "Other" Factors

In the redefinition of the business domain, decision-making by directors and top management is required. Decision-making by top management is necessary for redefinition of the business domain. Top management is responsible for decision-making, considering the survival and success of the organization and balancing the current and future business (Drucker, 1973, 1974). Upon assembling a vision for a business domain, top management must perform organizing and decisions necessary for achievement. This includes problems of how to realize the seeds of diversification that have occurred within the firm. Directors support, review and help external relations for top management (Drucker, 1973, 1974). Directors have the ability to review and support business initiatives, decision-making, and reorganization undertaken by top management.

In other words, there is a sense of crisis from changes in the competitive environment of the firm, and they try to respond to this change. Thus, "support of Directors" and "performance of top management" is an important factor in the redefinition of the business domain. In addition, redefinition of the business domain requires a reform of the structure. It must be as innovative a business as possible at this time. Then, by having expertise about an industry in top management, they can perform sustainable management of firm as possible during the redefinition of a domain.

Ⅹ. Hypotheses Presented

We present the hypotheses, such as the following, through the above discussion:

H1: Uncertainty in the company increases uncertainty as the technology increases.

H2: A proposal of diversion of technology in the research and development sector will increase uncertainty as technology increases.

H3: Uncertainty in the company as uncertainty in the market increases.

H4: The structural reform of top management increases uncertainty as the company increases.

H5: Support for structural reform of executives growing uncertainty in the company increases.

H6: Requests of new revenue bases in a business sector will increase uncertainty as the company increases.

H7: Proposal of diversion of technology in research and development sector will increase uncertainty as the company might increase.

H8: Business domain requests for a new revenue base as the business sector increases.

H9: Business domain is proposed diversions of technology in R & D increases.

H10: Business domain becomes wider through the will of structural as reform of top management grows.

H11: Business domain gives wider support for the structural reform of the officers.

H12: Business domain becomes wider as structural reforms create high ability to execute.

H13: Business domain becomes wider if expertise of top management is high.

In these hypotheses, it is necessary to use an analysis of covariance structure because it is not observable directly.

Ⅺ. Conclusion

In this paper, we present the hypotheses that, with respect to redefinition of business domain, compare actual firm behavior in summary. In addition, we have extracted the concepts necessary to perform an empirical analysis of the hypotheses. In the future, it will be necessary to create a more concrete rather than an abstract concept for demonstration.

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Exploring the Market Opportunities for a Philippine Biotechnology Product: The Case of a Coconut-based Plant Growth Regulator

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ABSTRACT

Cocogro is an organic plant growth regulator (PGR) or promoter that is derived from coconut water or milk. Despite being available on the market since 1996, Cocogro remains to be little known even to the locals of Los Baños, where BIOTECH is located. This study was conducted to explore potential for the market of Cocogro among field-cut flowers and ornamental growers in Los Baños and Calamba, two towns in the province of Laguna which are located in the Philippines. Data on the respondents' demographic and farm enterprise profile, level of awareness on plant growth regulators (PGRs) and their buying and usage behavior were analyzed using descriptive statistics. The Chi-square test, Pearson correlation and the market build-up method were also utilized. PGRs were found to be associated by the respondents with other terms such as 'growth stimulant', 'growth promoter', or 'root booster' among ornamental growers and 'phytohormones' among field-cut flower growers. Field-cut flower growers used PGRs on a seasonal basis while ornamental growers used PGRs all throughout the year. There were significant relationships found to exist between the decision to buy PGRs and two variables; the size of production area and the age of respondents. It is recommended that the product and the process involved in manufacturing the product still be further refined.

Keywords: Cocogro, field cutflowers, market potential, organic PGR, ornamentals, plant growth regulators (PGRs).

Ⅰ. Introduction

Since the 1970s, coconut waste water has always been a problem for companies which rely heavily on coconuts. This problem becomes more apparent with the obnoxious smell the waste creates when it ferments. Most coconut-based product processors choose to dump these wastes in rivers instead of opting to build water treatment facilities or transform coconut waste water to marketable products. It was not until 1988 when an innovative use for coconut water was made public by a group of researchers in BIOTECH-UPLB (National Institute of Molecular Biology and Biotechnology, University of the Philippines Los Baños), headed by Dr. Juanita Mamaril.

Dr. Mamaril had devised in the 1970's a process or technology that separates the growth hormone from coconut waste water. The growth hormone extracted from this process has since been called Cocogro. Cocogro is an organic plant growth regulator or promoter that is derived from coconut water or milk. These growth substances were identified as a mixture of hormones such as indole acetic acid (IAA), kinetin, gibberellic acid, abscisic acid and 1, 3-diphenylurea (del Rosario et al., 1986; Mamaril et al., 1988 as cited by del Rosario et al., 2005). Several experiments in the past had proven Cocogro to be quite effective in the rooting of Vanda species and the growth of sweet peppers.

Plant growth regulators (PGRs) or plant growth hormones (also called "phytohormones") are either natural or synthetic compounds that can influence the growth of plants. These compounds are produced naturally in small amounts in plants and may promote, inhibit or quantitatively and/or qualitatively modify plant growth and development. These hormones can induce cell elongation, cell division, cell differentiation, seed dormancy, germination, flowering and fruiting in plants. PGRs are currently being used to speed up growth of plants, initiate rooting of cuttings, and induce germination of seeds, delay ripening or ageing, and improve production.

Since 1996, BIOTECH-UPLB has been producing Cocogro on a laboratory scale and selling it to walk-in customers. However, despite more than a decade of existence, Cocogro is only known to very few people and it still remains unknown even to the locals of Los Baños where BIOTECH-UPLB is located.

Along with the retirement of Dr. Mamaril in 1997, studies for Cocogro have been discontinued. Production of the Cocogro was stopped until 2004, when the product was again made available in BIOTECH-UPLB. In 2008, the patent for Cocogro was withdrawn and BIOTECH-UPLB again continued its research and development activities on Cocogro under a different project leader, Dr. Lorele Trinidad, working with a colleague, Dr. Veronica Migo. The project team's aim now is to refine the process of production by controlling quality and content of the product, as well as setting up the technology for large scale production. They also intend to extend the use of Cocogro to other crops such as vegetables, fruit trees, rice and corn by conducting field experiments.

Cocogro may also help the country reduce its dependence on synthetic and imported growth regulators. From 2003 to 2005 the Philippines had, on average, imported chemicals such as pesticides, anti-sprouting products, PGRs and other similar products, mostly from China, amounting to \$90,555,667. This fact suggests that there may be market opportunities for a cheaper and environmentally-safer growth regulator derived from locally-available raw materials.

Despite the value proposition presented by this technology, it is important to find out if this product innovation can be marketable. This study aims to explore the market opportunities for a Philippine biotechnology product, Cocogro. Specifically, it attempts to: 1) describe the current and target users' demographic, farm enterprise profile and their awareness, buying and usage behavior and attitude towards PGRs; 2) assess the market potential of the product; and 3) formulate market development and/or product development strategies for Cocogro.

Ⅱ. Methodology

Ornamental growers in Los Baños and Calamba, Laguna were the focus of this study as: 1) Laguna happens to be among the top producers of ornamental plants from foliage to flowers; 2) the ornamental industry is known to use PGRs extensively in their production, and 3) the two areas mentioned are located near the Cocogro production site (i.e., BIOTECH-UPLB).

This study made use of descriptive analyses - consumer and market surveys (i.e., Usage, Attitude and Image (UAI) survey), Focus Group Discussion (FGD), store checks and a business market survey to determine the respondents' demographic and farm enterprise profile, which includes: their awareness, buying and usage behavior and attitude towards PGRs and the market-related problems and opportunities facing Cocogro. The data was analyzed using descripttive statistics, specifically: frequency counts, percentages, mean rating, ranking and cross-tabulation analysis. Further, chi-square tests and the Pearson correlation were utilized to determine the variables which could be associated with the decision to buy PGRs among the respondents.

The market build-up method was also used to estimate the market potential in the towns of Los Baños and Calamba. The method calls for identifying all the potential buyers in each market and estimating their potential purchases.

Forty-nine respondents from Calamba and Los Baños were interviewed for the survey: 39 from Los Baños and 10 from Calamba. Meanwhile, six distributors were interviewed for this survey: two in Los Baños and four in Calamba. Store checks were also conducted among agricultural supply shops and other commercial stores such as supermarkets and hardware stores.

Field-cut flower growers were identified using a list taken from the Los Baños Municipal Agriculture Offices (MAO) and through referrals from key informants, while ornamental growers were identified through the snowball method and also through referrals from key informants.

Secondary data were gathered from government agencies and institutions such as the University of the Philippines Los Baños (UPLB), the Department of Agriculture (DA), the Philippine Council for Agriculture, Forestry, the Natural Resources Research and Development (PCAARRD), the Fertilizer and Pesticide Authority (FPA) and municipal offices for local statistics.

Ⅲ. Results and Discussion

Data were collected in the towns of Los Baños and Calamba, Laguna in the Philippines from August to September 2008. The respondents in the study were categorized into two groups: the field-cut flower growers who grew crops such as asters, azucena and gladiolus, and the ornamental growers who grew a variety of live plants, from orchids to foliage plants. All of the 25 field-cut flower growers interviewed were from Los Baños; the 24 ornamental growers interviewed came from Los Baños (14) and Calamba (10) (Table 1).

Table 1. Distribution of Respondents Based on Location and Ornamentals Grown

TYPE OF ORNAMENTAL GROWN	LOS BAÑOS		CALAMBA			
	No. of Respondents	%	No. of Respondents	%	Total Respondents	%
Field-cut flowers	25	64.10	-	-	25	51.02
Orchids and various ornamental plants	14	35.90	10	100	24	48.98
TOTAL	39	100	10	100	49	100

3.1. Demographic and Farm Enterprise Profile of Respondents

From Table 2, it can be seen that a majority of the respondents were male. The average age of all the respondents from both towns was 50 years old. The oldest respondent was 79 and the youngest, 29. For the field-cut flower growers in Los Baños, the average age was 49 years old. On the other hand, the ornamental growers from both Los Baños and Calamba had an average age of 55.

A majority of the respondents, particularly the ornamental plant growers, possessed a college degree. Some of the ornamental growers were formerly hobbyists who later on converted their small-scale production ventures into commercial-scale level undertakings. The field-cut flower growers, on the other hand, claimed that they were in the business as a result of following in the footsteps of their parents.

Most of the respondents were not members of cooperatives. However, there was one cooperative in Barangay Bayog which supplied the field-cut flower growers there with GA3. Most of the respondents get their information about PGRs and other growth-promoting products from other growers. Other organizations cited where the growers were affiliated with were the Los Baños Orchid Society and the Philippine Orchid Society, both organizations for ornamental growers.

Some of the field-cut flower growers had other non-farm sources of income such as tricycle driving, landscaping, and contract working. On the other hand, a majority of the respondents relied mostly on ornamental growing as their main source of income.

Table 2. Demographic Profile of the Respondents

SOCIO- DEMOGRAPHIC VARIABLES	CATEGORIES/ RANGES	NO. OF RESPONDENTS	%
Gender	Male	30	61.220
	Female	19	38.780
	Total	49	100.000
Age	20-29	1	2.040
	30-39	8	16.330
	40-49	17	34.690
	50-59	11	22.450
	60-69	6	12.245
	70+	6	12.245
	Total	49	100.000
Educational Attainment	Elementary	14	28.570
	High School	9	18.370
	College	23	46.940
	Agriculture or related course	6	
	Unrelated to agriculture	17	
	Vocational	3	6.120
	Total	49	100.000
Coop/Organization Membership	Non-Member	40	81.630
	Member	9	18.370
	Total	49	100.000
Other Sources of Income	Flower vendors	2	
	Tricycle drivers	2	
	Barangay officials	3	
	Cable engineer	1	
	Networker	1	
	Landscape designer	2	
	Institutional workers	2	
	Delicacy vendor	1	
	Total	14	
Ornamentals Grown	Field-cut flower	25	51.020
	Assorted Ornamentals	24	48.980
	Total	49	100.000

Source: Field Survey (2008).

Table 3 presents the farm enterprise profile of the respondents. The overall average length of business existence of all respondents was 19 years. However, the average length in business of the field-cut flower growers was a little longer, 21 years, than that of the ornamental growers (18 years).

The overall average farms size of the respondents was 0.225 hectare, with field-cut flower growers having an average of 0.317 ha and potted ornamental growers, 0.130 ha. Most of those who grew field-cut flowers rented their farm at a cost of Php1,000-2,500 per year per pilapil – an area corresponding to the size of a rice paddy in the Philippines. The size of a pilapil is roughly 600 square meters. In contrast, for the ornamental plant growers, the area of production was not a definite determining factor of volume of production.

The average monthly income derived from the business of all respondents was Php18,294.60. The highest monthly income recorded was Php100,000 (for ornementals) and the lowest, Php580 (for field cutflower). It was noted that there was a large difference in the monthly income among field-cut flower and ornamental growers, the average field-cut flower was Php7,403.20 and ornamentals, Php35,312. This could be attributed mainly to the difference in value of the crops and varieties they produced. Further, cut flowers are seasonal in demand and thus fluctuations in prices occur. Also, as cited earlier, some of the field-cut flower growers had other non-farm sources of income such as tricycle driving, landscaping, and contract working and were perhaps therefore already content, even with their not-so-high profit from their farm enterprise.

Table 3. Farm Enterprise Profile of the Respondents

VARIABLE	TYPE	MEAN	S.D.	MIN.	MAX.
Years in Business	Field-cut flowers	21 yrs.	12.69	3 yrs.	50 yrs.
	Ornamentals	18 yrs.	12.50	1 yrs.	40 yrs.
	Overall	19 yrs.	12.52	1 yrs.	50 yrs.
Size of Production Area	Field-cut flowers	0.317 ha	0.307	0.003 ha	1.000 ha
	Ornamentals	0.130 ha	0.158	0.005 ha	0.600 ha
	Overall	0.225 ha	0.261	0.003 ha	1.000 ha
Monthly Income	Field-cut flowers	P7,403.20	6,320.53	P580	P21,000
	Ornamentals	P35,312.50	38,467.25	P1,000	P100,000
	Overall	P18,294.63	27,728.16	P580	P100,000

Source: Field Survey (2008).

3.2. Awareness, Buying and Usage Behavior and Attitude towards PGRs

A majority of the respondents in both towns claimed to be aware of plant growth regulators available in the market (Tables 4 and 5). Awareness of the product includes basic knowledge about the generic term for the product, the product's use and purpose, as well as its existence in the market. Product awareness is expected to be associated with the buying decision of current and potential users.

PGRs were found to be associated by the respondents with other labels such as 'growth stimulant', 'growth promoter', or 'root booster' among ornamental growers and 'phytohormones' among field-cut flower growers. As for the growers' source of information about PGRs, it was mainly primary reference groups such as other growers, friends, relatives and acquaintances for the field-cut flower growers, whereas among assorted ornamental growers, it was the media and garden shows.

Similarly, a majority of the respondents from both categories claim to be aware of organic PGRs on the market. The main source of information of the cut flower growers was the media. On the other hand, for ornamental growers, it was their primary reference groups and garden shows.

Based on the chi-square test conducted between awareness of PGR versus buying decision (i.e., user or non-user), there exists a significant relationship between the two variables (Table 6). The Pearson correlation test result validates the existence of a positive correlation between the two variables. This suggests that if the grower is aware of the existence of PGRs, then he/she is more likely to buy and use the product.

Table 4. Respondents' Awareness of Plant Growth Regulators in Los Baños

AWARENESS OF PGRs	FIELD-CUT FLOWERS		ORCHIDS & ASSORTED ORNAMENTALS		OVERALL	
	No. of Respondents	%	No. of Respondents	%	TOTAL RESPONDENTS	%
Aware	14	56	12	85.71	26	66.67
Unaware	11	44	2	14.29	13	33.33
Total	**25**	**100**	**14**	**100**	**39**	**100**

Table 5. Respondents' Awareness of Plant Growth Regulators in Calamba

AWARENESS OF PGRs	ORCHIDS & POTTED ORNAMENTALS	
	No. of Respondents	%
Aware	8	80
Unaware	2	20
Total	**10**	**100**

Table 6. Summary of Chi-square Results for Awareness of PGR vs. Buying Decision

CATEGORY	CHI-VALUE
Cutflower (LB)	14.313*
Ornamental (LB)	4.200*
Ornamentals (LB and Calamba)	2.274
Calamba	0.985
Los Baños	17.55*
Overall	12.690*

Note: Degree of dependence = 1, Level of significance = 0.05, X2 = 3.841, *significant.

Out of the 49 respondents, 27 were users of flowering or rooting PGRs. Those who claimed not to use these reasoned that: (1) PGRs are an added cost; (2) they lack knowledge about the chemical, and (3) they have tried using it but found it to be ineffective for their crops. Others who reported not using PGRs cited health concerns as their main reason for not using them.

From the store check results, the PGR brand most available among the farm supply shops was ANAA, which was produced by the company Philor, or Philippine Orchard Corp. The brand was also the most commonly-known and frequently-bought rooting PGR, according to the distributors. The next most popular product was Hormex, which was also a rooting PGR. The common marketing strategy utilized by suppliers of growth regulators was the distribution of samples and brochures among agrichemical stores, as well as field demonstration sites.

There are five major types of PGR in the market, namely: *auxin* (IAA) for root and shoot development; *gibberellins* (GA) for cell or stem elongation; *cytokinins* (Ck) for shoot formation; *ethylene* for ripening; and *abscisic acid* for leaf shedding and inhibiting growth.

Those who use PGRs cited two main purposes for their using the product. Field-cut flowers, aside from their application of GA3, use PGRs to induce and hasten flowering of the crops. Cut flower growers in Los Baños also usually use the cocktail brand Turton, a mixture of liquid fertilizer and PGRs, to promote flowering. Meanwhile, the ornamental growers use

PGRs to initiate the rooting of planting materials; more specifically, they use growth regulators to decrease the mortality rate among newly-planted ornamentals. For this purpose, auxin-based brands such as ANAA and Hormex were used. The most commonly-known PGR brand for rooting was Philor's ANAA. Many of the ornamental growers who propagated varied ornamenttal plants used it as their primary brand. The respondents cited that their current brands gave quick results, were affordable and were easy to use.

Most of the respondents surveyed were aware of the risk involved in using the product. A majority of them therefore tended to be hesitant to try out new products. They claimed they would only venture to try a product if they saw for themselves that the product was effective, or whenever they would hear credible testimonials about it from other growers.

A majority of the respondents in Los Baños purchase their PGRs from farm supply shops. Aster growers cited the Bayog Cooperative as their main source of GA3. On the other hand, the ornamental growers in Los Baños and Calamba purchased their brands from farm supplies shops and other ornamental growers.

Field-cut flower growers purchase PGRs one to two times a year during peak production season. Ornamental growers, meanwhile, usually purchase two to six times a year, depending on the level of production or the type of ornamental produced. In general, the usage of PGRs among field-cut flower growers appeared to be seasonal while ornamental growers used PGRs all throughout the year.

Price emerged to be the most important concern among all the attributes of PGR for both locations and ornamental types. Since growth regulators were perceived as merely fertilizer supplements, it was a product that they considered they could do without. They felt that growth regulators could be easily substituted with fertilizers as the latter promised the same results, that is, fast rooting and speedy growth. The next most important attribute for field-cut flower growers in Los Baños was the concentration. A higher concentration for them denoted a lower cost per usage.

This was found to be one of the weaknesses of Cocogro. Based on the cost-volume comparison of other PGR brands versus Cocogro, the latter proved to have the highest cost per usage among the brands for both shooting and rooting purposes (Tables 7 and 8). This implies that using Cocogro would be more expensive than using other brands in the market.

Table 7. Cost per Liter of Usage of Prominent Brands for Rooting versus Cocogro

BRAND	RATE OF USAGE	PRICE/VOLUME	COST OF PGR BRANDS PER LITER OF WATER USED
ANAA (Philor)	4 tbsp per gallon (60ml per 3.8 L)	P250/1 liter	P3.95
Hormex	10ml per gallon (gallon= 3.8 L)	P600/500ml	P3.16
Cocogro	50-100ml per liter (ave. 75ml)	P500/1 liter	P37.50

Source: Field Survey (2008).

Table 8. Cost per Liter of Usage of Prominent Brands for Shooting versus Cocogro

BRAND	RATE OF USAGE	PRICE/VOLUME	COST OF PGR BRANDS PER LITER OF WATER USED
Turton	1 sprayer = 16 L = 100ml Turton	P240/1 liter	P1.5
Cocogro	10ml per liter	P500/1 liter	P5.00

Source: Field Survey (2008).

3.3. Variables Associated with Buying Decision

When chi-square and Pearson correlation tests were done to determine the variables which could be associated with the decision to buy PGRs, the results revealed that there was a significant relationship between buying decision of respondents and size of production area (Table 9), as well as buying decision and age of respondents (Table 10). However, there was a negative correlation found between buying decision and size of production area based on the Pearson correlation test. This finding suggests that as the farm size increases, the likelihood of them to use PGR diminishes. One of the possible explanations for this is that the cost of production also rises as the size of production increases. To cut costs, these farmers forfeit their use of PGRs and substitute it with fertilizer brands or other methods. On the other hand, a positive relationship was seen from buying decision and age of respondents. This finding indicates that the older the grower, the more likely he/she will use PGRs. This can be attributed to age being also an indicator of years of experience. As growers become older (and more experienced through time), the more likely that they have heard or come across PGRs and the more likely they have used it. There was no significant relationship found between buying decision and educational attainment, as well as with buying decision and years in business.

Table 9. Summary of Chi-test Results for Size of Production Area vs. Buying Decision

CATEGORY	CHI-VALUE
Cut flowers	7.187
Ornamentals (LB)	0.389
Ornamentals (LB and Calamba)	1.536
Calamba	5.312
Los Baños	5.637
Overall	**8.074***

Note: Dependence level = 3, level of significance = 0.05, X^2 = 7.815, *significant.

Table 10. Summary of Chi-test Results for Age versus Buying Decision

CATEGORY	CHI-VALUE
Cut flowers (LB)	8.974
Ornamentals (LB)	6.741
Ornamentals (LB and Calamba)	21.570*
Calamba	5.313
Los Baños	9.015
Overall	14.140*

Note: Dependence level = 5, level of significance = 0.05, X^2 = 11.07, *significant.

3.4. Market Potential of Cocogro

A computation of the market potential for each of the market segments based on type of ornamentals grown was done. The market potential of Cocogro for field-cut flower in Los Baños can be established using the area of land devoted to cut flowers. A total of 115 hectares as of 2008 was devoted to aster and azucena production. Based on this, the potential market for Cocogro can be calculated by considering the amount of Cocogro that can be used on a given area of land. The method used in determining the market potential of the product is called the market build-up method.

For a liter of water, 10 ml of Cocogro is needed. For one sprayer that has a capacity of 16 liters, which is sufficient or a 600m2 of land, 160 ml of Cocogro is required. Based on this, the potential demand for Cocogro can be derived. A hectare of land (which is equal to 10,000 m2) divided by 600m2 results in 16.67. The total number of hectares of land devoted to cut flowers can then be used to get the total annual amount of Cocogro required in Los Baños. The final computation will also consider the assumption that the farmers use growth regulators twice a year and twice per cropping. Further, the current concentration and rate of usage of the product will also be used in the final computation. The market potential for field cut flowers was therefore computed to be 600ml x 16.67 x 115 ha = 1,150, 230 ml or 1,150.23 L of Cocogro x 2 per cropping x 2 times a year = 4,600 liters of Cocogro per year.

On the other hand, an estimate of the demand for Cocogro among the ornamental growers from Los Baños can be made by subtracting the number of growers in the barangays or areas within the town of Los Baños which produce field cut flowers – Bayog, Maahas, and Malinta − from the list of growers provided by the MAO. The ornamental growers from Los Baños would then total 70. With an average usage of 3 times a year and the usual purchase of one liter, the calculation would proceed as follows: 1 L x 70 growers x 3/year = 210 liters of Cocogro per year.

For ornamental growers in Calamba, the study conducted by Apigo (2003) revealed that there are about 125 nurseries located in Calamba. The estimated market potential in Calamba is 1 L x 125 nurseries x 3 times a year = 375 liters of Cocogro per year.

Ⅳ. Conclusion and Recommendations

In its present state, Cocogro is not ready to be marketed commercially. Despite the potential demand for Cocogro and the added benefits it can give to the farmers, there are still areas for product improvement. This includes the concentration of the product and the control of the mixture of hormones contained in the product. Furthermore, the technology for extraction and filtration should first be refined and tested.

Relative to concentration, Cocogro has a high cost per usage due to its lower concentration. Considering that price was found to be the most important buying consideration, Cocogro will be facing a price disadvantage compared to other brands in the market if the concentration issue is not addressed.

Moreover, there is a need to determine the content of growth hormones in coconut water. Since the content of growth hormone in coconut water varies depending on the age of the coconut, the identification of content at each age level is needed. This identification is also needed in order to determine the age of the nut when it will have the highest growth hormone content, and also to determine the amount of growth hormone that can be acquired from a specific age group. This will call for more research and development activities.

After the identification of content in coconut water is done, then the extraction method of the individual growth hormones should be addressed next. Coconut water contains different types of growth hormones that can be used for different purposes. Some of these hormones can hinder the effects of each other such as auxin, which promotes rooting, and cytokinin, which is known for shooting or lateral growth of plants. The ratio of these two would determine the reaction of the plants. In order to fully utilize these substances, they can be separated into two variants of the product. One variant would focus on the shooting of crops; while the other on the rooting of cuttings and seeds. Auxin is present in coconut water in the form of indole acetic acid (IAA); cytokinin is present in the form of kinetin.
Field-cut flower, aside from their application of GA3, use PGRs to induce and hasten flowering of the crops. Cutf lower growers in Los Baños also usually use the cocktail brand Turton, a mixture of liquid fertilizer and PGRs, to promote flowering. Meanwhile, the ornamental growers use PGRs to initiate the rooting of planting materials. More specifically, they use growth regulators to decrease the mortality rate among newly-planted ornamentals.

By producing product variants, other target markets can be explored. The target markets that can be considered are the ornamental and fruit tree growers (for rooting variant), and the vegetable and cut flower growers (for shooting/flowering variant).

After proper extraction and formulation of variants has been done, these variants or products made should be tested in the lab and in the fields. This is also in accordance with the FPA registration requirements. The product will be tested with crops such as ornamentals and vegetables.

Other areas for product improvement of Cocogro should also be addressed, such as the product's shelf-life. Branding, label and packaging, and accreditation by the country's Fertilizer and Pesticide Authority (FPA) should also be considered before the product is launched in the market. After Cocogro has been improved, collaborations with organizations or cooperate-ves like the cooperative in Bayog and the Los Baños

Orchid Society, as well as the Philippine Orchid Society, can be arranged for product testing and promotion.

This paper has elucidated on the salient features of Cocogro. It also discussed the market potential and product improvements needed for Cocogro. However, it fails to investigate the financial viability of large-scale production and marketing of the said product. Future studies may focus on this aspect. The relationship existing between the decision to buy PGRs and the size of production area and the age of respondents should also be validated. In particular, there should be a more in-depth examination of the farm size or farm size range which can benefit the most from the utilization of Cocogro.

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Evolving Coco Coir Supply Chains. The Case of the Coco Coir Industry Cluster in Laguna, Philippines

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ABSTRACT

One of the most vital agro-based and export industries in the Philippines and among the most studied is the coconut industry. Among the many products from coconut, the potential of coco coir particularly in climate change mitigation is not widely tapped. The Philippines exports minimal volumes of coco coir to the global market despite its status as one of the largest coconut producers in the world. This study analyzed the case of the Laguna coir fiber industry cluster structure and players in the context of the current status, issues and opportunities that the industry faces as well as the global trends that significantly affect the industry. Emerging local and export opportunities are discussed in a strategy blueprint for policy-makers and other industry stakeholders. Managing a sustainable, agile industry cluster using adaptable supply chain design strategy via industry organization and governance changes, better knowledge management, enhanced readiness and cohesiveness of chain participant interaction within supply chains and among supply chain networks and synergistic policies is suggested.

Keywords: coco coir, coir fiber, evolving supply chain, industry cluster, Laguna,

Ⅰ. Introduction

The coconut industry is considered one of the most important industries in the Philippines. One of the untapped sectors in the industry is coir fiber production. Coir fiber, also known as coco coir, is a by-product left from the process of extraction of coconut oil and other products. Coco coir is the primary raw material used in the production of high-value export products such as bed mattresses, mats, car seats, ropes and twine, grow poles, plant liners, wattles for orchids, pots and geotextiles or bioengineered fascines that control erosion.

Global demand for coco fiber has been large in Europe, particularly in the Netherlands, USA and the Asia Pacific Region, especially in China. China is considered the largest market for baled fiber, which remains a leading export product, accounting for 51% of the total world absorption in 2008 (Yogaratnam, 2012).

The top five coco coir exporting countries are India, Sri Lanka, Vietnam, Indonesia and the Philippines (Isip, 2011). India and Sri Lanka are considered the top producers of the global coco coir industry accounting for 90% of total world production (Bonina, 2011).

The global trade volume of value-added products made out from coco coir is now valued at about $140 million annually. Exports of manufactures are projected to grow by 1.2% per annum to 80,000 tons in 2012, while exports of fiber are expected to expand to about 123,000 tons (Yogaratnam, 2012).

Past studies conducted mostly focused on the analysis of the entire coconut industry in the Philippines. In a study about the performance, issues and recommendations for the coconut industry, Dy (2006) primarily focused on the current programs and policies governing the coconut industry in the Philippines. Some problems regarding the current program were pinpointed followed by recommendations that the coconut industry can take in order to counteract the issues in the industry.

In a research report prepared by Warner et al. (2007), the global trends of some products derived from coconut were discussed. The study tackled the status of the coconut industry in some countries, particularly Sri Lanka, Papua New Guinea and the Philippines and briefly discussed some global issues and trends related to coco coir. The study revealed the constraints in coco coir processing. According to the study, India and Sri Lanka became the leaders in coco coir exports because of the low cost of labor prevalent in the area.

Endaya et al. (2006) discussed some of the prospects and issues faced by emerging non-traditional coconut products in the Philippines. They provided insights on the barriers to product development faced by the coco coir industry in the country, which included supply problems for the coconut husk. Moreover, global prospects for the product such as the passing of the clean development mechanism of the Kyoto Protocol, in which developed industrial countries agreed to enter into an emission trading agreement with developing countries, were presented.

Most of the studies related to coco coir just provided snippets of the whole picture of the industry. Previous studies referred to coco coir as one of the emerging products that can be derived from coconut. Although global trends and issues were fully tackled in such studies, no study so far has focused on the coco coir industry in the Philippines, particularly the case in the province of Laguna. This study assessed the Laguna coco coir industry cluster structure and players amidst local and global challenges and prospects and offered strategic directions for this emerging cluster.

Ⅱ. Methodology

Descriptive research was used in identifying the internal and external factors, and in the assessment of the current status of coir businesses in the province. Formulation of strategies was based on the collected and analyzed data.

As for primary data collection, personal interviews with the currently existing coir firms in Laguna, a province located around 60 km southeast of Manila, were conducted: three (3) coir producers which are all located in Victoria, a town in Laguna; two (2) coir processors in two other towns namely, Cabuyao and San Pablo; and a producer-processor located in Calauan, still another town in Laguna. However, the snowball sampling method was used in identification of traders. For other technical information and performance statistics, secondary data collection from different government and institutional sources was done. Electronic mail correspondence and official government websites were also useful in finding publications and market reports.

Data analyses included the use of the following tools: trend, supply and demand gap, supply chain, cost and return and SWOT analyses.

Ⅲ. Results and Discussion

3.1. Philippine Coco Coir Industry

3.1.1. Local Production

According to the Fiber Industry Development Authority (2009), the output level of the Philippines' coir industry grew substantially in 2007 after the entry of competing substitutes such as foam and plastics. This was a banner year for the industry, achieving an annual output of 10,019 metric tons and export of coir products placed at 11,753 metric tons.

However, in the year 2010, FIDA reported that the production of coir significantly increased again to an average annual production of 120,082.10 metric tons. In 2011, the average production of coir reached 144,736 metric tons. Davao del Sur in the island of Mindanao in southern Philippines remained the top producer of coir with annual production of 57,713 metric tons (39.87%), followed by two other provinces in Mindanao: Davao Oriental with 40,631 metric tons (28.07%), and Davao del Norte with 20,208 metric tons (13.96%). Laguna ranked sixth with 3,876 metric tons (2.68%).

3.1.2. Coconut Exports

The largest contributor to coconut exports in terms of FOB value is coconut oil with an average export share of 98.725% as mentioned in a report on Philippine Coconut Exports (2006-2011) provided by the Department of Trade and Industry in 2012.

Following the lead of coconut oil in terms of exports is coconut shell followed by products related to the coir industry, such as the dust/peat, geotextiles and coir fiber. It is coir fiber which has the biggest potential in the export market with exports significantly increasing during the period from 2009-2011. A majority of the coir fiber is primarily exported to Taiwan and China. Other finished coir products are exported to Japan, Australia and the United States.

Recent developments in the Philippines pertaining to the exportation of coconut products and the coco coir industry include the institution of the Philippine Coco Coir Industry Development Plan (PCCIDP), which is a five-year plan (2011-2016) that generally aims to increase the local production of coir and its products, and address product development issues. Its target is a ten-fold growth for the industry in its exports, or a 400% increase in coco coir exports valued at $6.5 million by 2016 (Bonina, 2011).

3.2. Laguna Coco Coir Industry Cluster

The Laguna coir industry cluster consists mainly of coir fiber and dust producers, processors, producer-processor, local traders/exporters, and end users. These industry cluster players are classified according to their operations and handling of coir products.

3.2.1. Producers of Coir Fiber and Dust

The process of coconut coir extraction is commonly referred to as decorticating and defibering. The major products being produced like raw coir fiber are still subject to further processing while coir dust or coco peat is usually sold as is.

In Laguna, there are a total of three (3) registered and operational decorticating plants producing raw fiber and coir dust. These are Herb Republic Agro Ventures Inc., Philippine Environmentech Products Corp. (PEPCO) and Wua-Yei Enterprises.

3.2.2. Coir Processors

Coir processors are those that produce semi-finished and finished coir products. They are the chief buyers of raw fiber which are converted to other readily usable products. Their operations involve dyeing, compressing, stitching and other fabricating procedures. These processors are typically the ones who export their products as well.

In Laguna, there are two (2) processors offering products such as geo-nets, coir mats, plant liners and bio-trays. These are Cabuyao, Marycheck Corp. and Pilipinas Eco Fiber.

3.2.3. Producer-Processor of Coir

Unlike coir producers and processors, a producer-processor does both operations such as decortication and further processing of coir. The products they produce include raw fiber and finished coir products. The Imok Agrarian Reform Community Women's and Farmers' Multi-Purpose Cooperative is the only coir producer-processor in Laguna.

3.2.4. Local Traders / Exporters of Coir Products

Local traders of coir are those that further disperse the coir products produced by the industry in Laguna. In the province, mostly the entities acting as local traders are the owners of ornamental gardens. Only the products of coir producers, particularly coir dust, are patronized by said traders since it is a major input in the ornamentals industry.

In Laguna, there are about 14 local traders of coir. They are located in parts of Calamba, Los Baños, Bay, Calauan, and Victoria, Laguna.

3.2.5. End Users of Coir Products

The end users are those that purchase coir products for their final utilization. For coir processors and fiber producers, the end users are typically those who buy the end products within and outside the country. However, for coir dust and peat producers, also with the help of local traders, coir dust and coco peat are sold to gardeners to be used as growing medium for ornamental plants.

In Laguna, the end users of coir products, specifically coir dust, are gardeners and landscapers. Since coir dust is a major input in gardening businesses, all of them are seen as end users of coconut coir dust or coco peat.

3.2.6. Total Available Supply in Laguna

The coir industry cluster solely relies on the coconut production from which their raw materials are obtained. Copra makers and producers of desiccated coconut are the major sources of coir producers' raw material: the coconut husk. In Laguna, the leading source of coconut husks is Quezon province, a province adjacent to Laguna, where coconut production is relatively abundant. Particular sources in Quezon are the municipalities of Sariaya, Tiaong and Candelaria. Moreover, other towns in Laguna which supply coconut husks are San Pablo City, Calauan and Nagcarlan.

3.2.7. Local Production

Coir producers and processors in Laguna offer coir products such as raw fiber, coir dust, and other processed items. Table 1 shows a summary of the type of product and the monthly volume.

Table 1. Total Available Supply of Coir Products in Laguna

Coir Product	Volume of Production (per 20-day operation)
Coir fiber (raw and finished products)	170.05 tons raw and processed coir fiber 215.45 tons coir dust 300 dug-outs 150 coir mats 3,000 coir pots ≥ 600 plant hangers ≤ 500 bio-logs
Coir dust	11,410-16,380 sacks coir dust per month

Source: Field interview (2011).

3.2.8. Demand

According to Business Insight (2011), the demand for coir mattresses from China alone is already 100 million pieces annually, with an estimated demand growth of 20 percent every year. Moreover, China's annual demand for coir geotextiles is about 270,000 square kilometers. This is due to the 1.27 percent yearly expansion of their desert areas as a result of sandstorms.

However, in Laguna, in the case of Pilipinas Eco Fiber, the demand for coir products in their firm alone receives is placed at a minimum of 100 metric tons per month. As for Imok Multi-Purpose Cooperative, the Department of Public Works and Highways (DPWH) requires them to produce 500 pieces of bio-logs every two to three months for the restoration of landslide-prone areas.

3.2.9. Consumption Trends

According to the latest reports of FIDA, the local consumption of coir from year 1999 to 2008 averages 351 metric tons per year, with the highest level in 1999 of 729 metric tons, and the lowest in 2003 of 119 metric tons. Although local demand seemingly decreases, this does not mean that the utilization of coir was reduced, but rather processed into high-value finished products.

3.2.10. Present Markets

The foreign markets of the Laguna coir industry cluster are China, Taiwan, Japan, USA, Australia and Korea.

In the local scene, some of the local companies that the coir industry in Laguna deals with are Rim Construction, Cacho Construction, M.E. Sicat Construction, Tagaytay Highlands, Ayala Land, Inc., Belle Corporation, Sherton Industrial, Inc., Philippine Gold Mining Co., Philmenera, Salem Beds, Avatex, and Coco-Green. Other markets of the industry are rice farmers in Northern Luzon, the DPWH, the Department of Agriculture (DA), the Philippine National Oil Company (PNOC), and some garden owners and landscapers.

3.3. Supply and Demand Gap

Table 2 shows a comparison between the supply and the local and foreign demand for coir products. The values for Laguna's supply volume were adjusted to an annual basis because capacities were on a monthly basis.

Table 2. Supply and Demand Gap

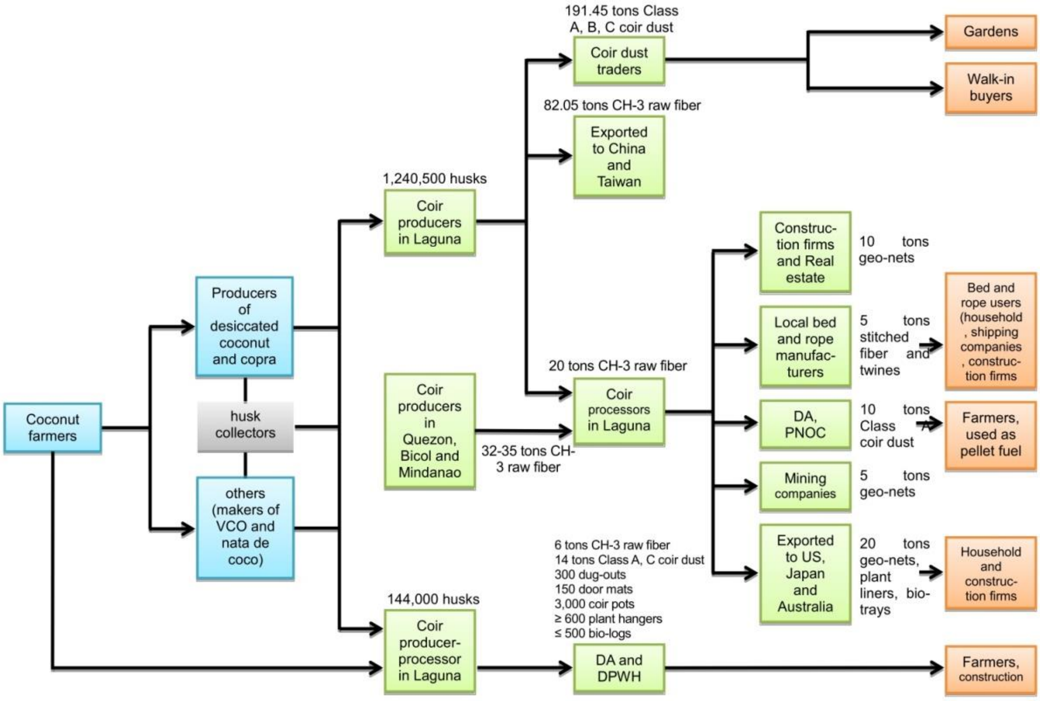
Product Form	Demand Volume for Coir	Estimated Annual Supply of Coir Products in Laguna	Estimated Surplus/ Shortage
raw and processed coir fiber (includes mattress sheets, geo-nets and plant liners)	100 million coir mattresses from China (~450,000 tons) 270 million square meters coir geo-nets from China (~108,000 tons) 4 million square meters coir geo-nets from DPWH (~1,600 tons) minimum of 1,200 metric tons coir products per year, from markets of Pilipinas Eco Fiber	2,040.60 tons	shortage of ~555,959.40 tons for global market; shortage of ~759.40 tons for local market
coir dust	~100,000 tons from DENR for reforestation ~277.90 tons from coir traders in Laguna per year	5,920.20 tons	shortage of ~94,357.70 tons for DENR and Laguna traders
dug-outs	no definite demand	3,600 pieces	supply was enough
coir mats	no definite demand	1,800 pieces	supply was enough
coir fiber pots	~1 billion pieces from DENR for reforestation	36,000 pieces	shortage of ~999.964 million pieces for DENR
plant hangers	no definite demand	7,200 pieces	supply was enough
bio-logs	3,000 bio-logs per year, from DPWH	3,000 pieces	supply was enough

Source: Icamina (2011) and Field interview (2011).

3.4. Supply Chain Analysis

The supply chain of the Laguna coir industry cluster can be characterized as fairly short and simple in terms of the number of players and loose and weak in terms of interaction among chain participants. As other inputs such as technology are sourced abroad or self-fabricated, this supply chain focused on the primary input, which is the coconut husk for coir producers, raw fiber and dust for coir processors, and coir dust for traders. The chain starts with the suppliers of raw materials (coconut husks), who are then linked with the producers of coir products to the processors, and then distribute directly to the industry's present markets. Traders participate only in the supply of coir dust to end users. Fig. 1 shows the supply chain of the coir industry cluster in Laguna, including the volume and grades/classifications of the products.

Fig. 1. Supply Chain of the Laguena Coir Industry



Note: Values are based on a 20-day operation.

3.5. Cost and Return Analysis

To determine the performance of the Laguna coir industry in terms of profitability, a cost and return analysis was done. The values were based on the combined costs and profits of the players in the industry.

Shown in Table 3 are the monthly costs and earnings of the coir producers, processors and traders. As seen, a bulk of the returns of the industry comes from the sale of geo-nets (73.80%) while the lowest comes from the sale of plant hangers (0.62%). However, the monthly production costs primarily come from the raw materials and electricity expenses since these are the major requirements for coir production.

Computing the difference between the total sales and production costs per month, the net profit of the Laguna coir industry cluster reached Php 1,988,120.06, which was 58.69 percent of the total monthly sales.

Table 3. Cost and Return Analysis of the Laguna Coir Industry

Cost and Return		Amount (Php)
Monthly Sales (20-day operation)		
Raw and processed fiber	Php	345,000.00
Geo-nets		2,500,000.00
Dug-outs		96,000.00
Coir mats		22,500.00
Coir pots		45,000.00
Plant hangers		21,000.00
Bio-logs		90,000.00
Coir dust		268,030.00
Total Monthly Sales (excluding transportation charges)		3,387,530.00
Less: Monthly Production Cost		809,932.50
Raw materials		44,100.00
Labor		9,600.00
Depreciation (0.80%		480,000.00
of equipment cost)		4,800.00
Energy costs		
Repair and maintenance (0.40% equipment cost)		
Total Monthly Production Cost		1,348,432.50
Monthly Gross Profit		2,039,097.50
Less: Taxes (30% annually)		50,977.44
Net Profit	Php	1,988,120.06

Note: Philippine Peso (Php)- US Dollar (USD). Exchange rate in 2011 was Php 43.31: 1USD (NSCB Website).

Source: Peñamora and Santos (2006) and Actual field interview (2011).

3.6. Major Issues Confronting the Industry

The following are the major issues that need to be addressed in the Laguna coir industry.

3.6.1. Insufficient Supply of Coconut for the Processing of Coir

Laguna does not produce as many coconuts as are needed to sustain the operations of coir firms. There is a gradual decline of coconut production from the year 2006 (102,409.31 metric tons) to 2008 (98,490.75 metric tons). Production fell again by 0.10% in 2010 to 107,215.68 metric tons. This can be attributed to the continuous industrialization in Laguna where the agricultural land areas are used for real estate development and the proliferation of commercial establishments.

3.6.2. Competition between Coir Firms in Laguna and Coir Firms in the Nearby Quezon Province

Because coir firms in Laguna source coconut husks from Quezon, coir firms in these two provinces compete for the limited supply. Husk suppliers tend to prioritize coir firms which are near their vicinity in order to cut transportation costs. As a result, the volume of husks supplied to Laguna is inconsistent: sometimes abundant, other times in short supply.

3.6.3. Low Bargaining Power of Coco Coir Firms in Laguna

According to a PCA informant, Laguna producers cannot offer a husk buying price at a very low rate. One reason for this is that due to the rising opportune-ties for employment in Laguna, collectors of coconut husks would think that it will be more beneficial for them if they get a job than to collect and sell husks. Since these raw materials are limited in Laguna, coir producers have no choice but to purchase husks at the price requested by suppliers.

3.7. Industry Assessment: Strengths, Weaknesses, Opportunities and Threats (SWOT)

The Laguna coco coir industry cluster can be considered a promising and growing industry as it has a number of strong points. However, weaknesses are inevitable. While there are many opportunities that it can take advantage of, there are also threats that the industry cluster must counteract. Table 4 below illustrates the strengths, weaknesses, opportunities and threats faced by the Laguna coco coir industry.

Table 4. Laguna Coco Coir Industry Cluster: SWOT Analysis

STRENGTHS	WEAKNESSES
1. The pioneer for the Laguna coir industry remains to be a key player in the industry. 2. Accessible networks and linkages 3. Highly supported by the ornamental plants industry 4. Available labor force 5. Exported products achieve quality specifications 6. Has established connections with clients	7. Inefficient machinery 8. Few coir-producing and coir-processing firms 9. Unable to meet local and international demand 10. Low coconut production in Laguna 11. Produces mostly coir fiber grades CH-3 and CH-4 only 12. Highly dependent on transportation 13. Most coir firms do not disclose relevant information to government agencies. 14. Lack of promotional strategies
OPPORTUNITIES	**THREATS**
1. The existence of the The Philippine Coco Coir Industry Development Plan 2. Increasing local and foreign demand for coir products due to climate change initiatives 3. Support from private organizations and government agencies 4. Many coconut husk materials are underutilized. 5. Continuous research and development for coir technology 6. Still has low competition for coir producers and processors 7. Available agricultural lands 8. Mindanao coconuts are affected by diseases like *Kadang-kadang* (yellow mottle disease). 9. Increase in government budget for the coconut industry to Php1.75B 10. Increasing demand for organic materials rather than synthetic materials	1. High exportation and freight costs 2. Establishment of coir plants in Quezon and in Mindanao 3. Government programs focused only in Mindanao 4. Lower-priced coir dust in Quezon 5. Increasing coir production of Vietnam, Thailand, and other Asian countries 6. Coconut varieties in the Philippines have bigger kernels and yield less coir fiber. 7. Among coconut products, Philippine producers and processors give more attention to production of copra and desiccated coconut. 8. High capital requirement for entrants

Some strategies have been derived from the SWOT analysis, supply chain analysis and by assessing the problems and issues confronted by the industry. The SWOT Matrix, as illustrated by Table 5 outlines the strategies and directions that the Laguna coir industry cluster could take.

Table 5. SWOT Matrix

	Strengths	Weaknesses
Opportunities	**S-O Strategies** • Establish an industry association among players with the participation of private organizations and supporting agencies. -S2, S1: O10, O8, O3 • Product Development -S5:O1, O2, O3 • Strengthen the quality of coco coir products for export -S5: O1, O2, O3, O10	**W-O Strategies** • The coco coir producers should locate in regions where coconut husk is not primarily used for production W4: O4, O8 • Create promotional materials and website for coco coir products W8: O1, O2, O10
Threats	**S-T Strategies** • Enhance public sector support S1: T3, T4 • Improve research and development of coconut varieties and coir equipment S5: T6, T7, T5	• W-T Strategies • Promote and implement coconut replanting programs. W4: T2, T6, T7

Ⅳ. CONCLUSION AND RECOMMENDATIONS

Today, as the movement for a healthier and greener lifestyle continues to grow amidst the backdrop of climate change, so does the increase in the demand for coir and related products both in the domestic and international markets. However, the current performance of the Laguna coir industry cluster demonstrates the critical issue of coconut husk supply shortage which reverberates in its supply chain going downstream. Other factors such as inefficient machinery, coir firms' lack of cooperation with industry-supporting government institutions and unorganized industry cluster players also impede the development of this industry cluster. However, as the awareness on the innovative use for coir and its profitability expands, the Laguna coir industry cluster is seen to expand in terms of production and scope of distribution. Thus, the coir industry cluster in Laguna is a developing industry with high growth potential if sufficiently tapped.

In general, it is suggested that the government's strategy blueprint for the Philippine coconut industry be re-examined and revisions made to reflect or emphasize the need to integrate and rationalize the supply chains of all coconut products besides coco coir for clarity in terms of prioritizing areas planted to coconut grown for copra, desiccated coconut and related products and coconut grown for husks which are needed by the coco coir industry, synthesizing a market information databank to enhance knowledge management capabilities of all supply chain participants and providing a more relevant set of other support services. Supply chains are dynamic and in order to capture time-bound opportunities, the Philippine coconut industry, and the Laguna coco coir industry cluster's supply chain in particular must continually evolve and remain agile at all times, responding to market opportunities with fluidity. The Laguna coco coir industry cluster's profitability can be enhanced through economies of scale as more coconut husk is produced, bringing down the cost of the husk material. Initial strides in developing this industry cluster further could include the following:

4.1. Coco Husk Farmers

The farmers should first organize themselves together into a cooperative (similar to that of the Imok Multi-Purpose Cooperative) and then into a federation of producer cooperatives as they forge a strategic partnership with government institutions, such as the Philippine Coconut Authority (PCA) and the DA. The PCA and DA should focus their research and development efforts toward developing coconut varieties more suitable for coir production and hinge on productivity and quality standards of the export market. Since there is a growing demand and a large potential for coco coir in the export market, they might want to consider expanding their coconut farms and planting varieties which yield bigger kernels such as the Catigan Dwarf Variety characterized by its thicker husk (Philippine Coconut Authority). Links with other supply chain players (both downstream and upstream) must be explored to bring the highest value for their product.

4.2. Coir Producers, Processors and Producer-Processors

Regarding the short supply of coconut husk materials, producers could look for other suppliers from regions where copra and desiccated coconut producers are plentiful. According to the PCA, about 12 billion husk materials are only thrown away or burned to cook copra. Laguna coir producers should determine where these husk supplies are located so that it can be produced into more useful products, thereby increasing the production of coir in Laguna.

There are newly-discovered materials from which coir could be used. It can now be a substitute for jute in the making of bags for rice, sugar, coffee and sand; suitable in the production of pulp and paper; it could be used to make wall boards which are termite-proof and comparable to qualities of narra, plywood or Masonite; and for other items such as coir yarn, husk decors, mannequin wigs and fishnets (Isip, 2011). The processors could probably add other products such as those mentioned in order to accommodate the needs of other sectors. In addition, these supply chain participants must improve their relationships with their downstream and upstream links to foster stronger ties through better information flow and enhanced supply chain profitability.

4.3. Local Traders/ Exporters

For the local traders who are mostly owners of ornamental gardens, they could consider undertaking value addition activities for the coir products.

In the case of exporters, information dissemination is an important tool to increase awareness about the coco coir related products coming from the Philippines. One way to fully expose Philippine coir to the export market is through participation in international seminars and trade fairs and product promotion programs. These are other aspects where the government and private sector can also assist.

Finally, local traders and exporters should also strengthen links with the other supply chain participants for better information exchange and improved transact-tional relationships.

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