ERIA Research Project Report 2008

No. 4-1

Development of Regional Production and Logistic Networks in East Asia

Edited by

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March 2009

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Executive Summary

Development of Regional Production and Logistics Networks in East Asia

Kitti Limskul

1 SIGNIFICANCE OF THE PROBLEM AND OBJECTIVES

The Association of Southeast Asian Nations (ASEAN) and East Asia have shown satisfactory growth and development in recent years. Their manufacturing sector's value-added as a proportion of GDP followed a general pattern of growth and structural transformation in line with Syrquin's paper (1988). We also observe the narrowing down of the economic development gap (i.e., late comers are now showing fast-growing GDP and increasing income per capita). Most importantly, the level of growth may stem from the fact that the ASEAN and East Asia now have a deeper regional economic integration, as a result of trade liberalization and the formation of industrial clusters or agglomerations. In other words, the economies in the ASEAN and East Asia showed an unprecedented improvement in their international production networks with lower business linkage costs.

However, most economic development theories in the past have not introduced explicitly the role of spatial economic dynamics. Most relied on heuristic assumptions of perfect competition, constant returns to scale, etc., such that firms in a general equilibrium situation are free from issues of immobility of factors, scarcity of land input, congestion, and pure diseconomies. Increasing return to scale, thick markets, knowledge spillovers and other pure external economies are out of reach as well. Fujita *et al*. (1999) have resolved these shortcomings by proposing a general equilibrium model that drives forces of spatial concentration and dispersion of economic activity. The sustainability or instability of concentration depends on two forces; namely, *centripetal* force, which tends to promote concentration of economic activity, and *centrifugal* forces, which act against concentration. In an elemental model for two-region economy, industry disperses to two regions when transport cost is enough high, while the one region gets whole industry and the other region loses it as the transport cost decreases.

Agglomeration and regional growth have been further studied by Fujita and Thisse (2002, pp.338-431). A simple endogenous growth model for a two-region economy is used. This represents a combination of core-periphery model and differential products, with the R&D sector added explicitly, so that the number of firms that use skilled labor to create new varieties for the modern sector is variable. The study shows how the growth of the global economy depends on the spatial agglomeration of the innovation sector across regions. However, if the patents for new products can be transferred without cost, R&D activities will concentrate in a single region. The modern sector is either fully or partially agglomerated in the same region as the R&D sector. The core-periphery structure in which the innovation and the modern sectors are entirely agglomerated into the same region is stable when the transport cost of the goods produced by the modern sector is sufficiently low. If knowledge externalities among skilled workers become more localized, the range of transport costs expands to stabilize the core-periphery relationship.

The R&D sector is a strong centripetal force at the multiregional level, amplifying the circular causation of the core-periphery model. This confirms that “growth and agglomeration go hand in hand” (Fujita and Thisse 2002, p. 391). In short, when the economy moves from dispersion to agglomeration, innovation follows at a faster pace and the unskilled labor residing in the periphery will prosper as well, provided that agglomeration is strong at the core.

The objective of the research is to study the dynamic process of industrial clustering of firms in selected ASEAN and East Asian economies. The nature of clusters (whether called “innovation clusters,” “high-technology clusters” or “innovative milieu”) has the following characteristic: geographical concentration that, according to Porter (1988, p.78), has a high degree of specialization, a large number of mainly small- and medium-size firms; ease of entry and exit; and a high rate of innovation. Smith (2006) has noted the pioneering study of Porter (1990) and Krugman (1991) on industrial agglomeration or clustering. The industrial clusters typology follows the proposition by Markusen (1996), who differentiates four distinct types of clusters as (1) *Neo-Marshallian industrial district cluster* (large number of small firms agglomerate; strong inter-firms link within the cluster; high proportion of workers in design-and-development type activities; a seedbed of innovation present; knowledge community activates generation and diffusion of knowledge that leads to a high rate of innovation); (2) *Hub-and-spoke cluster* (hub firms are typically large, with oligopolistic power and dominate a single industry; relationship with spokes takes the form of supply contracts); (3) *Satellite platform cluster* (concentration of branch plants of large externally-owned and headquartered organizations; plants set up “stand alone” facilities detached in spatial terms with few linkages to other firms in the cluster; linkages are more to the parent corporation, or other branch plants located in other regions; investment decisions, finance, technical expertise, and business services are from external location and into a region; government-sponsored clusters can be high-technology centers; linkage between large foreign firms and small, local ones, with high degree of collaboration); (4) *State-anchored cluster* (universities, large public laboratories, and government offices acting as anchor). Porter’s work on clusters paid attention to the importance of competitiveness as a tool to promote national and regional growth and innovation. In sum, *clusters that are conducive to innovation have the following features: networking, specialization, ease of entry and exit, and resource mobility*.

In our study, the formation of industrial clustering is an essential step for emerging developing economies in catching up with forerunners. Additionally, it helps to stabilize the industrialization process and, through the business linkage within and outside the clusters, assists local entrepreneurs to acquire innovations in various forms.

Kimura and Kobayashi (2009) have two arguments on the dynamics of clustering. The *fragmentation theory* argues that the key to attracting fragmented production blocks is improving location advantages by creating special economic zones, and improving logistics infrastructure and customs procedures so as to reduce the cost of service links. On the other hand, the *new economic geography* emphasizes the effectiveness of utilizing the dispersion forces from congested neighboring cores. The study here fundamentally follows the work done by Fujita *et al*. (1999).

2 METHODOLOGY OF RESEARCH

In our study, we have attempted two levels of hypothesis testing. The first level pertains to a broad regional macroeconomic or general equilibrium economic effect of *agglomeration forces* versus the *dispersion forces* on economic activities (Kumagai *et al*. 2008, p. 10), which is in line with the new economic geography (NEG) model of spatial economics. The agglomeration forces drive the forward and backward linkage of the economic activities, while the dispersion forces are caused by immobility factors. Congestion has resulted in severe price competition among firms and rising land prices as well as wage rates. Mobile workers can choose between regions based on wage rates and price differentials. If transport costs are high enough and reach a limit or threshold, this can cause firms to lose in fierce price competitions even if the market size is large due to congestion. Economic activities will disperse as a result.

The contrary is true also when transport cost decreases to a certain point. In such a case, firms enjoy substantial profit from large markets with low procurement costs even if there is stiff price competition. This results in economic activities that foster agglomeration. The dynamic process of agglomeration can be simply shown as the “circular causality” between consumers and producers. The more consumers are located, the greater the demand for more variety of manufacturing goods, causing a backward linkage with scale of economies in specialized production. On the other hand, new varieties of manufactured goods to be produced will have forward linkages with high-income consumers who prefer a variety of choices. Therefore, the second level pertains to the spatial economics of firms' behavior in the dynamic networking process and supply chains that result in clustering or agglomeration.

The first attempt is carried out by applying the IDE Geographical Simulation Model (IDE-GSM). The second attempt is the result of a field survey by the working group in their respective countries.

The study starts with the new geography model, where Kumagai *et al*. (2009) predicts the effects of an infrastructure development such as the completion of the East-West Economic Corridor[i] (EWEC). Kumagai *et al*.'s (2008) first-generation IDE-GSM was developed to determine the dynamics of locations of the population and industries in East Asia in the long term. It also predicts the impact of specific infrastructure projects on the economies at sub-national levels. Its fundamental hypothesis is that the inter- and intraregional income gaps may become wider as various trade costs such as transport costs, tariffs, and/or service link costs are lowered (Kumagai *et al*. 2008, p2).

The second-generation of IDE-GSM has been expanded to predict changes in the location of populations and industries in regions for seven sectors, namely, agriculture, automotive, electric and electronics, textile and garment, food processing, other manufacturing and services. The simulations reveal that the effects of infrastructure development on each region are significantly different by industry.

To investigate the typology of agglomeration or clustering of industries in the ASEAN and East Asian economies, specific case studies were done on Indonesia (JABODETABEK), the Philippines (CALABARZON), Vietnam (Hanoi and its vicinity), and Thailand (Bangkok and its vicinity). We also learned about Brunei's own pre-feasibility study on the infrastructure development of its geographic linkage to the

East Asia–ASEAN economies. Through the initiatives of a Japanese econometric analysis team (Machikita *et al*. 2009), we are able to test our hypothesis on the relationship between innovation clustering and industrial agglomeration. With country-specific linkage typology, we try to discover how innovation leads to certain production networking of firms in project areas. With each country-specific finding and policy recommendation, and hypothesis-testing put forth by the econometric study, we derive a typology of agglomeration in the ASEAN and East Asia that can lead to a common policy recommendation and strategy for the region.

3 RESULTS OF THE SIMULATION AND EMPRICAL ANALYSIS

3.1. Model Description and Simulation Results

3.1.1 Model description

As mentioned earlier, the IDE-GSM was developed first to determine the dynamics of populations and industries in East Asia in the long term. Secondly, it is used to analyze the impact of specific infrastructure projects, such as the East-West Economic Corridor in Continental South East Asia (CSEA), and of reduced border costs, on the regional and sub-national economies. This approach tries to quantify the cost and benefit of "integration."

The IDE-GSM was based on a general equilibrium framework of spatial economics with the following features: increasing return to scale; imperfect competition; heterogeneous demand system (i.e., love for variety in products); and endogenous agglomeration forces. The model incorporates a topology of administrative cities and routes that are interconnected, per the study of Fujita, Krugman, and Venables (1999).

The first-generation IDE-GSM used CSEA as its study area for analyzing both backward- and forward-linkage economic integration. It is based on the hypothetical assumptions that a symmetric structure is maintained only when transport costs reach a particular level and that the core-periphery structure emerges when transport cost approaches the lower threshold.

The IDE-GSM covers 10 countries/regions: Singapore, Malaysia (Peninsular), Thailand, Myanmar, Cambodia, Laos, Vietnam, Bangladesh, Western India, and Yunnan, Guangxi and Guangdong provinces of China. Each country/region is subdivided into states/provinces/divisions. Each state/province/division is represented by its capital city. Altogether, there are 361 sub-national regions. The study at the sub-national level in the model is done with data on (1) GDP by sector (primary, secondary, and tertiary industries); (2) employees by sector; (3) longitude and latitude spatial location; (4) area of arable land; and (5) distance of 700 routes between cities under the road networks.

The general equilibrium effect under the IDE-GSM depends on the magnitude of such parameters as transport costs by industry; the elasticity of substitutions; labor mobility; consumption share of goods by sector; cost of labor in the production of agriculture; and input share of intermediate goods in manufactured goods production.

To perform the simulation, IDE-GSM was set with a baseline scenario with the following assumptions: (1) GDP per capita of each country is assumed to increase by an average rate for the year 2000-2005; hence, the GDP per capita of each city is determined and compared with the baseline; (2) The national population of each country is assumed to increase exogenously; (3) There is no immigration between CSEA and the rest of the world.

The second-generation NEG model by Kumagai *et al*. (2009), called the IDE-GSM, was a refinement of the first generation model. The extended version of the IDE-GSM has the following features:

a) Economic sectors are expanded to include agriculture and five manufacturing sub-sectors: automotive; electric and electronics; textile and garment; food processing; other manufacturing sector; and services;

b) The model includes 361 cities expressed by the same variables as those in the first generation and linked by 691 routes expressed by variables on distance and average speed;

c) The assumptions on variables -GDP per capita growth, population growth, migration, speed of car, border costs of time for customs clearance- in the baseline scenario are similar to those of the first generation.

The refinement of the model has produced key results that will be helpful in giving a broad perspective on the spatial economic development in our study.

The findings from the first generation model are summarized as follows:

a) Border costs play a big role in the dynamic relocation of populations and industries. Physical infrastructure alone is not enough to capitalize on its advantage. Kumagai *et al.* (2008, p 30) notes that a reduction of the border costs of time seems to be more effective than the development of physical infrastructure;

b) The nominal wage differential between cities, intra-nationally and internationally is the main driver for agglomeration. Bangkok and Ho Chi Minh, and their satellite regions and other capital cities and surrounding regions have higher nominal wages than the national average, and most of these cities have location advantage by having Bangkok as the "core" city. The wage differential can be balanced by an infrastructure development. The EWEC draws populations from the Bangkok metropolis to Northern/Northeastern Thailand and diverse populations from Vientiane to Savannakhet.

A model extension by Kumagai *et a*l. (2009) predicts the trend in agglomeration of population in 2005-2025. Per the model's results, the populations of Bangkok, Ho Chi Minh, Dongguan, Vientiane, and Krong Preah Sihanouk are expected to increase over the long term. From the simulation, Thailand may become a core country in 2025, while some Chinese cities will tend to be core-periphery. In sum, the model predicts similar population dynamics revealed by the first generation model.

3.1.2 Comparative Advantage and Agglomeration/Disperse of Industries

The model predicts industries' long-term agglomeration/dispersion trends by comparing the industrial comparative advantages in each region. This is based on the Revealed Symmetry Comparative Advantage (RSCA) index of industries in the baseline scenario and the scenario of ‘Economic Effect of having the East West Economic Corridor with Customs Facilitation’

(1) Industrial Growth under the Baseline Scenario

Automobile Industry

The second-generation model has produced interesting results on the advantages of industrial location. Per the results, the automotive sector becomes an advantageous sector in some regions of India. This may be driven by a huge demand for automobiles as India has a large population with rising per-capita income. The initial production in the baseline of the automobile product is quite small.

It is quite interesting to learn that Bangkok and its vicinities, and some cities in the Northeast of Thailand such as Nakhon Ratchasima, regions around Ho Chi Minh and cities such as Vinh Phuc in Vietnam, Selangor and Malacca of Malaysia, and some regions in India and China such as Liuzhou, have a comparative advantage in the automotive industry.

Electronics Industry

The model also predicts that Shenzen, Hezhou, and Guangzhou of China occupy the top slots regarding comparative advantage in the electronics industry. In fact, the top seven regions are located in China. In sum, the comparative advantage in the electronics industry concentrates in Singapore, Malaysia, parts of Thailand, and China.

Textile and Garment Industry

The top 20 locations with the highest comparative advantage in the textile and garment industry include Pabna and Dhaka in Bangladesh, and Phnom Pen in Cambodia. It is expected that the cities in Bangladesh and Cambodia would occupy slots in the top 20 regional rankings because both countries have abundant labor and established industrial presence in their baseline. In fact, comparative advantage is dispersed across Cambodia, Vietnam, Thailand, China, and Bangladesh.

Food Processing Industry

It is interesting to learn that Ca Mau of Vietnam is predicted to be at the top rank among sites with a comparative advantage in food processing. It is followed by Soc Trang and Bac Lieu in Vietnam and some regions in Myanmar. In fact, comparative advantage in the food processing sector within the CSEA is dispersed. This can be explained by the fact that it is the latecomers that have higher potential to grow than the existing production regions in the baseline.

Again, comparative advantage in the food processing, and textile and garment industries tends to be dispersed, while that in the electronics and automotive industries tends to agglomerate in a small number of regions.

(2) Economic Effect of the East-West Economic Corridor and Improved Customs Processing

The infrastructure development involving EWEC, along with improvements in custom facilitation, can reduce the border cost of time in shipment, etc. The completion of EWEC in 2011 is expected to benefit the region economically. Such economic effects can be measured in terms of GDP growth rates from the baseline year and until the EWEC project reaches completion sometime between 2011 until 2025. The study found that Champasak of Laos will be the top gainer in GDP growth at 6.1 percent once the project is completed.

The customs facilitation will benefit parts of Laos, Vietnam, and Northeastern Thailand. It is interesting to note that the geographical periphery of the region, especially West India and Bangladesh, the Malay Peninsula, and Guangxi and Guandong provinces of China will also benefit from the EWEC. This is because the EWEC will reduce transport costs all over the region, and not only in the four core countries: Myanmar, Thailand, Laos, and Vietnam in the CSEA. Industrialization along the EWEC and its periphery has raised nominal wages and attracted migration, igniting a new round of circular causality between consumers and producers. In terms of the core and its periphery agglomerates, Cambodia is found to be affected by the dispersion of economic activities because of the presence of the EWEC. Surprisingly, many regions in Cambodia will have lower GDP growth potential as compared with the baseline.

Improved customs facilitation at the EWEC also gives rise to increasing RSCA of different industries in each region. Regions in Vietnam, Laos, and Thailand tend to gain ranks in RSCA in comparison to regions in the remaining countries. However, the EWEC customs facilitation will help promote the development of the textile/garment and food processing industries.

Additionally, the new geographic approach to economic development has been laid out in Brunei's Brunei Darussalam-Indonesia-Malaysia-Philippines (BIMP) study. This study highlights the importance of a geographic approach to the economic integration of the ASEAN and the East Asian region. Geographically, Brunei's involvement in the project will complete the transport equation: its sea and air linkages supplement existing land linkages.

3.2. Empirical Analysis on Innovations, Linkages, and Performance of Firms

3.2.1 Research focuses

The second part of the study calls for an econometric analysis of firms' behavior in selected countries, namely, the Philippines, Vietnam, Indonesia and Thailand. The field survey on firms was conducted by a working group per location. Collected data are analyzed based on econometric procedure by Machikita *et al*. (2009). The study is an evidence-based policy formulation according to the Comparative Agglomeration Dynamics (CAD) presented by Machikita and Ueki (2008).

The CAD is a study of production and distribution with a spatial dimension. It raises the importance of geographic proximity, real linkages and management practice of industrial parks, by investigating the bottlenecks and effects quantitatively, and by identifying pathways for the causal effects of agglomeration on innovation. The study has tried to identify the pro-competitive effects on firms by learning from knowledge that spilled over through established linkages. The CAD follows the proposition of spatial economics dynamics according to Markusen's typology (1996). The study by the working group also aims to investigate the dynamic effect of worker mobility, the contractual environment, and heterogeneous plants and production linkages in a single industrial park and/or multiple industrial locations.

A common questionnaire is used for each study area. The questionnaire consists of four parts: (1) Profile of sample firms in operations; (2) Innovation activities for business upgrade in the last three years; (3) Business linkages with present customers and suppliers; and (4) Sources of information and new technologies for innovation and business upgrade. The cross-references between variables and key words in our study are as follows:

Linkages explains any linkages or contacts between firms and customers or suppliers in term of local or foreign firm, university and industry R&D relations, government or public organizations and industry, dispatch of engineers to customers/suppliers, capital tie-up with customer/suppliers, duration of the relationship with the customer/supplier.

Agglomeration explains benefits from activities that firms obtain when situated near each other or in the same industrial estate or as an industrial cluster. This study refers to distance and travel time from firms to customer/supplier, and the just-in-time distribution system adopted by the customer/supplier.

Innovation explains product enhancements when firms introduce new products/services to the market, and adopt new processes such as buying new machines or using facilities with new operational functions, improving existing machines, equipment or facilities, or introducing new technology into their production methods. In addition, this can refer to securing new suppliers, seeking new markets/customers, and improving business processes.

Performance explains the business performance of firms in comparison with the previous year's. Examples are when there is an increase in sales or profits, number of employees, value of exports, value of exports to developed countries, number of export destinations; productivity improvement in quality of products; reduction in product defects, production cost and lead times.

3.2.2 Overall findings from the empirical analysis

Machikita *et al*. (2009) have analyzed their results from a survey sample of 605 firms. This sample comprises 204 from the Philippines, 138 from Vietnam, 150 from Indonesia, and 113 from Thailand.

To investigate how the production network affects firms' incentive to innovate when inter-firm linkages become dense, questionnaires were sent to producers in selected industries. The sampling by product/industry included: Food products (13.31%), Apparel (17.47 %), Wood products (5.16%), Paper products (4.49%), Chemical products (9.82%), Iron and steel products (3.99%), Metal products (6.16), Machinery (4.99%), Electronics (8.99%), Automobiles (5.32%), and Transport (1.33%).

The study therefore focused on three major industries in four countries: (1) Food processing, apparel, and wood products for Indonesia; (2) Food processing, apparel, and electronics products for the Philippines; (3) Food processing, apparel, and chemical products for Thailand; and (4) Chemical products, machinery, and electronics products for Vietnam.

The profile of firms in the sample are as follows: (1) Firms have been in existence for an average of 14 years; (2) Average employee size 293 persons per firm; (3) Most are local firms (60%), while joint venture and multinational enterprises (MNEs) are 13 percent and 25 percent of the total number; (4) If categorized by their functions, firms that produce raw materials are 46 percent of the total number; those producing components and parts, 28 percent; those producing final goods, 71 percent; and those engaged in the procurement of raw materials and parts, 24 percent. Around 77 percent of the firms are improving their product quality while almost 70 percent are working to reduce production defects.

Innovation in our study is classified into three categories: (1) Product innovation; (2) Process innovation; and (3) Securing of new customers and suppliers. Product innovations are being achieved by almost 45 percent of the sample. Those that achieve new market and product innovations based on a new technology are only 9 percent and 11 percent of the sample. Firms in metropolitan areas have a higher chance of securing new local suppliers and customers than those outside metropolitan areas. Here, 63 percent of the firms have secured new suppliers while 65 percent of metropolitan firms secured new customers. In comparison, 56 percent and 58 percent of companies in non-metropolitan areas had secured new suppliers and new customers, respectively.

Seventeen percent of those in the metropolitan areas succeeded in securing supplies from MNEs, as compared with 16 percent of firms not located in metropolitan areas. Also, 30 percent of firms in metropolitan areas have secured linkages with customers that are MNEs compared with 21 percent of firms in non-metropolitan areas. About 27 percent of companies accepted technical assistance from their government or a public agency, while 23 percent cooperated with local universities.

Of the sample, 34 percent utilize their own R&D departments as sources of information and R&D, while 38 percent utilize the sales department as their source of information.

Since firms operating in the ASEAN and East Asia have to supply goods and services to domestic and international markets, they have to compete at the international level. Thus, they need to adopt new technologies and acquire new organizational structures to survive the competitive environment. They have to create new markets, secure new inputs to improve product quality, and introduce new products.

In their study, Machikita *et al*. aim to test whether innovation and linkages of firms are correlated. Empirically, they have to test the relationship of innovations and agglomeration through linkages, given that, empirically, industrial agglomeration has reinforced the growth of firms.

The number of innovations for each firm is the sum of the product innovations, process innovations (including organizational changes), and how firms decide to secure new customers and suppliers. The number of linkages is the sum of sources of information and new technology of the sample firms.

An average index of innovations---the count of firms' positive responses to the questions---is 8.96 for the pooled samples, and the score for linkages is 8.04.

The index of linkages is quite different across countries as a result of differences in industry composition and the nature of their production networks. In other words, agglomeration and the dispersion of firms are affected by the deepening relationship between linkages and innovation.

Machikita *et al.* analyze significantly different characteristics between linked and non-linked firms' innovations. The linked and non-linked firms are defined by the median linkages index level. If we believe that the cost of introducing new goods is hypothetically a decreasing function of the number of linkages, linked firms would have an advantage in product innovations. *However, their empirical study cannot find significant evidence that linked firms have succeeded in introducing new goods more than the non-linked firms. Neither is there any evidence that linked firms and non-linked firms will significantly differ in the new goods introduced to the new market, after securing a new technology.*

When it comes to how firms behave, linked firms are found to have achieved significant organizational changes as compared with non-linked firms in their process innovation. They have succeeded in reorganizing to market-based production processes--- i.e., adopted an ISO standard, introduced information and communication technology (ICT), and introduced internal activities in response to market changes. When firms have established a linkage with new suppliers, they will succeed in introducing new products. In addition, they can utilize a production process that brings with it cost efficiency as well as higher quality input.

The econometric estimates based on the samples indicate that firms with linkage relationships will tend to have higher propensities to secure new suppliers, both locally and internationally, than non-linked firms. More specifically, an econometric analysis can prove that firms that had secured new suppliers, both locally and internationally, tend to have higher levels of innovation.

Whenever firms find it costly to import new parts and materials, they will rely on external linkages with new suppliers located outside their cluster to overcome obstacles. Firms that have many production linkages would attempt more new alternatives than would firms without linkages.

Firms and their partners, both suppliers and customers, are linked since they send and dispatch engineers to give or get advice. This type of linkage has statistically significant effects on firms' product and process innovations; e.g., to introduce new product varieties, or to adopt an ISO standard. Such positive effects will lower communication costs between firms and their partners that are located remotely.

Empirical results confirm that firms with linkages, such as having an engineering face-to-face consultation and frequent interactions with production partners, tend to be successful in innovations. The econometric model reports the following reasons: (1) The knowledge diversity between firms and their partners has spilled over from combinations of different linkages; (2) Firms without internal R&D can get accurate information of others' trials and errors by having many types of linkages; (3) In the face of rapid change in market demand, firms can cope with it via frequent face-to-face communications with their partners.

4 OVERALL SUMMARY OF FINDINGS

4.1. Effects of the Corridor Development on Agglomeration in East Asia

In our study, we have applied the new economic geography theory extensively by construction of a numerical geography simulation model. The model has a clear proposition and testing procedure on agglomeration and the spatial dynamic growth of regions in East Asia. We find that the population dynamics of the regions has responded to different levels of nominal wages in regions. Industrial agglomeration is possible with the introduction of infrastructure development projects such as the road system along the East-West Economic Corridor that links Myanmar, Thailand, Laos, and Vietnam. This specific plan has direct and indirect effects on regions in East Asia, especially on the countries that belong to the Greater Mekong Sub-region. Projects like this can reduce the time cost of crossing borders and therefore facilitate trade and industrial agglomeration in different regions. Thailand, Laos, Vietnam, South China, and part of India will benefit from the industrial agglomeration, while Cambodia will have to disperse its industry as compared with the baseline scenarios during 2011-2025. It is recommended that there should be a coordinated effort among these countries in East Asia so as to balance the benefits and drawbacks of the agglomeration dynamics in the region. Although the model predicts gains and losses for the regions, it is still highly probable that the EWEC will bring larger economic benefits than losses.

On the academic front, it is clear that the new economic geography simulation model developed in our study has predicted useful findings that can help identify solid policy recommendations. It does, however, need to be extended to cover the aspect of income distribution explicitly in the model in future studies. The model extension would have to be with an internationally harmonized database for parameterization. We would like to recommend that this be pursued further through the continuous cooperation of all countries in East Asia. Especially, it is necessary to construct a common database on the spatial dynamics of networks in the East Asian regions.

4.2. Firms' Performance with Innovation, Linkage, and Agglomeration in East Asia

In our study, we have also further investigated firms' behavior in each country, namely, Indonesia, Vietnam, the Philippines, and Thailand. The working group in each country conducted a sample survey on firms. Questions asked touch on linkage, innovation, and agglomeration or clustering and the performance of firms in the identified locations. Interesting results have been reported by each study. The overall finding is that most agglomeration patterns in these developing countries may be closer to the "Hub-and-spoke cluster" mixed with "Satellite platform cluster" but without further study this is not conclusive at present. Furthermore, linkage and innovation are significantly related. Innovations are positively related to the performances of firms.

An econometric analysis confirms that (1) the more frequent the linkages, the deeper firms will be engaged with innovations, even if they have no R&D activity or are non-R&D firms from the beginning; (2) dispatching and accepting engineers to and from customers will induce firms to engage in innovations. Likewise, dispatching and accepting engineers to and from suppliers will bring about a similar outcome; and (3) utilizing more internal resources will also encourage more innovations.

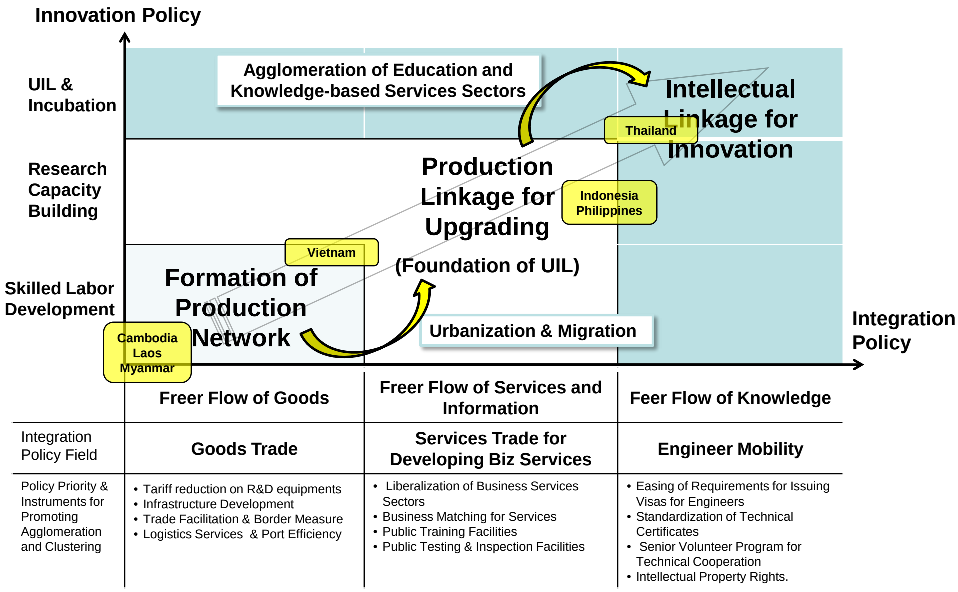
The study also found that East Asia has obstacles to business upgrade and innovations. Of those sampled, 27.8 percent are faced with high costs of R&D equipment and services. Further, East Asian countries have a rather weak support system needed to deliver R&D services at a reasonable price. In fact, most East Asian countries do not have specific organizations in charge of knowledge creation, diffusion, utilization, and value creation/commercialization. Most importantly, East Asian countries have to deal with a shortage of skilled labor, particularly qualified engineers.

5 RECOMMENDATIONS ON INNOVATION AND REGIONAL INTEGRATION POLICY

It is necessary to facilitate linkages between firms-both among local firms, and between local firms and MNEs-whether they be intra-cluster or outside the agglomerated district. This should facilitate the spillover of knowledge and innovation from suppliers to firms and from firms to customers, and vice versa.

The analyses of this research project provide policy opportunities for East Asian countries to take full advantage of economic integration effects in their industrial development policy, on the basis of experimental and empirical evidences. The IDE-GSM provides some macroscopic perspectives on long-term effects of declines in broadly-defined transportation and border-crossing costs on both intra-national and international core-periphery structures. On the other hand, the questionnaire survey and econometric analyses focus on intra and inter-regional business linkages, shorter-term firm-level effects of agglomeration and policy measures. The results of these complementary analyses enable us to derive the following six policy recommendations. The consequences of necessary actions are summarized in the following figure.

Figure 1. Pathway to Innovation



Source: Ueki (WG coordinator).

Recommendation 1: Strategic Development Policy with Target Industries and Balanced Regional Growth

The IDE-GSM revealed that the effects of infrastructure development on each region are very much different by industry. The model also produced the expected "core-periphery" structure, which will be salient for the implementation of customs facilitation measures. The IDE-GSM provides national and local governments with a direction for nominating "potential" target industries for each region with proper infrastructure development planning. Policymakers in East Asia need to pay attention to the negative side-effects that some regions will lose population or industry dramatically due to the expected "core-periphery" structure.

Policymakers in East Asia can coordinate with each other to make full use of transportation infrastructure and avoid a clear segmentation in East Asian society between gainers and losers from the regional integration policy. Highly recommended is consolidation of the existing diplomatic channels or organizations to encourage closer dialogues between related parties, or the establishment of an international body for planning and coordinating the balanced and strategic development of infrastructure in East Asia. Countries in East Asia also can seek further cooperation in FDI and trade policies, including bilateral and regional agreements on trade/investment to promote them in the harmonized manner consistent with the population dynamics and industrial agglomeration predicted by the IDE-GSM. In addition to the regional gap, special attention should be paid to small and medium-sized enterprises that can act as the main driver of modernization and development in the region when the East Asian governments consider a long-term policy of linkage-innovation-agglomeration and performance.

Recommendation 2: Establishment of a Geographical Economic and Social Database in East Asia

The recommended strategic development plan should be reviewed and revised according to changing economic situations, the progress of improvements in transportation infrastructure and industrial developments. An effective observation mechanism, ideally a PDCA (plan-do-check- act) cycle in, can be created. The establishment of a geographical economic and social database in East Asia is the first important step.

To conduct more accurate simulations with richer implications, more precise regional economic and demographic data are required at the sub-national level in each country. We need harmonized data as well as a harmonized data collection method in ERIA countries. ERIA is a suitable body to conduct capacity building for officials in national and sub-national departments of statistics. We also need more precise data on routes and corridors connecting regions. Information on the main routes between cities, times, modes of transport (road, railway, sea, and air) and border related costs should be collected and updated on a regular basis.

Recommendation 3: Facilitation of Movement of Goods for Promoting Innovation

Any improvement in goods movement promotes not only regional economic growth as expected by the IDE-GSM, but also innovations in intermediate goods importing countries, accompanying knowledge spillover to trade partner countries, rippled through international production networks. This spillover effect will strengthen the impact of the regional economic integration, with effective trade facilitation measures, leading to expanding production activities in the whole East Asian region.

Even though such positive impacts are expected, the firms responding to the questionnaire mentioned high tariffs as an obstacle to their productive and innovative activities. This finding reveals that broadly-defined transportation costs and inappropriate border measures hinder technological upgrading and innovation. The urgent necessity of eliminating these impediments is supported by the empirical result verifying the dependence of firm-level upgrading and innovation on production networks. This policy implication is relevant above all to Vietnam among the surveyed countries, and definitely to other CLMV countries.

Economic integration with technological upgrading and an innovation policy is a key concept leading to the establishment of complementary relationships between “cores” and “peripheries”, or to changing the impression of a core-periphery structure from that of a “development gap” to one of “rich diversity.” The empirical study verified that diversified production networks are closely correlated with product innovations and diversifications of innovations. The policy focusing particularly on decreasing the transportation costs of intermediate goods will have the merit of strengthening production linkages between core and periphery industrial districts in the short run, and achieving upgrading and innovation in the long run, as a result of the increased diversity of available inputs.

Recommendation 4: Enhancement of Management Capability through Localized Business Interactions

Just-in-time delivery systems, which are based on localized partnerships for goods transactions, promote face-to-face communication and frequent interaction with production partners, enabling them to share deep and timely information about changes in the market and market turbulence. It can be considered that a JIT system provides firms with useful information to adjust themselves to ever-changing market environments. They can therefore proactively change their internal management organizations, including introduction of ISO standards.

This empirical result suggests two policy implications. First, firms with a few continued customer-supplier relationships with specific partners, particularly small and medium enterprises (SMEs), should be at the core of policymakers' attention. Linked firms receive benefits from partners while providing important information about market changes to their other partners, especially their supplier. It is also important to devote policy resources to the implementation of JIT systems. If there are obstacles to implementing a JIT system that will help firms to upgrade, public assistance can be tapped to create such a network. Economies of networking, based on production linkages, could create such externality.

Recommendation 5: Consolidation of Intellectual Linkages by Developing Public Facilities and Services for R&D Support and Promoting the Private R&D Support Services Sector

The empirical study showed that linkages with the R&D-related public and private services sector, or intellectual linkages, are quite important for manufacturing firms in implementing innovative activities. Even so, such services are not necessarily available and affordable for companies, particularly SMEs in developing countries. High fixed costs related to R&D and other innovative activities need to be shared by firms in order to significantly decrease costs for the individual firm. In this sense, business associations, chambers of commerce and public R&D facilities should take a large role.

Nevertheless, the capability of these organizations is not rated highly by private firms.

There are urgent needs for improving public facilities and services, or promoting the private R&D-related services sector, to facilitate private efforts in innovation. Public resources can be intensively devoted to the development of public facilities for testing, business incubation, and training. Ariff (2008) shares common awareness of this issue. Deregulation and FDI promotion in the business services sector will also stimulate the development of private R&D supporting enterprises, and price competition among them. These policies will be effective for achieving industrial upgrading in the long run.

Recommendation 6: Facilitation of Movement of Knowledge Workers (Part of Service Liberalization)

Econometric analyses verified positive correlations between innovations by suppliers and dispatches of engineers from the suppliers to their customers, as well as between innovations by customers and acceptances of engineers from their suppliers. Face-to-face communication is recognized as one of the key channels of knowledge spillover: face-to-face communication allows sharing and utilization of market information in the development of new products. Therefore facilitation of movement of knowledge workers, above all engineers directly involved in innovation, is crucially important in the countries where labor market rigidities are serious obstacles to innovation, such as Thailand and Vietnam.

Engineer dispatches and acceptances observed from the questionnaire survey are cross-border, while domestic movements of engineers are mainly done between distant places. Based on these observations, improving and expanding transportation infrastructure and services is fundamental to promoting knowledge diffusion through engineer exchanges. If we consider international movements of engineers, policy emphases should be placed on liberalization of services, including reduction of visa requirements and simplification of visa procedures for skilled engineers, mutual recognition of certificates, qualifications and occupational licenses for technical workers and other intellectual professions such as patent attorneys and lawyers. Dispatches of senior engineers from advanced economies such as Australia, Japan, Korea and New Zealand to developing countries can be one of the key potential fields of international cooperation programs to be expanded by aid agencies.

NOTE

[i] The East-West Economic Corridor (EWEC) is a geographical linkage between Vietnam and Myanmar via Thailand, by a road system. The proposal to develop the Greater Mekong Sub-region (GMS) will directly affect Myanmar, Thailand, Vietnam, Cambodia, and Laos PDR. It is complementary with similar infrastructure development projects such as the North-South economic corridor (NSEC) and the Southern economic corridor (SEC), according to Kumagai *et al*. (2008).

REFERENCES

Ariff, Mohamed (2008), *Analyses of Industrial Agglomeration, Production Networks and FDI Promotion*, ERIA Research Project Report No.3, Chiba: IDE-JETRO, March 2008.

Fujita, M., Krugman, P., Venables, A.J., (1999), *The Spatial Economy: Cities, Regions and International Trade*, Cambridge, MA: MIT Press.

Fujita, M. and Thisse, J.F., (2002), *Economics of Agglomeration: Cities, Industrial, Location, and Regional Growth*, Cambridge University Press.

Kimura, F., Kobayashi, I., (2009) Why is the East Asia Industrial Corridor Needed? ERIA Policy Brief, No. 2009-011, January 2009.

Markusen, A. (1996), "Sticky Places in Slippery Space: A Typology of Industrial Districts." *Economic Geography*, Vol. 72, No.3. July 1996, pp. 293-313.

Kumagai, S., Gokan, T., Isono, I. and Keola, (2008), Predicting Long-Term Effects of Infrastructure Development Projects in Continental South East Asia: IDE Geographical Simulation Model, ERIA Discussion Paper Series, Economic Research Institute for ASEAN and East Asia, Jakarta, December 2008.

Kumagai, S., Gokan, T., Isono, I. and Keola, (2009), The Second Generation of Geographical Simulation Model: Predicting the Effects of Infrastructure Development by Industry, paper of the Working Group, presenting at the IDE-JETRO, Bangkok February 2009.

Machikita, T. and Ueki, Y., (2008), Comparative Agglomeration Dynamics (CAD): Field, Theory, Evidence-based Policy Making, paper presented at IDE and BRC-JETRO, Bangkok, October 1, 2008.

Machikita, T., Miyahara, S., Tsuji, M. and Ueki, Y. (2009), Linked versus Non-Linked Firms in Innovation: The Effect of Economies of Network in Agglomeration, The IDE working paper, March 2, 2009

Porter, M. (1990) *The Competitive Advantage of Nations*, Macmillan, Basingstoke

Smith, D. (2006), *Exploring Innovation*, the McGraw-Hill Companies.

Syrquin, M. (1988), “Patterns of Structural Change”, in ed., Chenery and Srinivasan, *Introduction to the Structural Transformation, Part 2*, Handbook of Development Economics Vol.1, North Holland, 1988.

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Industrial Agglomeration and Technology Upgrading and Innovation: The Experience of Indonesia

Dionisius A. Narjoko

Abstract

This study addresses the impact of industrial upgrading on firm performance. It puts forward a general hypothesis which states that linkages of firms with other firms or economic agents, either globally or domestically, should facilitate the upgrading process. The empirical results based on the survey of 150 respondents provide some support to this. In particular, and among others, foreign or joint venture firms seem to have been more successful than domestic firms in conducting industrial upgrading. The study also found some supportive argument based on a few in-depth interviews on the importance of the linkages. Specifically, having an export market orientation and a motivation to improve competitiveness encourages firms to upgrade their production capability, particularly in terms of the technology of their machinery.

Based on the key findings, this study puts forward some policy recommendations. One, the government needs to increase the level of foreign direct investment (FDI) as well as domestic direct investment, and to create a more liberal FDI policy such as non-discriminatory national treatment and liberal negative investment list. This recommendation is consistent with the argument that one possible explanation of the lagging technological development in Indonesia is the deteriorating investment climate after the 1997/98 economic crisis. Two, there is a need to speed up (unilateral) services trade liberalization for Mode 4. This is because the services of consultants seem to still play a crucial role in transferring knowledge and technology. And three, this paper also puts forward the recommendation to make comprehensive reforms in the logistics sector in order to reduce transport cost and improve service quality. Included here is the development of a national strategy on reforming the logistics sector and financing infrastructure projects.

1. INTRODUCTION

Industrial upgrading and innovation activities are important to facilitate industrialization in developing countries. They act as a driver for industrial growth through some channels and ways that improve a country's industrial competitiveness.

Experience from many developing countries indicates that linkages across firms, both internationally and domestically, help firms to upgrade their production capability and to innovate. Indeed, Ernst (2004) has argued and showed that international linkage plays a key determinant for the upgrading, and one of the important channels for this is in the form of a global/international production network (GPN). The East Asian experience suggests that a relatively open international trade and FDI regime facilitates the work and spread of the network. The domestic linkage, meanwhile, usually extends the results of the international linkage through the channelling of domestic trade and production activities, including the forming of many local industrial clusters within countries.

This study addresses this subject, taking the reference of the Indonesian experience. It benefits from the survey conducted in Indonesia for the overall research project. In particular, the study focuses on and asks about the importance of linkages with other firms or economic agents, either internationally or domestically, in determining firm performance in terms of competitiveness. In addition to examining the linkages, this study also draws some important observations from the survey, as a second objective, by describing the key characteristics of the survey's respondents. Assessing the characteristics is useful and contributes to the general literature on technology development in Indonesia.

Meanwhile, the case of Indonesia fits this subject well because of its rapid industrialisation in the past thirty years or so. Local industrial clusters have been developed over the course of this rapid industrial growth, and this study draws from information of some firms in the industrial cluster of the *Jabodetabek* (*Jakarta*, *Bogor*, *Depok*, *Tangerang*, and *Bekasi*) area which is located in the greater Jakarta area in Indonesia.

The rest of this paper is organized as follows. Section 2 briefly reviews the relevant literature, including a few key points about the technological development in Indonesia. Section 3 describes the distribution of firms in the Jabodetabek area while Section 4 describes some basic characteristics of the survey's respondents. Section 5 forms the core of this paper, reporting and discussing several key elements of the survey results. Finally, Section 6 puts forward a number of policy recommendations based on the findings of the study.

2. BRIEF LITERATURE REVIEW

2.1. The Determinants of Industrial Upgrading and Innovation

The study on industrial upgrading is considered to be necessary for developing countries in order for the industrialization process in these countries to allow firms to move up in the overall value chain of industries. To achieve this, developing countries could make use of their abundant FDI (IMF 2004). Thus, the international linkage of the domestic industry, which takes place through trade and production channels, could be a key determinant of industrial upgrading for developing countries (Ernst 2004). In the past decade or so, this has in fact been supported by the rise and surge in regionalism. This international relation may take the form of the global production network (GPN) model of industrial clusters.

Recently, there has been a wide interest in the study of GPN, defined as the nexus of interconnected functions and operations through which goods and services are produced, distributed, and consumed (Henderson et al. 2002). This network uses industrial clusters in each country as the location of the production process. While some studies on this subject are well documented (e.g., Yeung 2008, Dicken et al. 2001, Coe et al. 2004), there is little research on industrial upgrading as one of the consequences of the GPN model of industrial clusters.

This section aims at reviewing the literature concerning the current trend of the GPN production pattern, the model of industrial clusters, and upgrading. To acquire higher technological and managerial capabilities, it is argued that suppliers from less developed countries should operate in a cluster with complete supporting facilities for trade and industry, including adequate logistics services. As such, a cluster should be developed in order to engage with foreign producers and gain from said engagement. Moreover, this heightened cross-country economic activity should make use of the regionalization recently implemented through the ASEAN Economic Community (AEC), particularly in reducing cross-country distance and expediting the flow of goods and information.

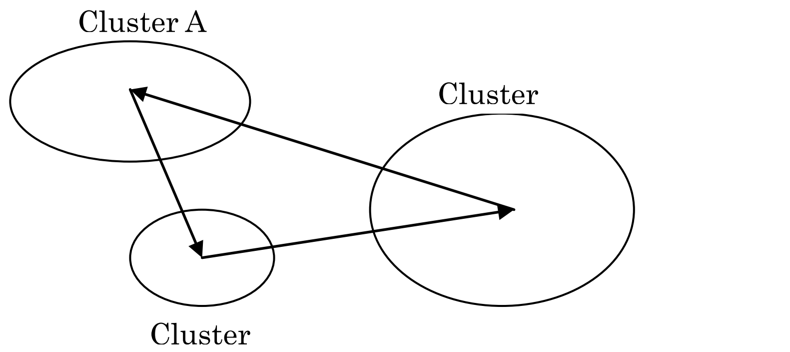
The next section discusses the international production network, more specifically, its elements, advantages, and critical points to be considered to enhance the advantages from the network. It then explains the role of industrial clusters and the criteria of a competitive cluster. The last part of the literature review provides evidence of upgrading as the effect of the production system.

2.2. GPN Model of Industrial Clusters

According to Ernst (2004) and Yeung (2008), a GPN is a geographically dispersed production where each stage of production is located in the most efficient place while industrial clustering is the localization of the operation of the GPN. Figure 1 shows the relationship between the two, whereby each cluster produces different outcomes and may locate in different countries but all clusters are connected in one production network.

Participants in this model involve a transnational company (TNC) as the lead firm and its subsidiaries, strategic partners, suppliers, customers, and non-corporate institutions. Yeung (2008) divides the functions of these participants into two categories: (1) the function of the TNC of conducting research and development (R&D) and arranging for strategic management, marketing, and distribution, and (2) the function of its partners of producing the goods.

Figure 1. Gross Production Network Model of Industrial Cluster

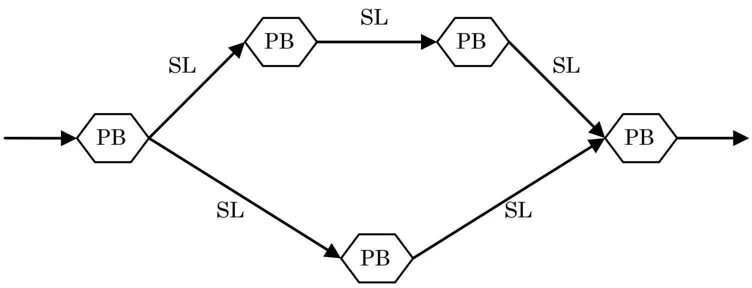


In this model, developing countries usually serve as suppliers for the TNCs. The literature (e.g. Ernst 2000, 2004; Ernst and Kim 2002) also organizes suppliers into two types: higher-tier suppliers, who are capable to manage the global supply chain, possess technology, and likely to have mini production network; and lower-tier suppliers, who have an advantage in low-cost production but do not have investments in technology and are vulnerable to external shocks. This organization of suppliers is important in assessing the upgrading level of domestic industry and its involvement in the international chain of linkages.

One of the advantages of a manufacturing model of this kind is the big possibility of industrial upgrading. Studies indicate that countries participating in this model have industrialized the fastest (Feenstra 1998, Jones and Kierzkowski 2000, Navaretti et al. 2002, as cited in Ernst 2004). The reason may be that this model reduces constraints of international technology spillover as well as increases the need for knowledge diffusion. As TNCs focus in R&D, their technological skills will be reflected in their high-standard demand to their subsidiaries around the world. This encourages the suppliers to upgrade their capability. The requirements for specific production process and competition among suppliers also result in a moving up of firms to the higher level in the value chain.

In order to identify the significant parts of the development of the GPN, one can use the approach of fragmentation theory by Deardoff (2001) which defines the production network as the split of production into production blocks (PB) where the blocks are connected by service links (SL) as shown in Figure 2. According to this approach, the two main elements that ensure a gain from this model are the lower costs in the service links and in the production blocks (Kimura 2008). Service links such as transportation and telecommunication should not be costly in this production system because the frequency of connection between blocks in this system is high. Thus, service links play an important role in the existence of this fragmented production. With regard to the lower cost in production blocks, it is achieved when manufacturing activity is located in a well-established industrial cluster system.

Figure 2. Fragmented Production



2.3. Industrial Cluster

This study argues that domestic industrial cluster should be developed in order for a country to gain from a GPN. The reason for conducting production activity in a well-established cluster is to deliver competitive and high-quality products. In a cluster, there is a lot of costsaving resulting from proximity and the relatively inexpensive cost of logistic such as easy access to information of products, market condition, and technology.

An internationally linked industrial cluster should be equipped with uncomplicated access to capital, human resource, market, hard and soft infrastructures, and logistics (warehousing, packaging, shipping, and airfreight), and should be supported by a stable macroeconomic condition. These factors should be supported by government policies.

Kuchiki (2005) therefore asserts that the role of government is to deliberately build a cluster on the basis of policies while the TNCs' role is to be the builder of value chain management.

2.4. Industrial Upgrading from the GPN Model of Industrial Clusters

The coverage of upgrading may include the introduction of new products, higher capabilities in design and development, and an improved and more integrated business process system. To be upgraded, firms may carry out the following innovation efforts such as technology search, technology purchases, and expenditure on licensing and consulting services. Ernst (2004) recommends the use of international linkages, namely: collaboration with foreign universities and research institutes in asking for customized training for the firm or industry, collaboration with international consulting firms, and participation in an international peer group network. Another common source of industrial advances is brain circulation where local citizens who have had experiences in industrialized countries return home and make use of what they have learned from industrialized countries. Ernst categorizes two aspects of upgrading: firm-level and industry-level. Firm-level upgrading is when the firm makes the effort to shift from generating low-end to high-end products while industrial-level upgrading is when innovations are conducted by universities and research institutions, without which firm-level upgrading will be difficult.

Both aspects, whenever conducted by firms, are likely to be the result of the engagement of the firms with foreign subcontractors. As mentioned, the TNCs force and/or give opportunity to suppliers to innovate, and industrial clustering enables the innovation to be realized. The position of the manufacturing firms in a cluster makes it possible for the firms to move up in their technological ladder. Thus, the involvement of local companies in a GPN as well as their location in an agglomerated economy may generate a larger value added from their production process.

Past researches show that this phenomenon does happen in East Asia, particularly in the electronics, machinery, and telecommunication industries (Kimura and Ando 2005, Athukorala and Yamashita 2006). A popular example is the electronic production chain involving Malaysia, Singapore, Thailand, and, to a little extent, the Philippines and Indonesia. Ernst (2004) finds evidence of more sophisticated softwares used in Malaysian firms as a consequence of linkages of local firms with global brand leaders. Ernst also considers four factors affecting the information technology changes in Malaysian electronic firms. One is the operation of US-based manufacturers in the country which had promoted improvements in the technological level of the domestic industry. The arrival of these flagships appears to be a contributing factor in the introduction of new products in the market - although Ernst considers this factor to have created only a limited upgrading in Malaysia. Two is that the acquisition of Asian suppliers by US manufacturers leads to an infusion of new capital and technology by the suppliers. Three is that the FDI coming from Japan and Taiwan for the production of raw materials for computer manufacturing provides upgrading opportunities in product design and supply chain management services for Malaysian companies as the investors' affiliates. And four is that in the midst of severe competition, domestic higher-tier suppliers become more aware of their needs to enable them to move their position up in the hierarchy of vertical integration.

Another example is given by Ernst and Kim (2002) about a global electronics brand leader named Cisco. Thirty-two manufacturing plants worldwide are connected to one another through Cisco. As suppliers, the plants need to obtain certain certifications in order to meet Cisco's requirements. This kind of standard requirements compels small- and medium- companies to enhance the quality of their products and/or business process.

In addition, the textile and clothing industry in Southeast Asia has gained from the GPN in the form of an improvement in technological and industrial capabilities. In the 2000s, the involvement of Hong Kong, Taiwan, and Korea in the GPN of apparel industry decreased whereas that of China and Southeast Asian countries increased. This has led to a change in the role of Asian suppliers in the manufacturing arrangement. Gereffi et al. (2002, as cited in UNIDO 2004) indicate that for over a few decades, the Asian manufacturers have only assembled fabrics according to detailed instruction from buyers. However, in recent years, they have started to move up the value chain by also offering designs of apparels, making samples, sustaining product quality, and meeting price and other requirements. This movement also works as a learning process for the local producers to deliver competitive consumer goods to the global market.

2.5. Few Key Points on the Technological Development in Indonesia

A very recent paper by a well-respected Indonesian economist, Thee Kian Wie, provides very useful key points on the technology development in Indonesia. The following paragraphs draw from this study (Thee 2006):

First, technology development in Indonesia seems to have lagged behind other developing countries which generally share the same industrialization process as Indonesia. This technological lag is illustrated in Table 1 which shows a low percentage of technology content in Indonesia's manufacturing exports relative to other countries in East Asia. The Table also shows that Indonesia's position is much lower than that of Thailand which has a similar industrial development as Indonesia.

Table 1. Indonesia's High Technology Exports in Regional Perspective, 2003

Country	High technology manufactured exports (US$ billion)	High technology exports as a percentage of total manufactured exports (%)
Indonesia	**4,580**	**14**
Malaysia	47,042	58
Singapore	71,421	59
Thailand	18,203	30
China	107,543	27
South Korea	57,161	32

Note. High technology exports are products with a high R&D intensity, as in aerospace, computers, pharmaceuticals, and scientific instruments.

Source: World Bank: *World Development Indicators, 2005*, table 5.12, pp. 314-8.

Second, the technology adoption that has occurred in the Indonesian industrialization seems to have taken place only marginally. As noted by Thee (2006, p.11), a comparative study on the link between manufactured exports and technological capabilities in Korea, Taiwan, Indonesia, Thailand, and Vietnam (Ernst et al. 1998) shows that even in export-oriented manufacturing firms in Indonesia, there were still limited basic production or operational capabilities required for the smooth functioning of the plants. Many of these firms adopted only minor changes in their capabilities, specifically with regard to the introduction of minor changes in process technologies to adapt to local conditions, and only a handful developed more sophisticated capabilities.

Third, as argued by Thee (2006, p.19-20), one important factor that might explain the lack of technological development of Indonesia vis-à-vis the other developing countries is the weak investment climate that occurred there after the 1997/98 economic crisis. Unlike the other developing countries such as Malaysia and Thailand, Indonesia experienced deterioration in its investment climate during the post-crisis period. Because of this lack of FDI – often regarded as an important source of technology transfer – Thee argued that many firms in Indonesia were not able to restructure their production capabilities to adjust to changes in the industrial structure after the crisis.

3. DISTRIBUTION OF MANUFACTURING FIRMS IN THE JABODETABEK AREA

Indonesian manufacturers seem to heavily concentrate in the Jabodetabek area which absorbs around 23 percent of the country's total number of manufacturing plants. Data on the geographical distribution of manufacturing firms in Jabodetabek suggest the existence of an agglomeration process in the metropolitan area (see Figure 3). Most industries are gathered outside Jakarta while the city of Jakarta itself functions, to some extent, as a place for the headquarters. In Table 2, majority of the manufacturers operate in Tangerang, Bekasi, Bogor, and North Jakarta. The proportion of industries in the city of Jakarta – in terms of the number of plants – is larger than in terms of the number of total employees. This indicates that the size of plants in Jakarta is somewhat smaller than in the outskirts of Jakarta.

Across Greater Jakarta, there seems to be a division of areas among the five major industries. Most of the firms in the textile and product textile (TPT), wood and wood products (WWP), and food, beverage, and tobacco (FBT) industries operate in Tangerang, Western Jakarta while majority of the firms in the machinery, electronics, and equipments (MEE), and automobile industries are located in Bekasi, Eastern Jakarta. On the whole, though, Tangerang absorbs more labor than Bekasi. This implies that the TPT, WWP, and FBT industries tend to be more labor-intensive than the MEE and automobile industries.

In addition, the TPT, WWP, and FBT industries seem to be more equally distributed across the metropolitan area than the other two important industries. This might be because the first three industries are easier to be established in terms of location and may not need a vast area and many facilities as the MEE and automobile industries.

Figure 3. Geographical Distribution of Industries by Employment in the Jabodetabek, 2006

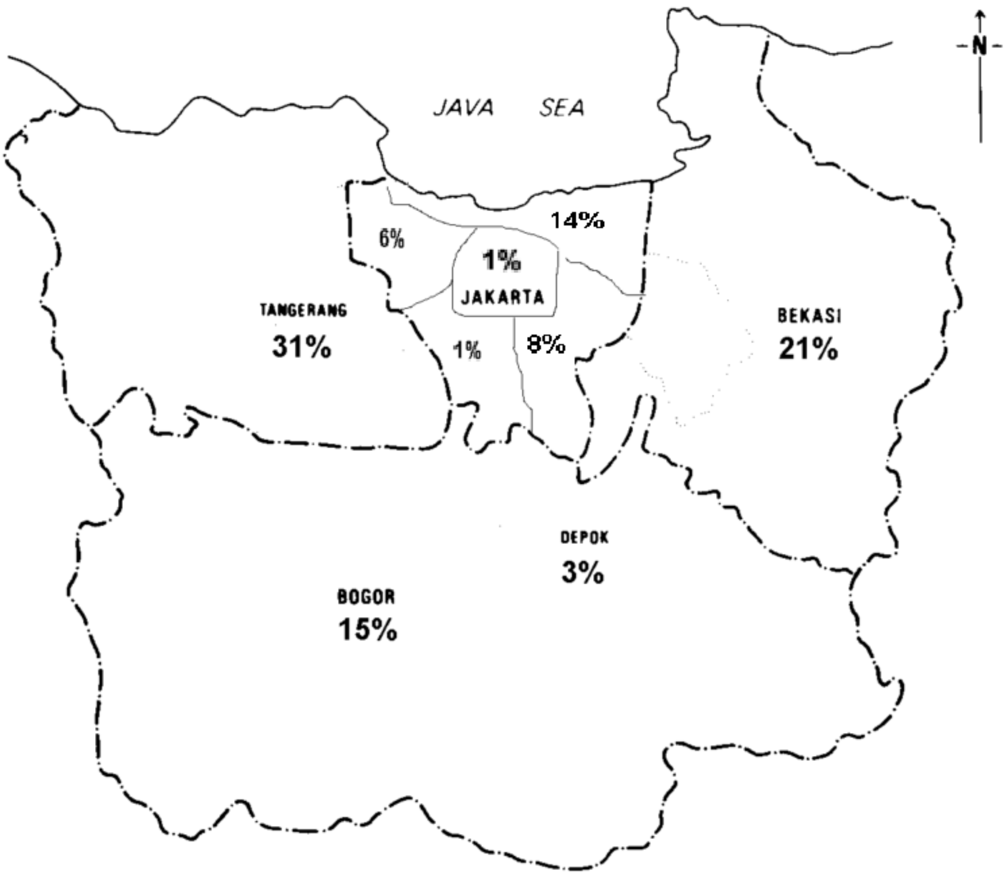


Table 2. Geographical Distribution of Industries in The Jabodetabek, 2006

Sub-region in Jabodetabek	# of plants		# of employees(% of total in Jabodetabek)							
	#	% of total in Jabodetabek	Total in #	Total in %	Food, beverages and tobacco	Textiles and products textile	Wood and wood products	Machinery, electronics and equipments	Automotives	Others
TANGERANG	1675	**25.0%**	420802	**31.2%**	**25.2%**	**36.7%**	**34.7%**	24.6%	14.0%	31.3%
WEST JAKARTA	1039	15.5%	76955	5.7%	7.8%	5.8%	4.4%	3.8%	0.9%	7.2%
CENTRAL JAKARTA	149	2.2%	8711	0.6%	0.4%	0.4%	0.2%	0.2%	0.1%	1.4%
SOUTH JAKARTA	229	3.4%	16994	1.3%	1.3%	1.3%	0.5%	0.2%	0.0%	2.0%
EAST JAKARTA	486	7.2%	108716	8.1%	12.9%	2.6%	6.8%	8.8%	14.9%	12.1%
NORTH JAKARTA	1048	15.6%	194196	14.4%	15.3%	20.0%	12.0%	3.2%	30.6%	8.4%
BEKASI	1094	16.3%	286188	21.2%	18.1%	11.4%	19.0%	**50.7%**	**32.4%**	21.6%
BOGOR	863	12.9%	201124	14.9%	16.8%	18.7%	19.6%	6.7%	6.7%	13.6%
DEPOK	130	1.9%	34208	2.5%	2.1%	3.2%	2.8%	1.9%	0.2%	2.5%
JABODETABEK	6713	100.0%	1347894	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
INDONESIA	29468		4755703							

4. THE SURVEY QUESTIONNAIRE AND CHARACTERISTICS OF THE RESPONDENTS

4.1. The Survey Questionnaire

As mentioned, this study benefits from the survey that is designed for the whole research project on the subject documented in this volume. The questionnaire tries to capture the extent of industrial upgrading and innovation in an agglomerated industrial area. This involves many aspects such as the characteristics of the firms, the nature and characteristics of the research and development conducted by firms, and some geographical aspects (e.g., distance across firms in industrial clusters as well as distance between firms and consumers, the availability of logistics services in the clusters, etc.). In addition, the survey also asks firms on some policy-related questions regarding government assistance for research within firms.

4.2. The Characteristics of the Respondents

This section discusses the firm-level survey of 150 companies operating across Jakarta and the surrounding cities (Jakarta, Bogor, Depok, Tangerang, and Bekasi/Jabodetabek). As Figure 4 shows, around 80 percent of the respondents are locallyowned while the other 20 percent are foreign-owned and joint venture firms whose major investors are Japanese, American, and South Korean (Figure 5). This characteristic jibes with the population level in the Indonesian manufacturing industry where majority of the establishments are local and a substantial number of investors in the industry are Japanese.

Figure 4. Ownership Structure of The Respondents

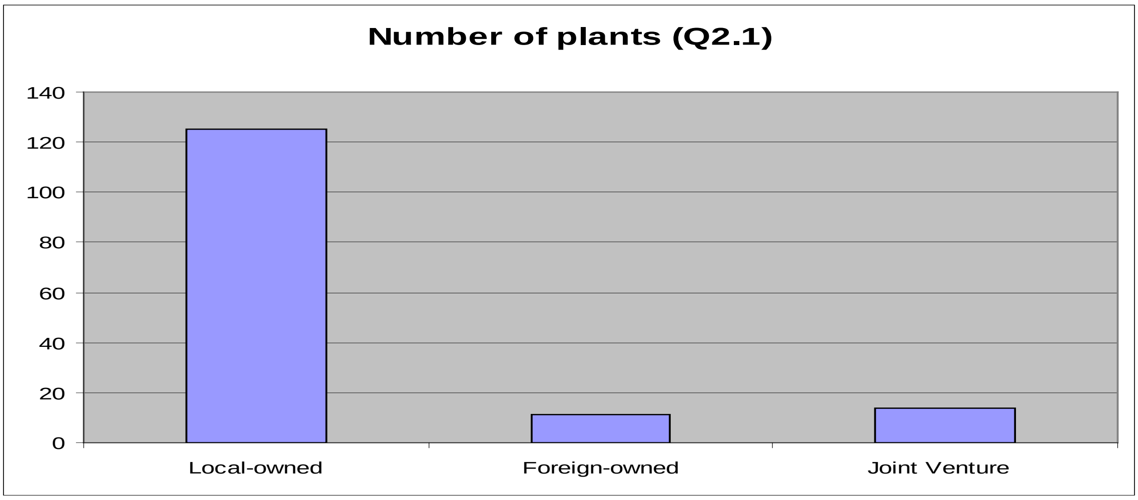
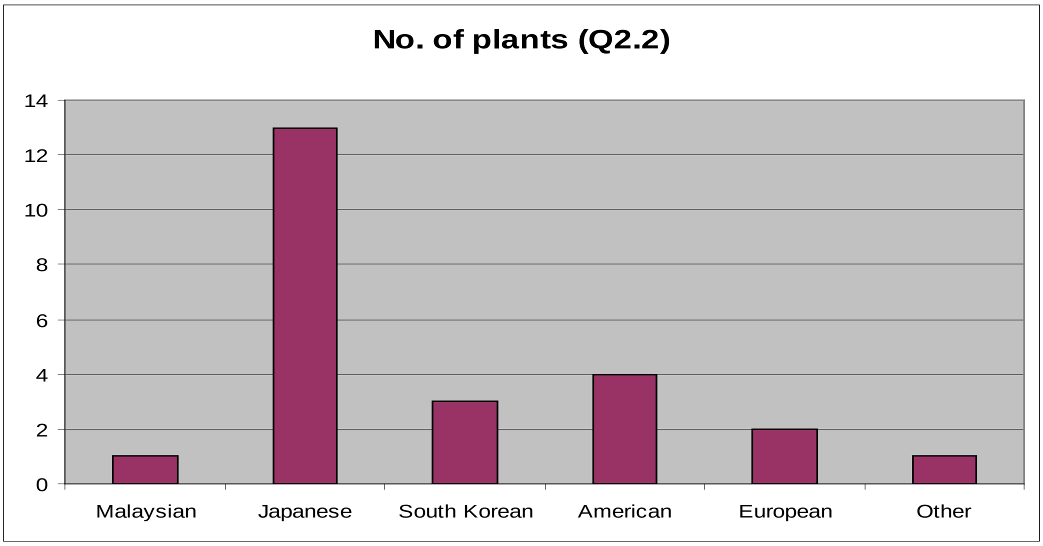


Figure 5. Largest Foreign Investor of Foreign-Owned and Joint Venture Firms



Regarding size of the respondents, the distribution of firms is more equal in terms of total assets rather than in terms of the number of full-time employees. As to total assets, one-sixth of the respondents have US$ 10 million and above while one-tenth manage assets worth between US$ 100 thousand and US$ 500 thousand (Figure 6). In terms of the number of employees, about two-thirds of the respondents are small and medium enterprises or those with less than 200 employees (Figure 7). This feature is consistent with official data showing that local enterprises tend to have a smaller size than foreign-owned enterprises.

Figure 6. Size of the Respondents, by Total Assets

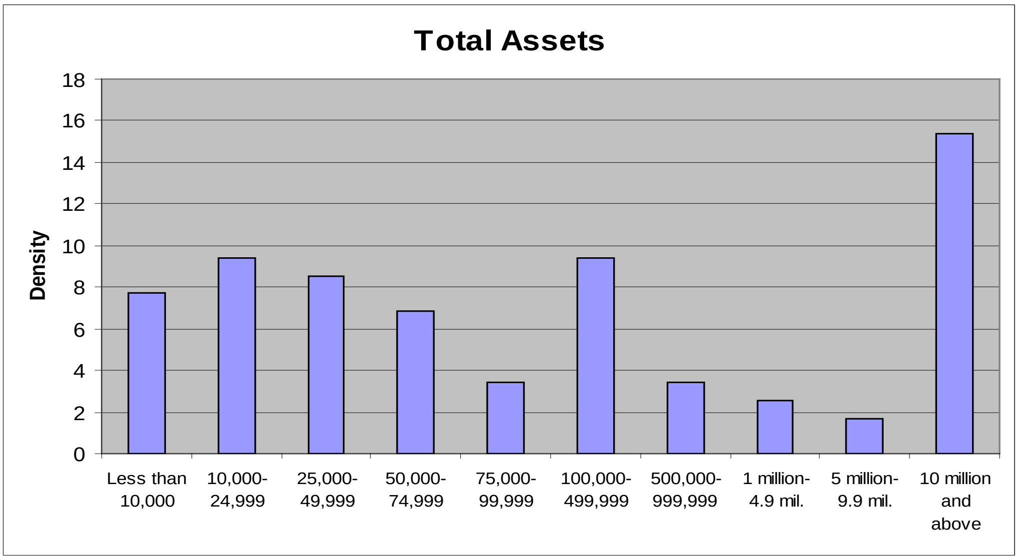
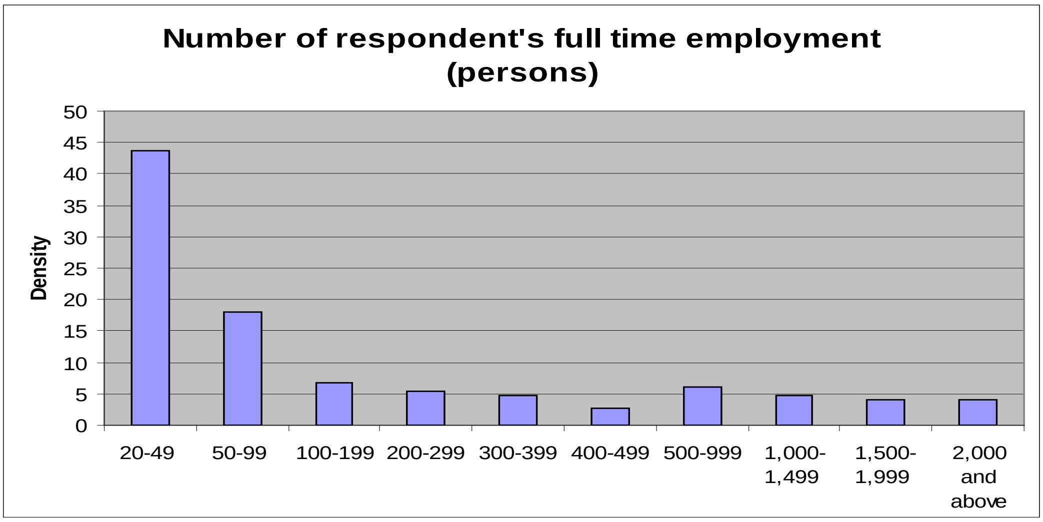
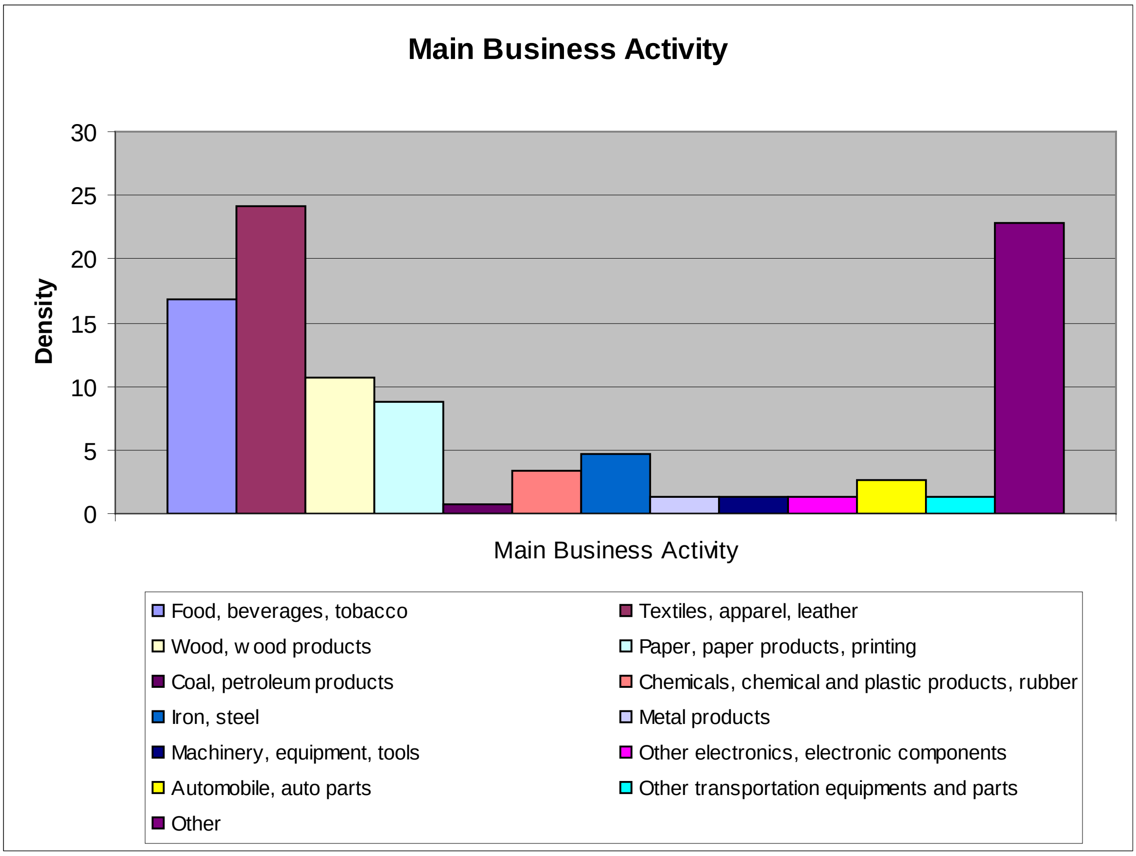


Figure 7. Size of the Respondents, by Number of Full-Time Employee



The respondents' main business activities vary, but most are categorized in the following four subsectors: textiles, apparel and leather; food, beverage and tobacco; wood and wood products; and paper and paper products (Figure 8). This is in line with the structure of the Indonesian economy which heavily relies on labor-intensive industries. Out of 17 categories presented to the respondents, a significant number among them chose ‘other industries’ as their main business activity. This is probably a result of their not knowing the classification of their products.

Figure 8. Main Business Activities of the Respondents



The presence of an agglomeration economy in the Jabodetabek area may be indicated by observing the supply and output of the respondent firms. Since most respondents are local firms, one may expect that their most important market is also local and not international. From around 140 manufacturers answering “domestic” as their market, approximately 85 percent of them target only Jabodetabek as their most important market (Figure 9). This is similar to the location of the companies’ suppliers. About 100 companies mention that their suppliers are also from this region (Figure10).

Figure 9. Location of Important Target Market

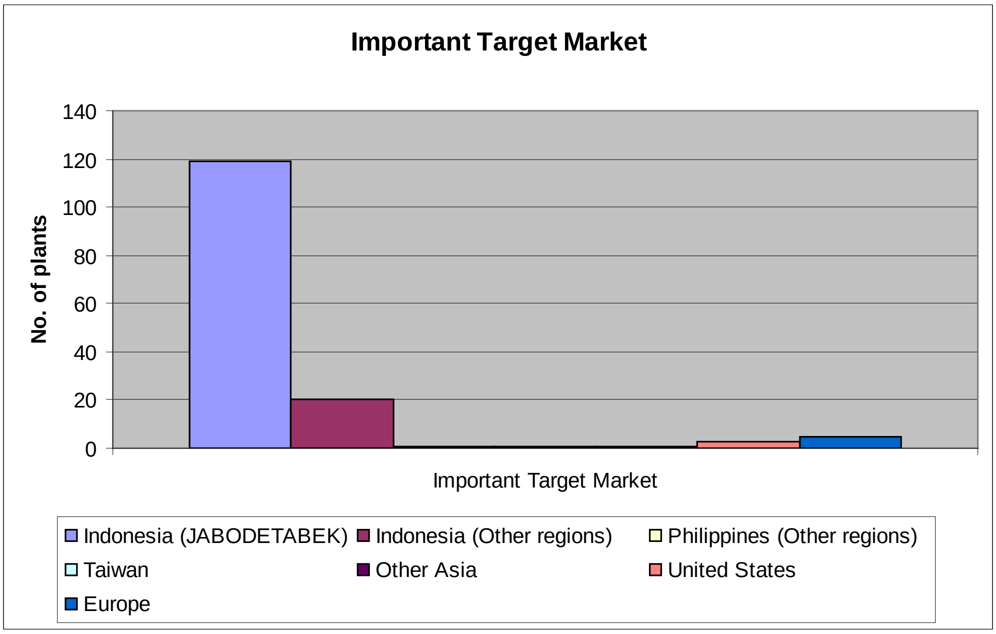
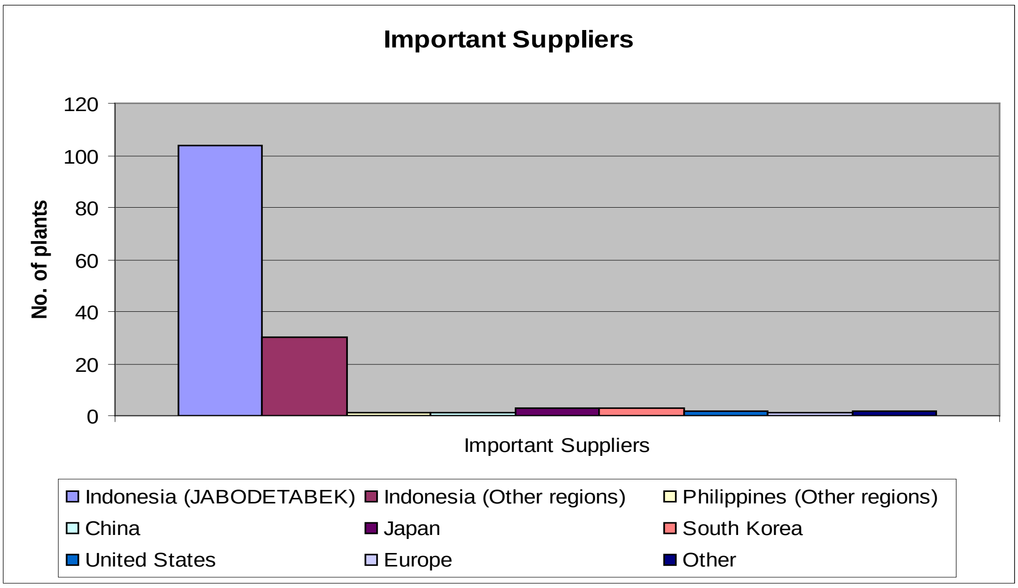
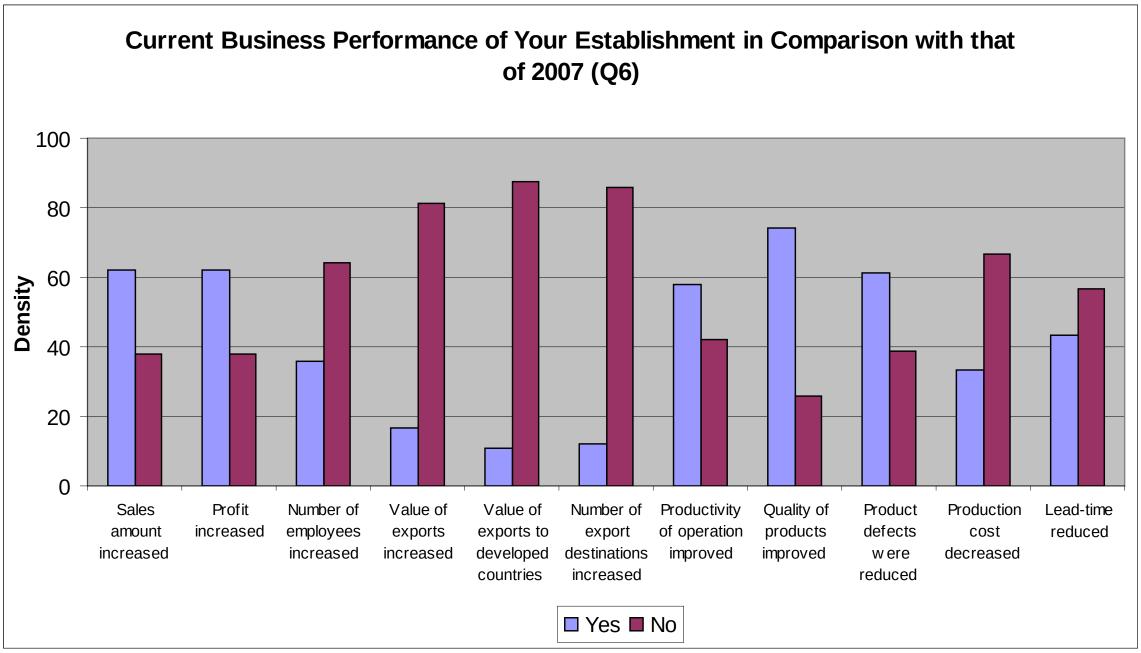


Figure 10 Location of Important Suppliers



Around 60 percent of the respondents report an increase in sales and profit of their firms, together with an improvement in their product quality in recent years (Figure 11). However, only a small portion of firms report a higher export value. This may be because majority of the respondents are small and medium enterprises, which tend to be non-exporters. Another possible reason is that the global crisis negatively affected the companies' export demand, particularly in the last quarter of 2008.

Figure 11. Business Performance in the Recent Year



Meanwhile, the functions of the establishments have not changed over time (Figure12 and 13) and majority of them are both producers and marketers. In the survey, the number of firms that changed their function/role is so small that no certain conclusion can be drawn.

Figure 12. Function of Respondents, at Present

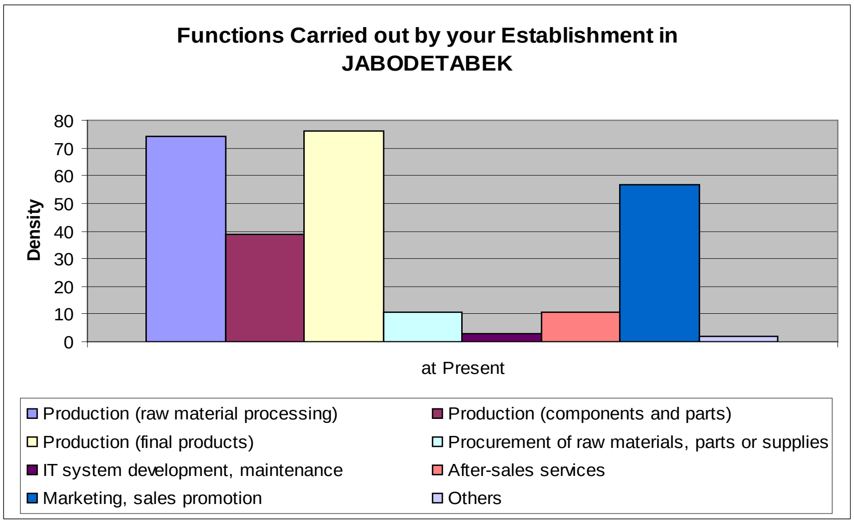
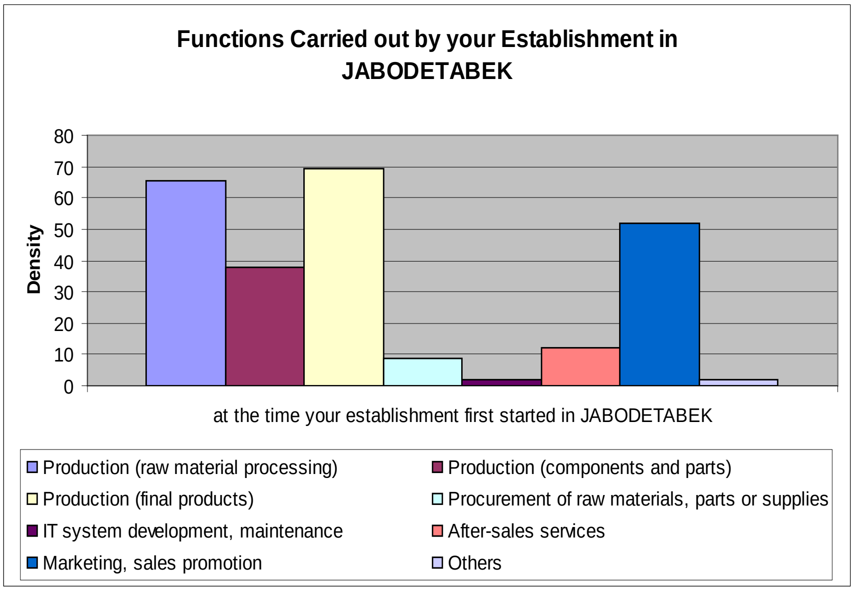


Figure 13. Function of Respondents, at the Start of the Firm's Operation



On being asked about R&D activities, around 26 establishments responded that they carry out such activities (Figure 14). One-fourth of these 26 companies (or about 5% of all respondents) have a special R&D department in their companies (Figure 15), with a few of these 26 companies having started R&D from the 1970s–1994. After 1994 until the present, though, a downward trend among companies starting to do R&D can be seen (Figure 16). There might not be any reason for this, owing to the fact that the total number of firms surveyed is only about 25, too small in terms of a sample size. Still, a possible reason is that during the 1980s and 1990s, the industry enjoyed a boost from government policies on industry and trade liberalization, thereupon not giving reasons nor encouragement for firms to initiate R&D activities. But then, the number of respondents conducting R&D increased considerably in the latter half of the 1990s due to the effect of the 1997 Asian financial crisis when domestic purchasing power was low and the Rupiah depreciated, causing many firms to switch their market orientation from domestic to export-oriented. Entering the international market forces some firms to acquire new machines and/or other factors of production. This is inferred to by respondents who answered that they started R&D in the period of 1995-99. Another interesting characteristic is that the number of firms beginning their R&D has decreased since then, which could be due to the impact of the poor business climate in the country in the year 2000s.

Figure 14. Proportion of Firms Conducting R&D Activities

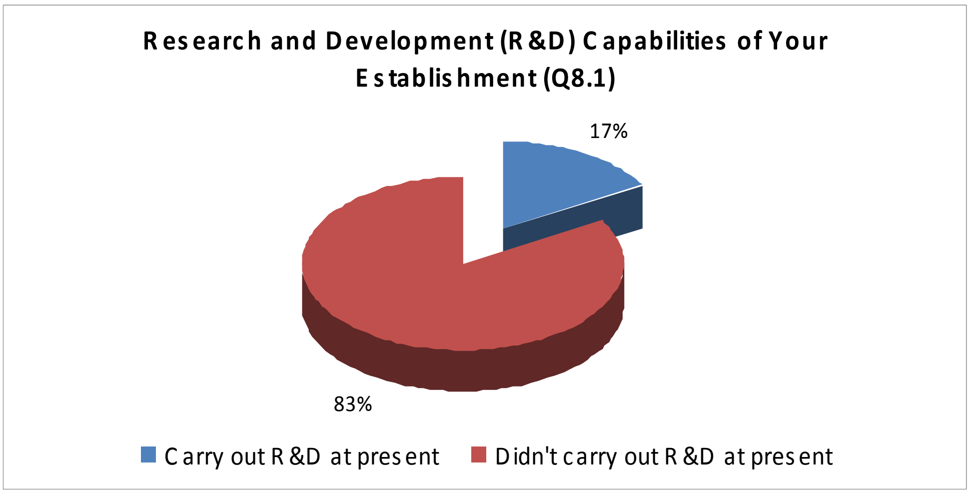


Figure 15. Proportion of Firms Having R&D Department
(to total firms conducting R&D)

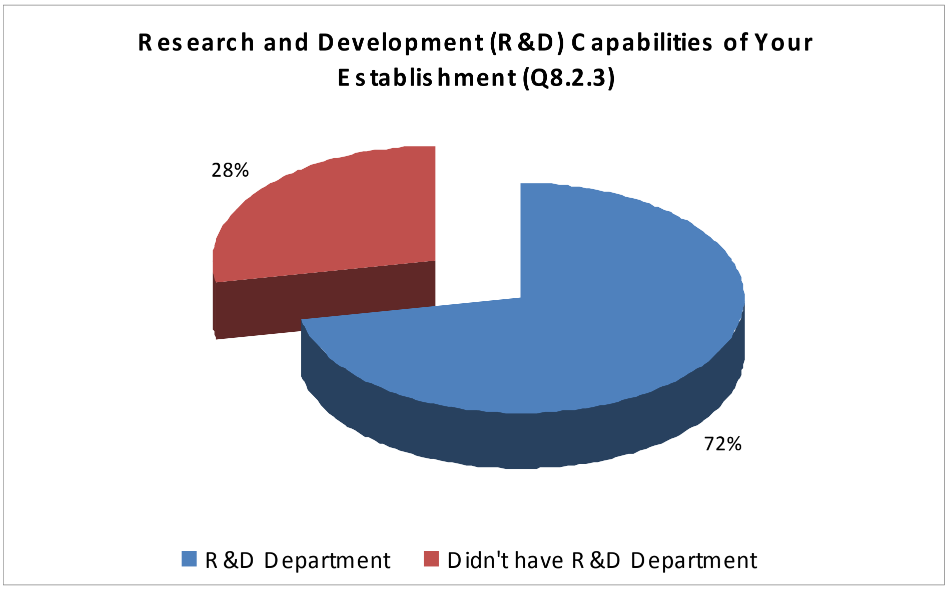
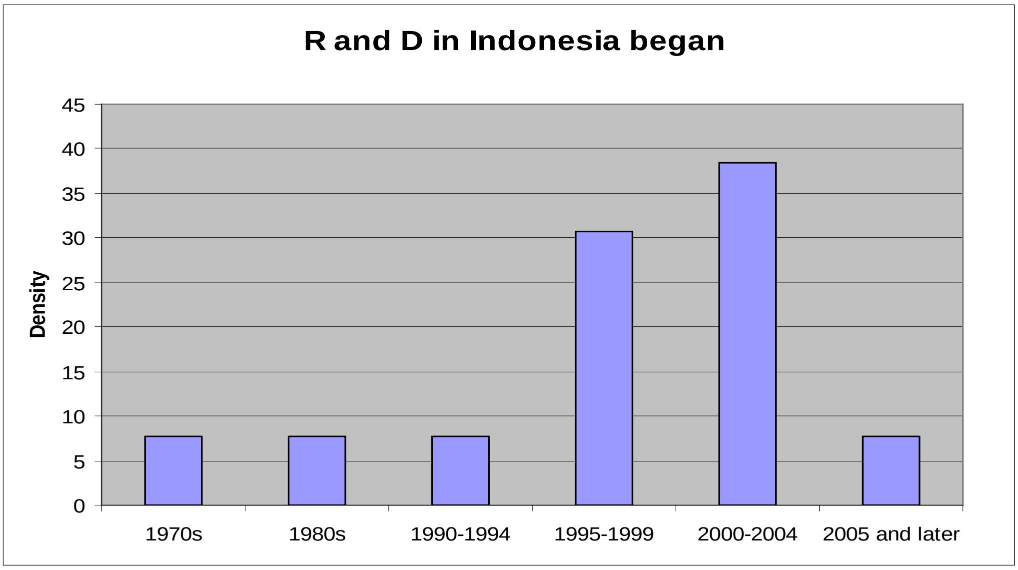


Figure 16. Number of Firms Starting R&D Activities, by Time Period



Nevertheless, their R&D activities seem to have been very minimal since about 40 percent of the 26 firms do not allocate any fund for R&D and employ only less than 5 people for this activity (Figures 17 and 18). However, there are five establishments with R&D expenditures of about 5 percent from its sales and two establishments employing between 26-50 people for R&D.

Figure 17. Proportion of R&D Expenditure to Total Sales

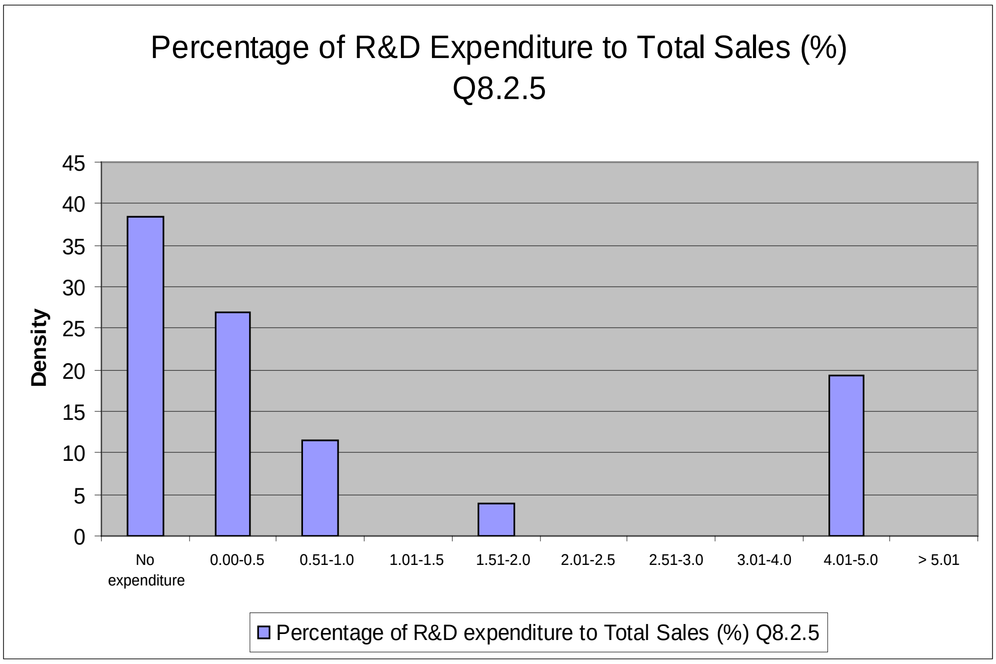
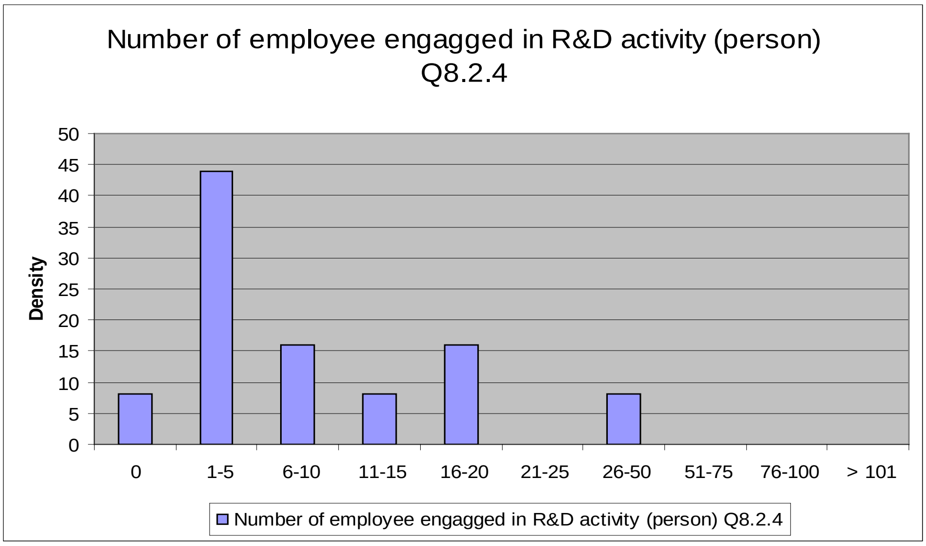
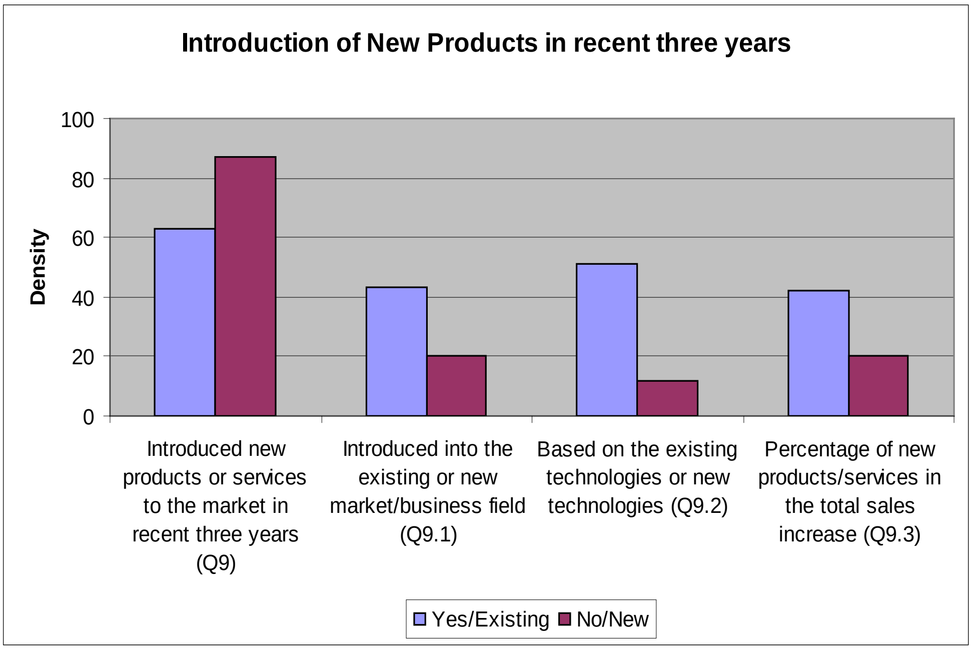


Figure 18. Number of Employees Engaged in R&D Activities



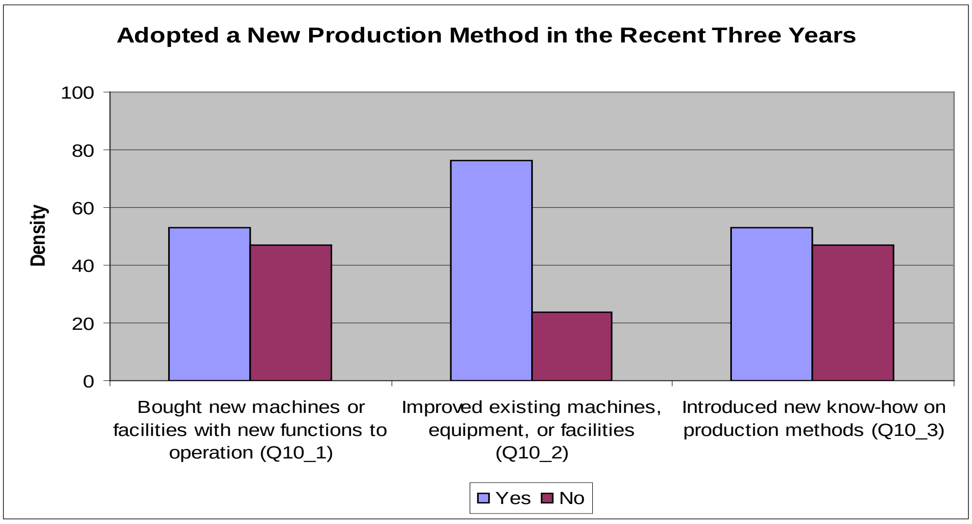
Regarding innovation, 40 percent of the respondents introduced new products/services in the last three years (Figure 19). About 80 percent of them appear to have succeeded for the reason that the proportion of the new products/services are becoming larger in their total sales since the time they were first introduced. However, this innovation does not refer to a great product invention because most of the new products still exploit existing markets and use existing technology.

Figure 19. Introduction of New Products in Recent Three Years



The respondents seem to have been active in the innovation of new or improved machines. In the last three years, approximately half of respondents bought new machines or facilities with new functions to operation and introduced new know-how on production methods (Figure 20). Moreover, almost 80 percent of the respondents improved their existing machines, equipment or facilities.

Figure 20. Changes in Production Method in Recent Three Years



Respondents were also asked about their sources of innovation and upgrading. Sources which are regarded to be important for more than 40 percent of the respondents include: recruitment of mid-class personnel, the firms' sales and production departments, technical information from patents, and foreign-made equipments and software (Figures 21 and 22). This indicates weak linkages between respondents and other firms/institutions, and/or small benefits from existing linkages between them in terms of technological spillover.

Out of 150 companies, there are about 125 companies who do not have R&D activities, and about 60 to 90 companies neither buy new machines nor introduce new products. According to the respondents, the major obstacles for innovation are high tariffs on equipment and materials needed for innovation, limited R&D supporting industry, expensive R&D support services, and insufficient protection of intellectual property rights (Figure 23). These obstacles indicate a need for government attention in improving the access to the materials. The impediments to innovation may also suggest that the agglomerated economy has not fully functioned as a supporting innovative environment for manufacturing firms in the Indonesian economy.

Figure 21. The Sources of Information and Technology for Innovation and Upgrading I

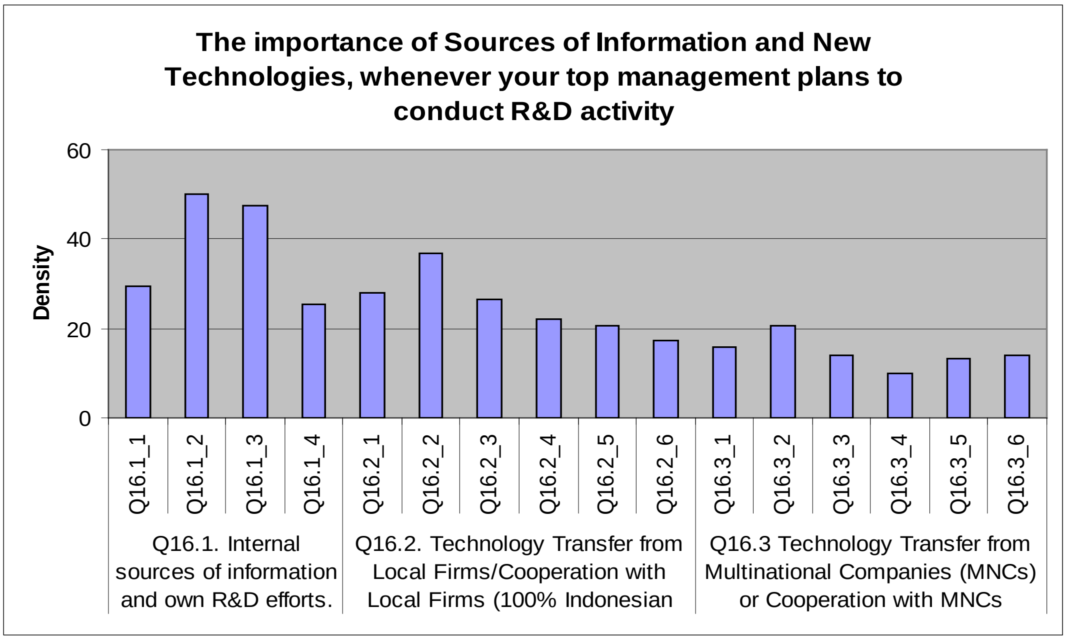


Figure 22. The Sources of Information and Technology for Innovation and Upgrading II

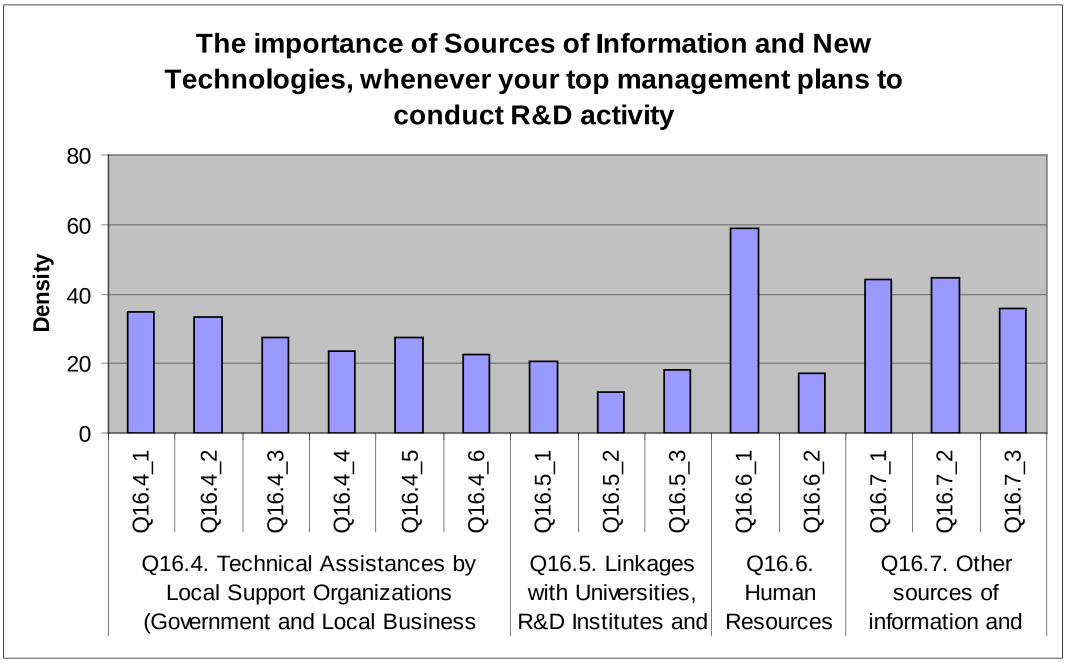
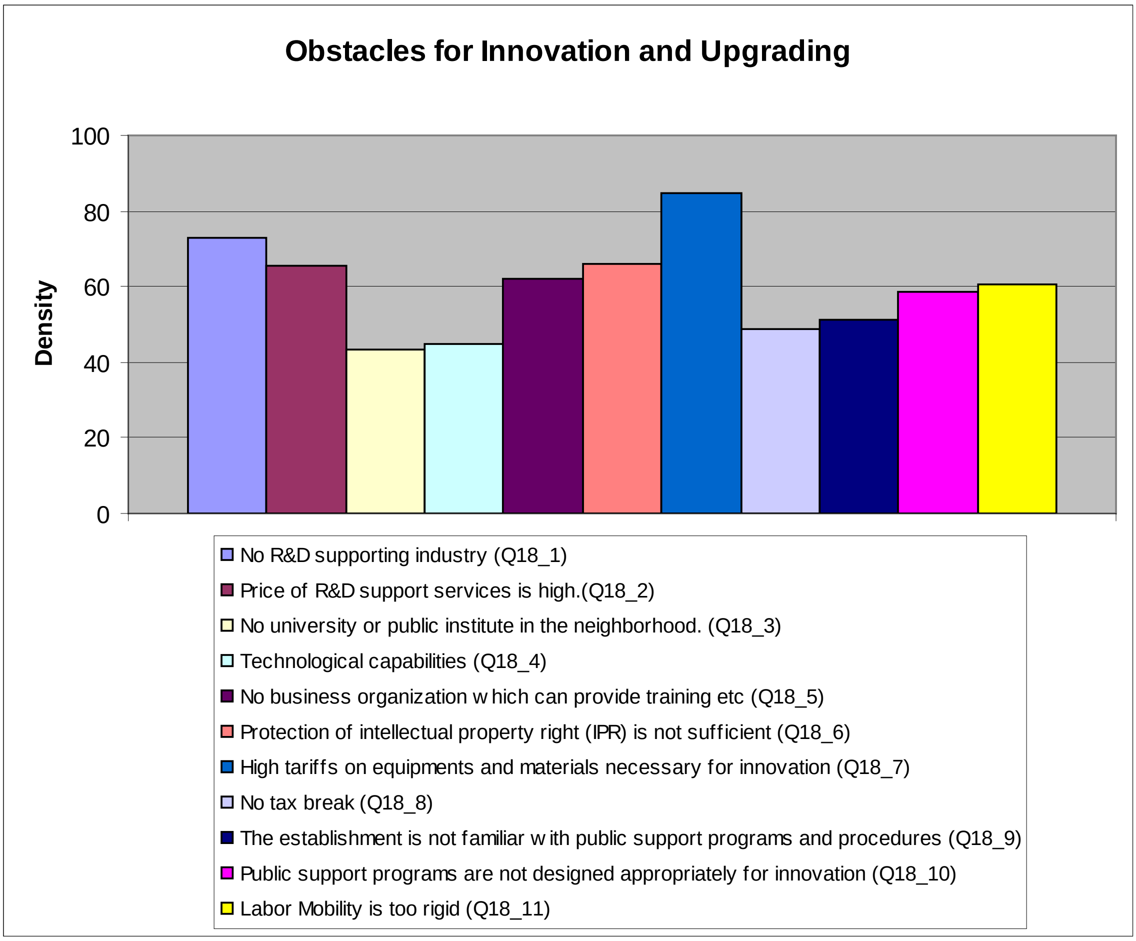


Figure 23. The Obstacles for Innovation and Upgrading



5. INDUSTRIAL UPGRADING, INNOVATION, AND FIRM PERFORMANCE

5.1. The Impact of Upgrading and Innovation on Firm Performance

This study defines some variables to measure the impact of upgrading and innovation on firm performance. These variables were extracted and devised from the survey questionnaire, as follows:

a. Productivity of operation (devised from Q6.7 of the questionnaire);
b. Product quality (devised from Q6.8 of the questionnaire);
c. Product defect (devised from Q6.9 of the questionnaire);
d. Production costs (devised from Q6.10 of the questionnaire);
e. Leadtime (the period of time needed to deliver a product from producer to customers as devised from Q6.11 of the questionnaire).

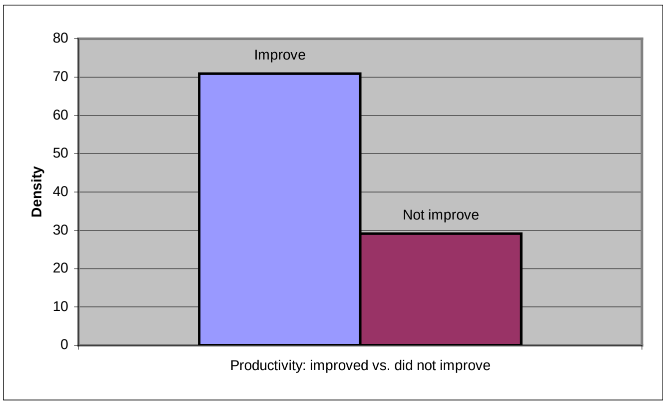
Some frequencies of distribution of the upgrading performance variables are produced to get some insights into the impact of upgrading and innovation. Figures 24a to 24e present these distributions.

Based on the figures, there is an overall mixed result on the impact. Favorable results are shown by the variable of productivity, product quality, and product defect variables (Figures 24a and 24c). As shown in Figure 24a, about 60 percent of the respondents cited an improved productivity while as shown in Figures 24b and 24c, more than 60 percent of the respondents experienced improvement in the quality of their products.

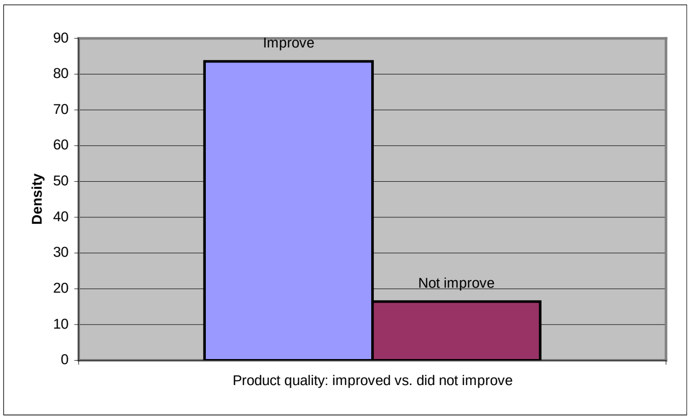
There are still some disappointing results, as indicated in Figures 24d and 24e. In particular, production costs evidently have not been able to be substantially reduced. On the delivery end, the lead time also has not been successfully reduced. Slightly more than 60 percent of the respondents were not able to reduce their cost performance in their production. These results indicate some problems in the logistics and transport area which might need further elaboration. Another potential explanation is that the extent of the ICT in the area of the survey is still relatively low, at least as compared with other countries in the region.

Figure 24. Frequency of Distribution of the Upgrading-and-Innovation Performance Variables

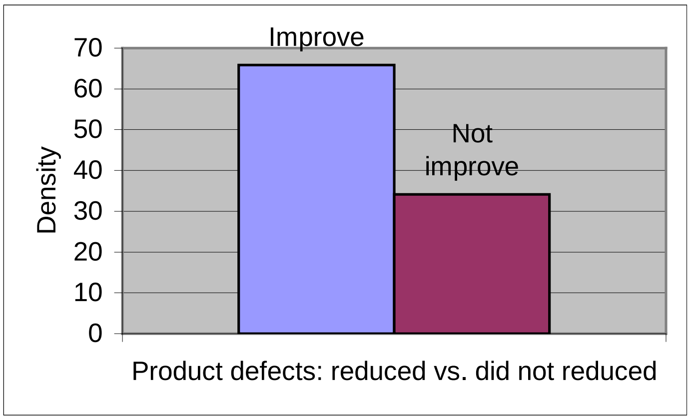
a. Productivity



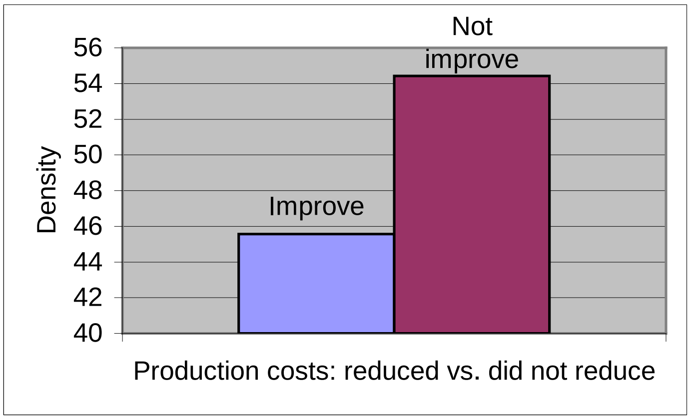
b. Product Quality



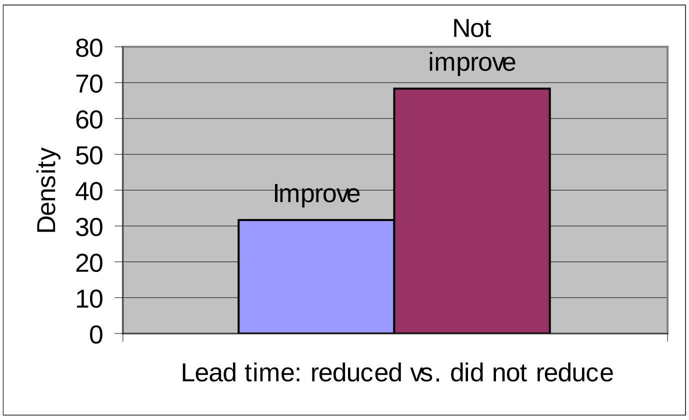
c. Product Defect



d. Production Costs



e. Lead Time



5.2. Factors that might Explain the Variation of the Upgrading and Innovation Impact on Firm Performance

Thus, all in all, there is variation in the extent of industrial upgrading based on the survey's results. Indeed, it is important to understand the factor causing this. This study thus moves forward to explain this variation (i.e., the variation in the extent of the industrial upgrading) by conducting descriptive analysis.

The study postulates that much of the impact of the upgrading and innovation depends on the pathways of industrial upgrading. This makes sense because there are many channels that a firm can take in upgrading its capabilities. Indeed, as Ernst (2004) pointed out, the upgrading process occurs quite often at the firm level, and given that one firm tends to be different compared with another, one should thus expect that the ‘pathways’ should matter because firms can choose many different channels to acquire the necessary upgrading.

The next step of our empirical exercise is therefore to attempt to get some insights on the pathways.

In conducting this exercise, for its methodological approach, ideally, one should have variables that describe the ‘dynamic’ process of the pathways. This is because the pathways tend to be a ‘process’ and could last within a medium- or long-term period of a company’s life. However, since our survey is static in nature, it could not therefore really describe the pathway.

This study then resorts to two strategies in an attempt to resolve the problem. First, we proxy the pathways with all of the performance variables. As a justification, this should represent the end-result of the pathways. The second strategy is to conduct in-depth interviews to get the details of the ‘dynamic’ nature of the pathways. This clearly serves as a complement to the first strategy.

The study asks the following questions in examining the pathways: “do linkages with other local and global companies and/or economies affect the extent of the pathways?” If so, “what is the relationship?” and “which one tends to give a better impact -- local or global linkages?”

In order to answer these questions, the study adopted the following general model:

The pathways (measured by the performance variables) = f (local and global linkages, other determinants).

Here, the pathways are assumed to come from such activities that involve exchange information and learning process about new technology (production and non-production), and all these can be facilitated through contacts with other parties (both local and foreign). Therefore, the variables for local and global linkages can be devised by choosing some variables that represent these contacts. This method follows the common strategy often implemented in ‘technology- or export- spillover’ studies.

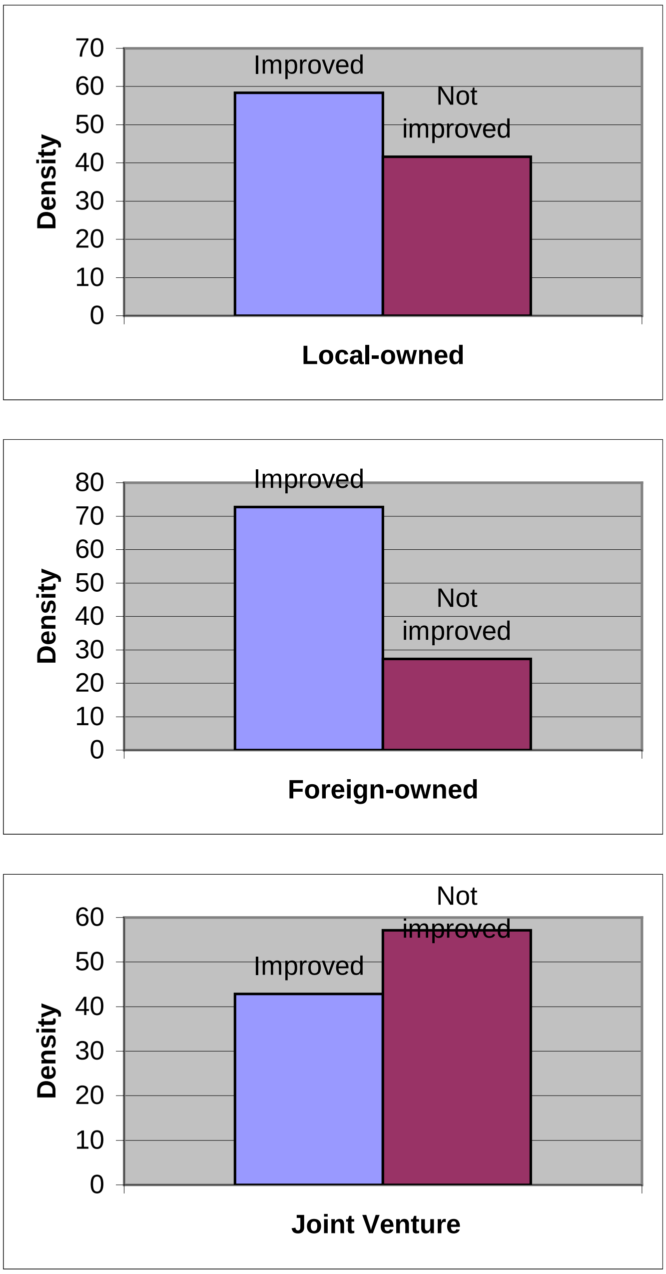
The key variables to represent the linkages are as follows:

a. Ownership (i.e., domestic, foreign, and joint venture);
b. Target markets (local or overseas); and
c. Source of inputs (local or overseas).

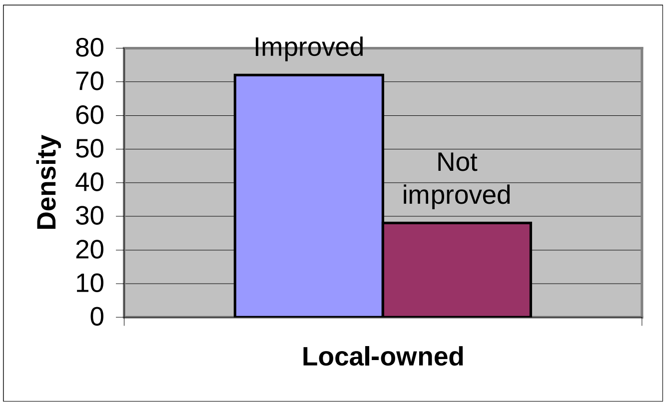
Some of the key points from the bi-variate descriptive analysis are presented below. Consider first the ownership variable as presented in Figure 25. The 100 percent foreign ownership seems to provide better pathways of the upgrading, rather than full (i.e., 100%) domestic ownership and joint venture (JV) firms. This is very clear when we observe the improvements with regard to productivity and production costs. This finding, however, does not mean that domestic and JV firms do not facilitate the pathways; the other upgrading performance variables also show favorable results for the fully domestic ownership and JV types of firms. This is consistent with the general findings from studies on multinationals and foreign direct investment.

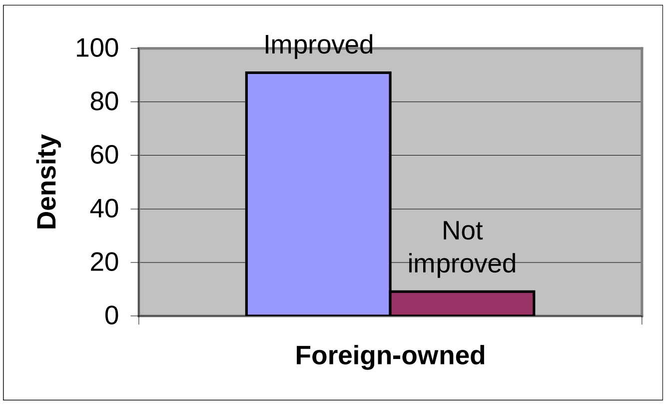
Figure 25. The impact of ownership variable on the upgrading performance variables.

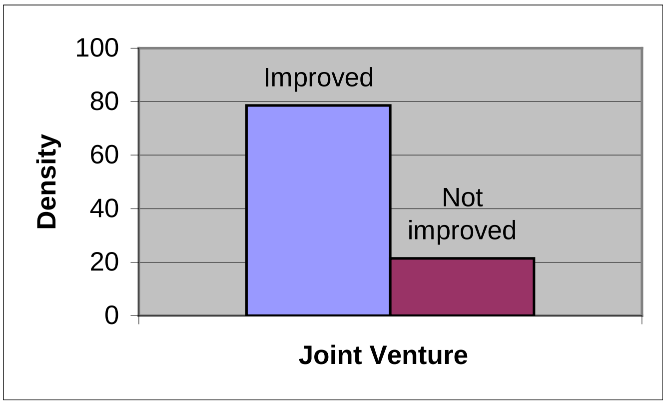
a. Productivity



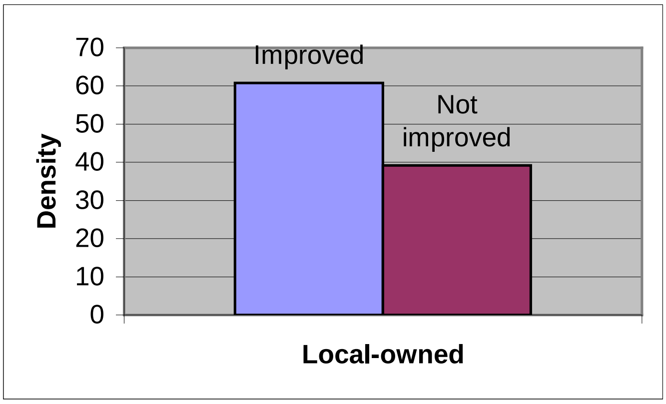
b. Product Quality

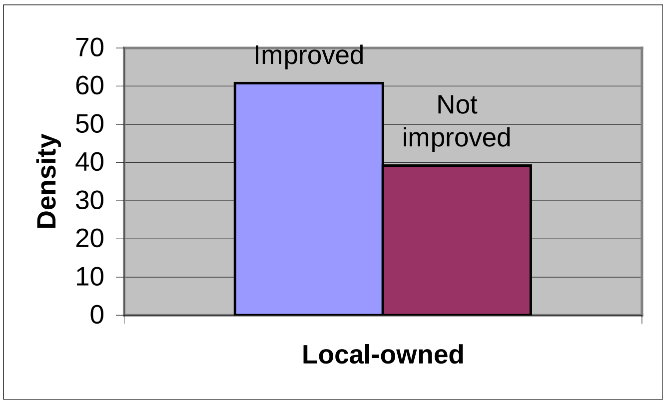


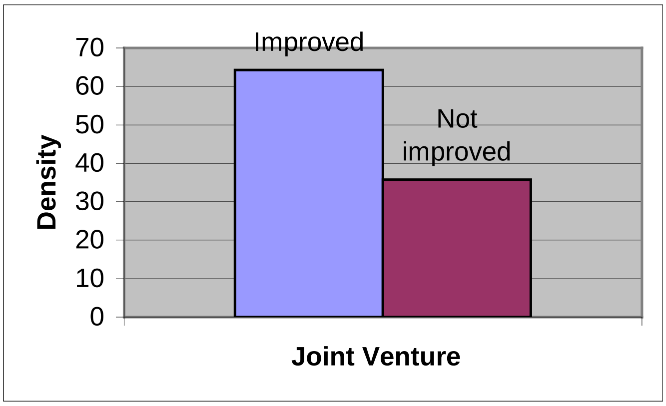




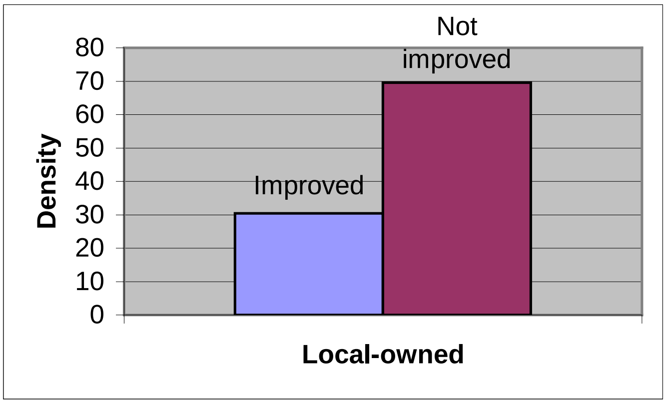
c. Product Defect

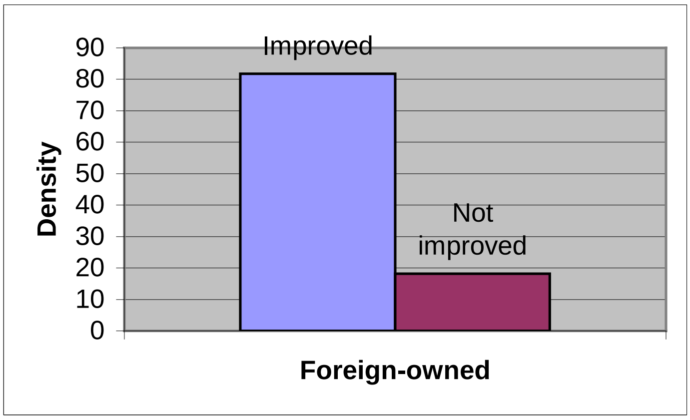


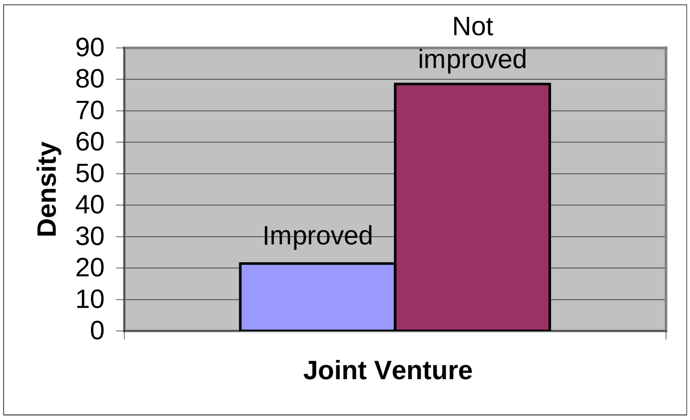




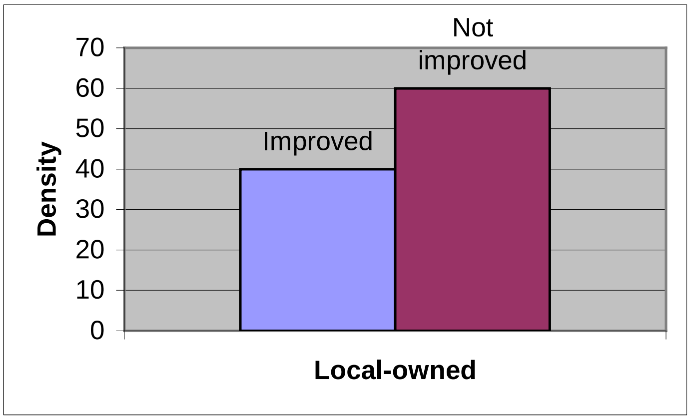
d. Production Costs

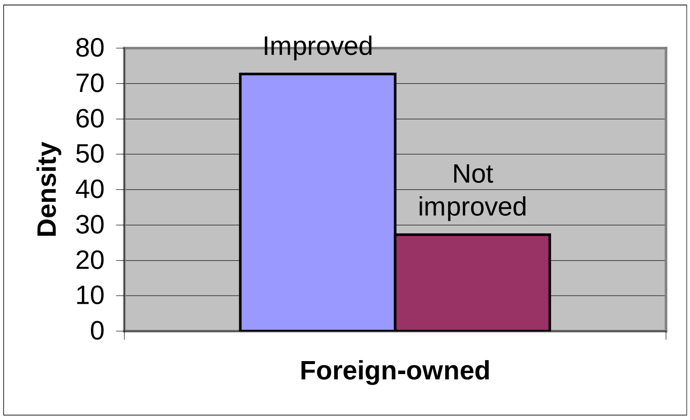






e. Lead Time


Density
70
60
50
40
30
20
10
0
Improved
Not
improved
Local-owned


Density
80
70
60
50
40
30
20
10
0
Improved
Not
improved
Foreign-owned

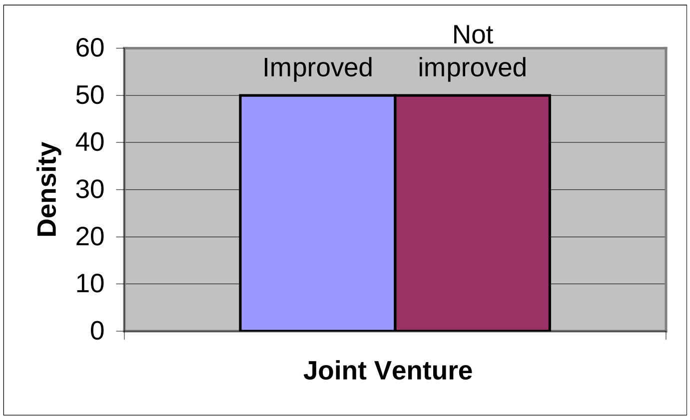
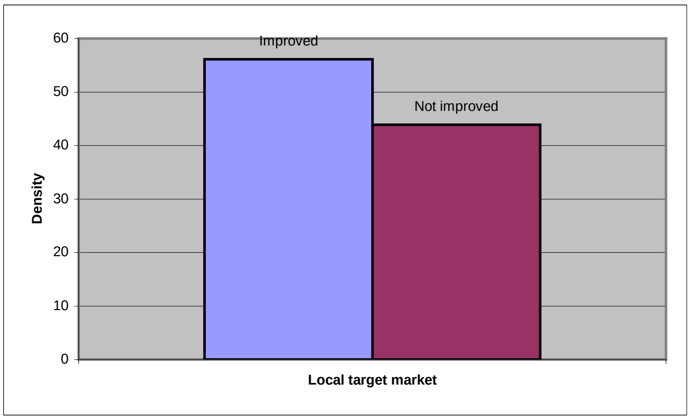
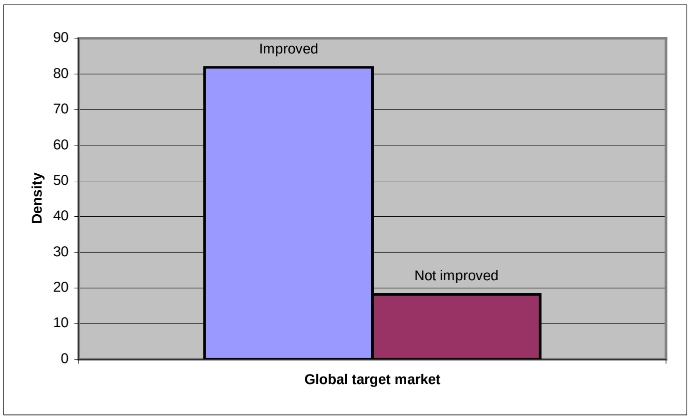

Density
60
50
40
30
20
10
0
Improved
Not
improved
Joint Venture

Figure 26, meanwhile, presents the frequency distribution of the target market variable by the response of the upgrading performance variables. Few key observations are clear. One, the impact of local and global linkages on the pathways is, in general, similar but with no clear pattern. The impact seems to be positive for productivity and product quality but not very clear for production costs and leadtime. However, in terms of production cost, global linkages have a slightly better effect than local linkages.

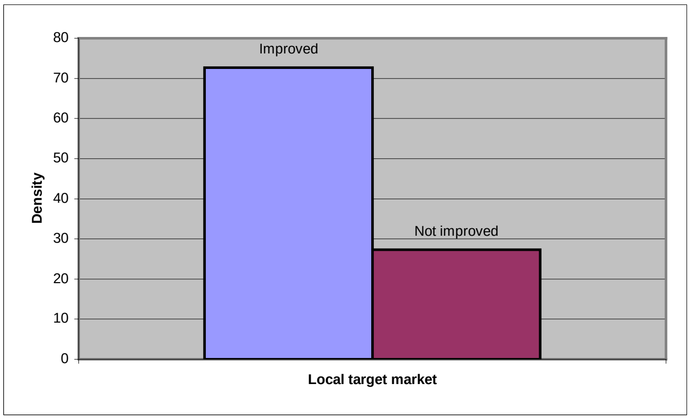
Figure 26. The Impact of Target-Market Variable on the Upgrading Performance Variables.

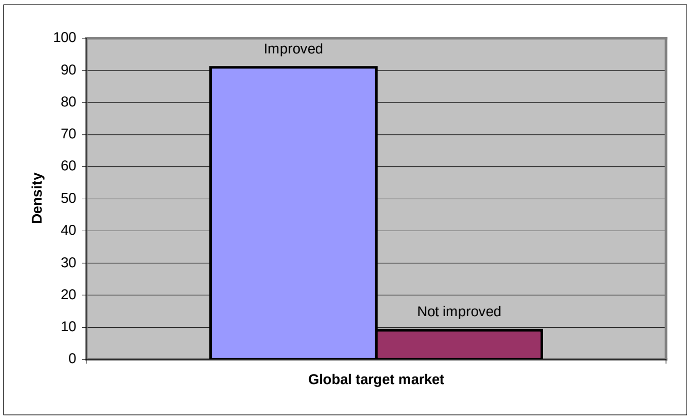
a. Productivity



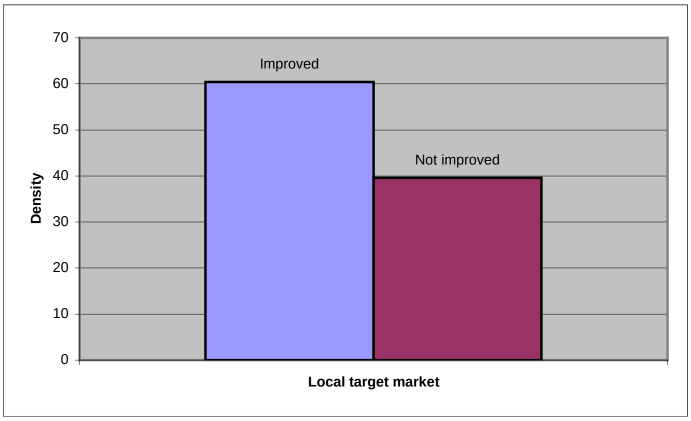


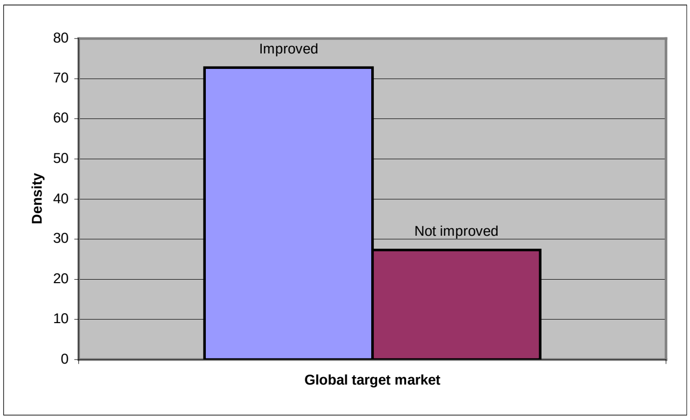
b. Product Quality



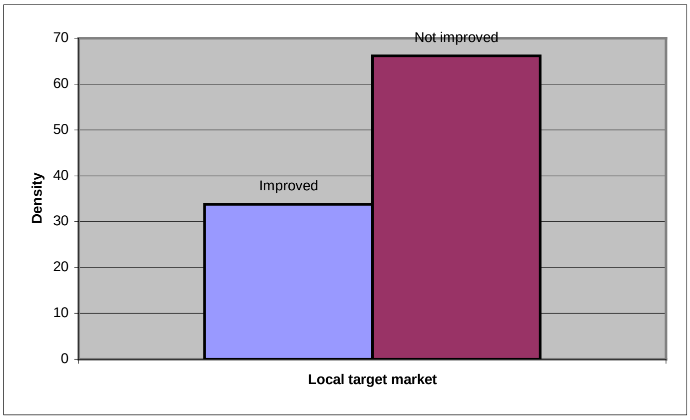


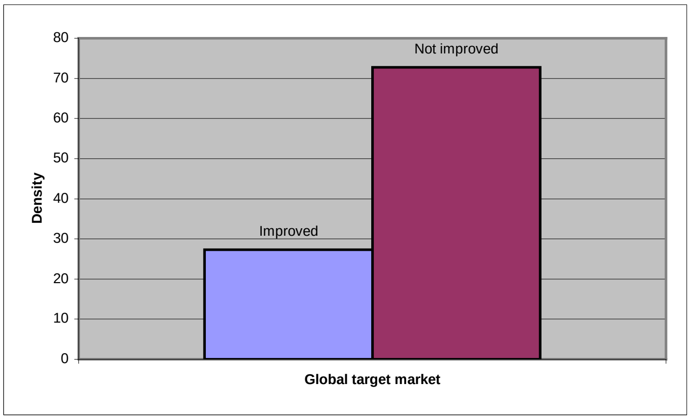
c. Product Defect



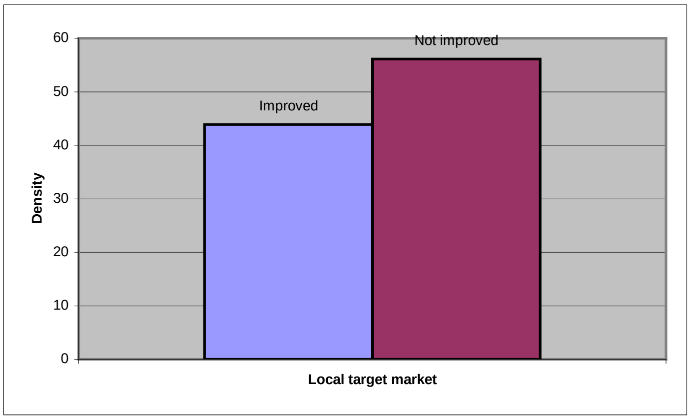


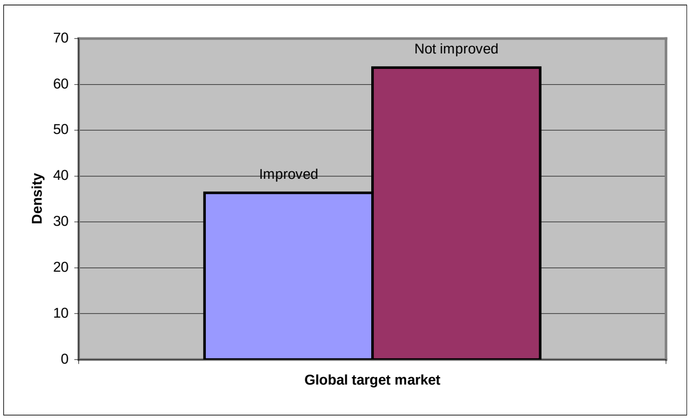
d. Production Costs





e. Lead Time

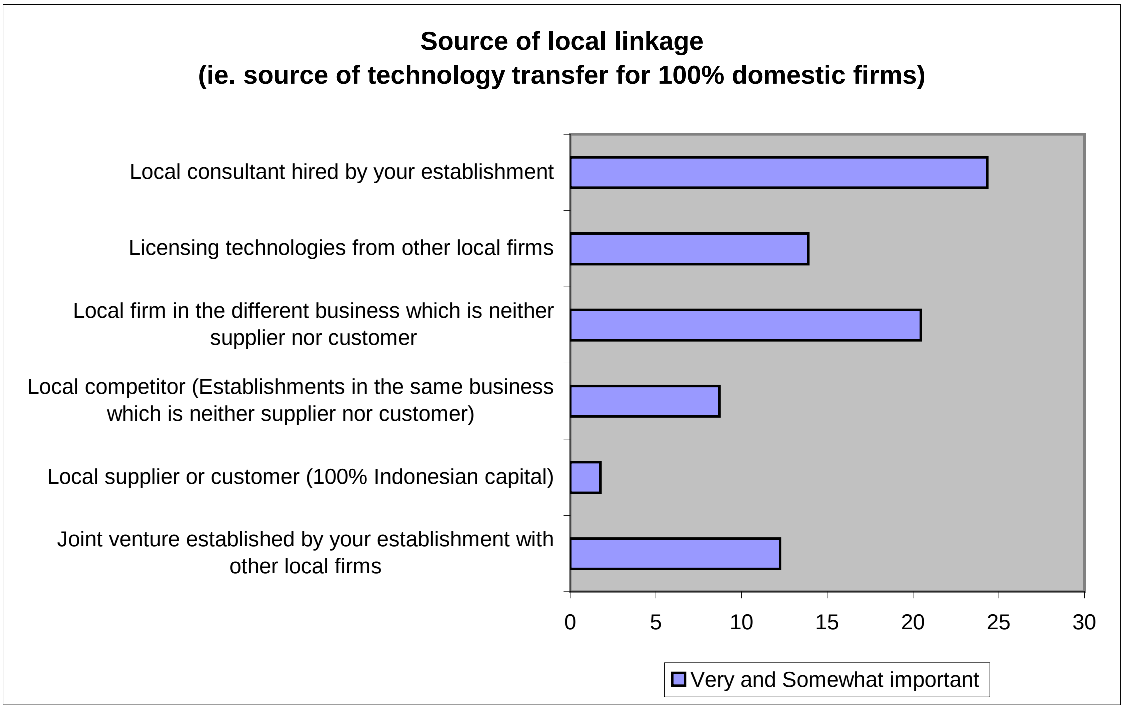




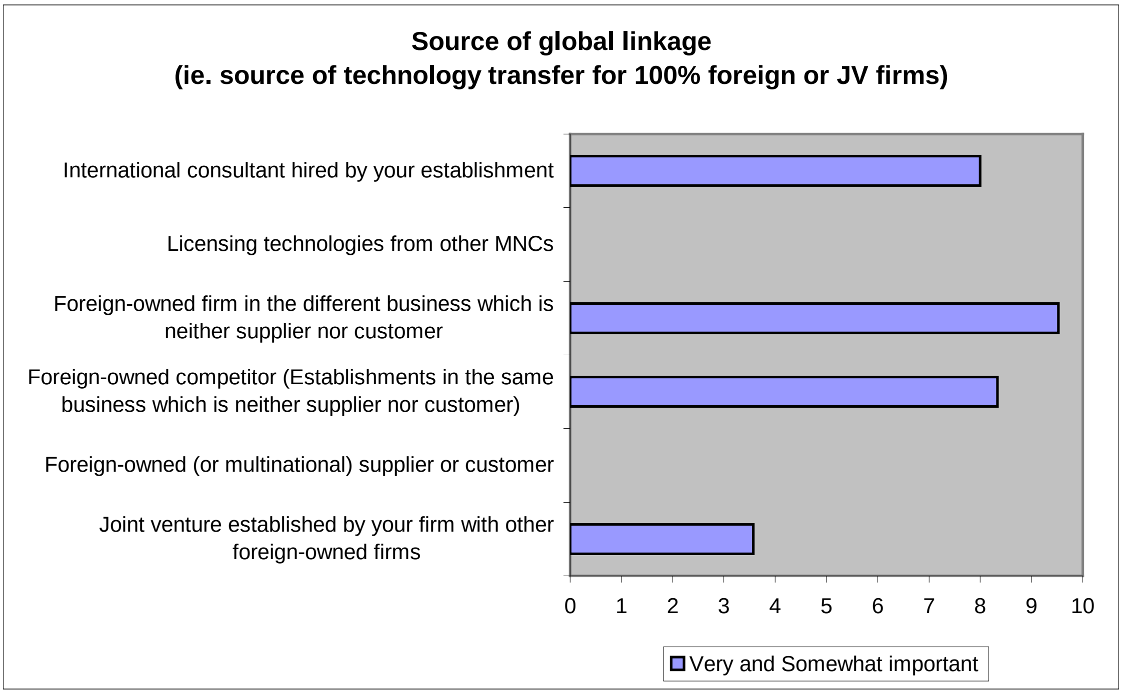
The above Figures provide some insights on the importance of local and global linkages on the extent of industrial upgrading and innovation. Equally important is the question of where these local and global linkages come from, making it worthwhile to look into. Figure 27 thus shows frequency distributions of the sources of the linkage as drawn from the answers to one of the questions in the questionnaire. Based on Figure27, consultants seem to play an important role in facilitating the impact of both local and global linkages on upgrading. In terms of the local linkage or local firms in particular, Figure 27 also infers that buying technology facilitates their upgrading and innovation although this does not seem to hold true for global linkage or for foreign and JV firms. And for both local and foreign firms, in the meantime, one can glean from Figure 27 that being in competition with other firms, either in the same business or not, also seems to be an important factor for the upgrading.

Figure 27. Source of Pathways of Industrial Upgrading

a. Local Linkage



b. Global Linkage



5.3. Few Insights from Interviews with Firms

As mentioned earlier, to complement the quantitative results of the study and to fill in certain gaps in insight and analysis as brought about by the dynamic nature of the upgrading process, the author also conducted in-depth interviews with the firms surveyed. Three firms -- two of which are garments companies (Firms A and B) and an auto-parts company (Firm C) were interviewed. The following points were gathered from these interviews with regard to the question of the importance of the global and local linkages in facilitating the pathways towards upgrading.

The first key point is that having an export orientation helps firms to upgrade. This is particularly the case with Firm A where it immediately had to restructure its plants once it acquired a substantial export order. The restructuring involves replacing its old machinery with new ones to be able to meet the quality standard required by the international buyers. Firm A had to replace practically all of its machinery because the 'system' nature of its production process, where replacement can not be done on a 'piece-meal' basis, dictated so.

Firm B faced the same situation where it had to install some new machinery. The only difference is that Firm B replaced its old machinery and installed a few very sophisticated machinery in terms of technology in order to boost the performance of its workers. And indeed, this is what happened after the installment. Labor productivity significantly improved, further enhancing the firm's competitiveness in the international market which includes major garment producing-competitor countries like China and India. The owner, also the director of this firm, claimed that the new machinery installed helped the company to win several export orders over other competitors from India.

While Firms A and B highlight the importance of global linkage in facilitating technology upgrading, Firm C demonstrates the importance of local linkage. Firm C, which is an auto-parts producer, explained that it tries to continuously reduce its dependence on foreign suppliers for its production. In particular, Firm C had shifted the sourcing of its production inputs from foreign to local suppliers. This somehow reflects the impact of technology spillover that had taken place among many local firms. Firm C also mentioned that the procurement of inputs from local suppliers is very competitive, and explained that any local supplier can immediately be dropped from its list of suppliers if the quality of the supplied inputs declines. After all, there are many other ready local suppliers to provide the inputs to the firm.

Another important point derived from the interview with Firm C is the fact that the lack of skilled labor seems to substantially constrain the upgrading process. Hence, this highlights the importance of training programs and some reforms in the education system of Indonesia if the country wants to substantially upgrade its industry technological capabilities.

6. SOME POLICY RECOMMENDATIONS

Developing economies should take advantage of the opportunity to undertake upgrading as provided by its industries' participation in the international production network. As a common factor behind the successful catching-up process in East Asian countries, active government involvement is needed to further the process in these countries. Three recommendations are hereby given to policy makers, namely, (a) support of production activity in cluster areas, (b) promotion of the quality of service links, and (c) creation of a national system of innovation. Supporting production activity could be done in many ways, including the maintenance of political and macroeconomic stability, development of human capital skills, and insurance of the operation of banks and non-bank credit institutions as financial intermediaries. With regard to promoting the quality of service links, the government should focus more attention to infrastructure, logistics, and trade facilitation. As to the third recommendation of creating a national system of innovation, this is taken from Nelson's work (2007) which says that investing in education and research effort, and enforcing property rights protection will be the foundations for building this system. It is hoped that these policy actions will assist industries in advancing their capabilities through their participation in the GPN model of industrial clusters.

In addition to these normative policy recommendations, the study also offers recommendations based on the findings of the survey and discussed in this paper.

For one, the government needs to increase the participation of FDI (and also domestic direct investment) and to create a more liberal FDI policy (e.g., non-discriminatory national treatment and liberal negative investment list). This recommendation is consistent with the argument put forward by Thee (2006) that one possible explanation of the lagging technological development in Indonesia is the deteriorating investment climate after the 1997/98 economic crisis. As argued in the literature as well as demonstrated by this study, global linkages through the presence of foreign ownership in Indonesian firms can improve the upgrading process. All these, however, need to be consistent with the World Trade Organization (WTO) rules and should give large marginal benefits to the ASEAN Economic Community (AEC), considering the blueprint’s objective of having an integrated ASEAN region.

There is a need to speed up (unilateral) services trade liberalization for Mode 4 since the services of consultants seem to still play a crucial role in transferring knowledge and technology. However, this requires the establishment of a regulatory framework that recognizes the skills of professional workers (e.g., engineers, lawyers, etc.). Equally important is to improve both the quantity and quality of training programs in Indonesia. As noted by the interview results, there seems to be a significant lack of skilled workers in some industries in Indonesia.

Moreover, in connection with the policy recommendation in terms of services, there is also a need to undertake comprehensive reforms in the logistics sector. This is to reduce transport costs and improve services quality. Included here is the development of a national strategy on reforming the logistics sector as well as the financing of infrastructure projects.

REFERENCES

Athukorala, P. and N. Yamashita (2006), 'Product Fragmentation Trade Integration: East Asia in Global Context', *North American Journal of Economics and Finance*, 17, pp.233-56.

Coe, N., M. Hess, H.W. Yeung, P. Dicken, and J. Henderson (2004). '"Globalizing" Regional Development: a Global Production Networks Perspective', *Transactions of the Institute of British Geographers*, New York Series 29, No. 4, pp.468-484.

Deardoff, A.V. (2001), 'Fragmentation in Simple Trade Models', *North American Journal of Economics and Finance*, 12, pp.121-37.

Dicken, P., P. Kelly, K. Olds, and H.W. Yeung (2001), 'Chains and Networks, Territories and Scales: Towards an Analytical Framework for the Global Economy', *Global Networks*, 1(2), pp.89-112.

Ernst, D. (2002), 'The Economics of Electronics Industry: Competitive Dynamics and Industrial Organization', in M. Warner and W. Lazonick (eds.), *The International Encyclopedia of Business and Management (IEBM)*. London: International Thomson Business Press.

Ernst, D. (2000), 'Placing Networks on the Internet: Challenges and Opportunities for Managing in Developing Asia', in B.A. Lundvall and K. Smith (eds.), *Proceedings of the Papers Presented at the Second Asia Academy of Management Conference, 15-18 December 2000, Knowledge Creation in Learning Economy*. Cheltenham: Edward Elgar.

Ernst, D. (2004). 'Global Production Networks in East Asia's Electronics Industry and Upgrading Prospects in Malaysia' in S. Yusuf, M.A. Altaf, and K. Nabeshima (eds.), *Global Production Networking and Technological Change in East Asia*. Washington DC: The World Bank, pp.89-157.

Ernst, D. and L. Kim (2002), 'Global Production Networks, Knowledge Diffusion, and Local Capability Formation', *Research Policy*, 31, pp.1417-29.

Henderson, J, P. Dicken, M. Hess, N. Coe, and H. W. Yeung (2002), 'Global Production Networks and the Analysis of Economic Development', *Review of International Political Economy*, 9(3), pp.436-64.

IMF (2004), *Global Financial Stability Report: Market Developments and Issues*, International Monetary Fund, Washington D.C., USA.

Kimura, F. (2008), 'The Mechanics of Production Networks in Southeast Asia: The Fragmentation Theory Approach', in I. Kuroiwa and Toh Mun Heng (2008), *Production Networks and Industrial Clusters: Integrating Economies in Southeast Asia*. Singapore: Institute of Southeast Asian Studies, pp.33-53.

Kimura, F. and M. Ando (2005), 'Two-dimensional Fragmentation in East Asia: Conceptual Framework and Empirics', *International Review of Economics and Finance*, 14, pp.317-48.

Kuchiki, A. (2005). 'A Flowchart Approach' in A. Kuchiki and M. Tsuji (eds.), *Industrial Cluster in Asia: Analyses of Their Competition and Cooperation*. New York: Palgrave MacMillan, pp.169-199.

Thee, Kian Wie. (2006). 'Policies Affecting Indonesia's Industrial Technology Development', *ASEAN Economic Bulletin.*

UNIDO (2004), 'Inserting Local Industries into Global Value Chains and Global Production Networks: Opportunities and Challenges for Upgrading with a Focus of Asia', UNIDO Working Papers, Vienna: UNIDO.

Yeung, H.W. (2008), 'Industrial Clusters and Production Networks in Southeast Asia: Global Production Networks Approach', in I. Kuroiwa and Toh Mun Heng (2008), *Production Networks and Industrial Clusters: Integrating Economies in Southeast Asia.* Singapore: Institute of Southeast Asian Studies, pp.86-123.

2

Sources of Innovation of Philippine Firms: Production, Logistics and Knowledge Networks

Mari-Len Reyes-Macasaquit[i]

Abstract

The story of the Philippines in terms of its foray into the S&T system is not unique when compared to other developing countries. It is not impossible for it to catch up with the more advanced, high technology economies but it has to aggressively pursue a national innovation framework that takes advantage of what each stakeholder of knowledge can offer. The difficulties of the S&T system in the country are well documented. Institutional structures exist, the legal and policy frameworks are in place but the process of diffusion, technology transfer and adaptation remains wanting. Propositions have been made that this may be traced to the weak innovative culture prevailing in Filipino society, the low priority accorded to S&T as evidenced by limited resources allotted to it, the dearth in a critical mass of manpower that could build up and sustain an innovative culture, and the inability of the government, the private sector and the academe to collaborate meaningfully. The country's weak performance in S&T lowers its productivity and adversely affects its overall competitiveness. As technological innovation and economic growth are mutually reinforcing, it is imperative that the Philippines continues with its efforts to play catch up in the technological arena.

Perhaps, the lack of appreciation of how the various linkages affecting productivity could affect innovation further aggravates the present condition. The country study aims to find out the present condition of the national innovation system and the types and strengths of linkages prevailing within. With the choice of CALABARZON as the locus of the study, the role of agglomeration economies in diffusing knowledge is featured. Moreover, it is hoped that with increasing integration with other economies in Asia under the web of production networks, a case could be made, based on the

Philippine story, for establishing a regional knowledge network, a possible building block for the creation of an ASEAN economic community.

1 INTRODUCTION

The current global economic downturn has cast a pall over the development path of emerging and developing economies in Asia. The closer integration of economies caused by increasing globalization has made certain that the effects of the crisis among developed countries would reach the shores of the developing world. This, in particular, is true for countries in Southeast Asia which have become the production capital of many multinational companies (MNC) based in North America and Europe. But this crisis has also brought to the fore all the more the necessity for Southeast Asian countries and its close neighbors in East and South Asia[ii] for closer intra-regional cooperation.

The presence of industrial clusters in these economies is said to be an important step for stabilizing the industrial structure, encouraging entrepreneurship and the establishment of local firms especially at the small and medium scale, and fostering the culture of innovation. While it is imperative that development gaps across regions within a country is narrowed through the formation of more industrial clusters and stimulating linkages, it would do well for deepening the relationship and closing the development gaps at the Asian regional level if inter-cluster linkages among countries could likewise take effect. Aside from production linkages, collaboration in terms of innovative undertakings would lead to heightened productivity in and competitiveness of the region. The first step in catalyzing this process is knowing the nature and extent of innovation taking place in the countries concerned, including the technological capacities available for absorbing new knowledge and for building up a knowledge-based economy, both at the country and regional level.

This paper attempts to investigate and analyze the channels by which information flows within and among firms in the Philippines, whether through their production linkages or the existence of knowledge networks. The former points to agglomeration effects while the latter to the known networks of innovation. To manage the analyses, focus is directed towards one of the most important regions in the country, based on its contributions to the national economy. The first section provides a brief review of the literature on agglomeration effects in terms of knowledge spillovers and other sources of knowledge and technology. The national innovation system approach is explained as framework for developing a national science and technology system at the country level. The next section provides a description of the national environment where firms in the country operate under the backdrop of an industrial and technological policy structure in the Philippines. The third section presents the hypotheses for the study and how these were tested through in-depth case study, analysis of survey results and econometric analysis. The section after this presents the situation in CALABARZON and the summary of findings from the survey and in-depth interviews of firms. The fifth section describes the econometrics results of the study as estimated by a Japanese team of collaborators. The last section puts forward propositions for policies at the country-level as well as at the regional level given the fact that the overall study is geared towards providing evidence-based recommendations that would help lead towards the creation of the ASEAN Economic Community in the near future.

2 TECHNOLOGY, AGGLOMERATION & INNOVATION: BRIEF REVIEW OF THE LITERATURE

Innovation is the novel application of economically-valuable knowledge (Feldman, 1999). Economic innovation as defined by Schumpeter (1934) could take any of the following forms: introduction of a new good or product; introduction of a new method of production; opening of a new market; engaging a new source of raw materials; and carrying out new organization or management systems. Innovation is synonymous with adding value leading to improved products or processes and yielding benefits to the firm.

It is an acknowledged fact that technological innovation can bring higher productivity and improves competitiveness of firms. In the aggregate, this increases output and leads to economic growth. The application of new knowledge and technology derived from various sources is what enables firms to reduce costs of production, be flexible in producing products that respond to demands, improve quality of products, and upgrade into higher value added production. It is claimed that technological innovation and economic growth are mutually reinforcing (Hirono, 1985 as cited in Cororaton, 2002). Higher growth enables the generation of further productivity enhancements through innovation derived from research and development (R&D) and this virtuous cycle can continue in a sustained manner as long as the appropriate policy environment remains conducive. The case of Japan and South Korea has been often cited in the literature for their success in catching up in terms of technological progress with highly advanced industrial countries. Cororaton (2002) cited the so-called convergence school that claimed that technologically backward countries can benefit from the technology already created by advanced countries. However, massive technology transfer should take place catalyzed by an appropriate technology policy and investments on education for building up human capital, infrastructure, management capability, and R&D efforts.

In recent years, a body of ideas has emerged pointing to the importance of locations as hubs of economic activities influencing regional economic development and contributing to national growth. The so-called new economic geography highlighted industrial agglomerations as clusters of growth and industrial development. Industrial clusters are formed due to a myriad of factors and the spatial configuration set by the balance between centripetal and centrifugal forces or the push and pull of various forces. To be sure, these clusters emerge due to the presence of Marshallian externalities, i.e. economies of scale; availability of specialized input services; highly specialized labor force; production of new ideas, indeed knowledge, arising from the accumulation of human capital and face-to-face communications; and presence of necessary physical infrastructure. As cited by Fujita and Thisse (2002), industrial agglomeration is an outcome of a “snowball effect” in which increasingly, firms would want to congregate in order to benefit from these externalities. The interest of this paper on industrial agglomeration is the acknowledged existence of knowledge spillovers in this spatial location. To quote from Alfred Marshall himself, *"the mysteries of trade become no mysteries; but as it were in the air….good work is rightly appreciated, inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed: if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas."*

Though even Krugman (1991, as cited in Feldman, 2000) himself mentioned that *"knowledge flows are invisible,"* and therefore difficult to quantify, this did not prevent researchers from measuring knowledge spillovers[iii]. Feldman (2000) in her review claims that the consensus arising from the body of empirical work done on this is that, knowledge spillovers are geographically bounded within a limited space over which interaction and communication takes place. One path is via the pool of skilled labor available within a cluster, presumed to be able to move freely from one firm to another or have constant and frequent face to face interaction with one another. Also highlighted was the importance of localized knowledge within the spatial configuration. This body of work, as summarized by Feldman (2000), presupposes that proximity matters in innovation and that there is actual interaction and cooperation taking place within an industrial cluster. But is proximity enough for knowledge to be exchanged? What if the firms in a cluster have limited interactions and do not fulfill the conditions for clustering oft-cited in the literature? What types of dynamics are in play within so called, technologically-backward countries? How knowledge is exchanged among firms within and how does this lead to innovation?

There is indeed, a technological divide in the global economy, with the existence of highly advanced economies and technologically-backward countries. Choi (1983 as cited in Cororaton, 2002) enumerated factors that have been causing this technology gap between developing countries and more advanced economies. The former are said to be weak in policy formulation related to S&T, with even the so called S&T culture among the public being low. Viable institutional structures are absent as well as adequate R&D systems. With fiscal constraints and competing priorities, capital outlay for research and budget in general are insufficient. Scientific manpower are also said to be limited in these countries that could have served as the critical mass for initiating scientific and technological pursuits, individually or collectively. Lastly, the participation of vital sectors in society are sorely lacking for the development of science and technology. The industrial sector, to which the adoption of technology for domestic application is most directed to, is singled out as lacking in its involvement.

The national innovation system framework is anchored on the position that the flows of technology and information among people, enterprises and institutions lead to the innovative process (OECD, 1997). Highlighting the complex relationships and interactions among these actors, the OECD (1997) identifies four types of knowledge or information flows: (a) interactions among enterprises themselves; (b) interactions among enterprises, universities and research institutions; (c) technology diffusion to enterprises; and, (d) personnel mobility or the movement of highly capable personnel within and between institutions. The study done by OECD, linking these channels to performance of firms, has found evidence that high levels of interactions in these different types of flows could indeed, lead to improved capacity of firms, whether in terms of products, number of patents and productivity.

This leads credence to the argument that industrial development necessitates technological capability in industry and that the use of technology is most critical at the firm level (Patalinghug, 2003). Other experts, as cited in Patalinghug (2003) and as would be enumerated here, provide clearer delineation of roles among stakeholders of the system. List (1959) mentioned the role of government in the provision of education and training as an important element as well as the infrastructure for supporting industrial development. Meanwhile, Freeman (1987) points to the organization of R&D and of production within firms, the role of government, the interfirm relationships, and the interaction between them. Nelson (1987, 1988) analyzes the combined public and private nature of technology and the role of firms, government and universities in the generation of new technology. This highlights the fact that new knowledge and technology can be derived from various sources that can be lumped into two channels. One, refers to the structure of the firm itself and its production linkages, both upstream and downstream, domestic or international, and with firms in the same location, whether cooperator or competitor. The other channel pertains to a knowledge network or a web of service providers that enables firms to access, generate, adopt, and utilize knowledge, whether geographically proximate or not. These are universities, research development institutions – both public and private, technology resource centers, manpower skills development institutions, industry associations, and even national S&T structures and the local government.

How these dynamics come into play in the case of the Philippines would be the subject of the succeeding sections of this paper.

3 THE PHILIPPINE INDUSTRIAL AND TECHNOLOGICAL LANDSCAPE

In the last eight years, the Philippine economy has posted positive growth. After posting a high 7.8 percent in its Gross National Product (GNP) in 2007, the economy went down to 6.1 percent and with the global downturn in effect, it is forecasted to further go down to 5.0 percent in 2009 (Yap, 2009).

Among the three sectors comprising its economic structure, services remains to be the main contributor at nearly half of the total, followed by the industry sector, which appears to have stagnated at the 32.3 to 32.7 percentage share level since 2005. A similar trend has been posted by the agriculture sector at a much lower 18 percent share (Yap, 2009). Since the Philippine economy could not get by with the services sector alone, efforts to revitalize the industry sector should continue as it remains to have a substantial share of total employment, the lion's share of which is traditionally taken by the manufacturing sector. Industrial development can be pursued with the appropriate industrial policy and as earlier cited, strengthening technological capability.

3.1. Industrial Policy

The Philippine industrial structure used to be characterized by a highly protectionist regime that lasted for three decades. In the 1980s, industrial reforms and structural adjustments were instituted aimed at pursuing a more efficient and internationally competitive economy. Such reforms ranged from trade liberalization to privatization and the aggressive promotion of foreign direct investments (FDIs), an export promotion strategy and the offering of a flurry of investment incentives to domestic firms. Add to this what started out as a regional dispersal strategy of industrial development through the establishment of export processing zones to what are now existing as well developed industrial parks and economic zones. The industrial clustering strategy was a recent addition as can be gleaned from various policy frameworks starting in 2001, highlighted by the creation of a National Cluster Management Team and the One-Town, One-Product initiative. The latter is aimed to be a collaborative undertaking among various sectors including small and medium enterprises, national government agencies with regional/local presence, and local government units[iv].

3.1.1. Trade liberalization

The Tariff Reform Program (TRP) was the lynchpin of the trade liberalization reforms that started in the 1980s. Since 1981, four TRPs were implemented, each one staged on a five-year period, except one. The TRPs were aimed at not only liberalizing the trade environment but also improving access to essential inputs, making available more choices of goods for the consumers, enhancing competitiveness of local industries in the domestic and export markets, and simplifying the tariff structure for ease of customs administration, among others.

3.1.2. Privatization

In the 1990s, the three-pronged policy of privatization, liberalization and deregulation commenced at the domestic level in line with the goals of engendering economic openness, divestment of state owned and operated enterprises, removal of monopolies in vital utilities in the country such as water, electricity and telecommunications, and promotion of competition. Specifically, the Foreign Bank Liberalization Act was signed into law in 1994 and triggered the entry of foreign banks, gradual at first, and signaled the start of the more efficient implementation of the banking system in the country. In 1995, the passage of the Public Telecommunications

Policy Act started the deregulation reforms, followed by the National Water Crisis Act on the same year and by the Electric Power Industry Reform Act in 2001.

3.1.3. Foreign direct investment policies

The Foreign Investments Act of 1991 was a landmark legislation that allowed foreign equity participation of up to 100 percent in all sectors in the country, except those included in the Foreign Investment Negative List. Four years hence, the List was significantly reduced to allow for greater foreign participation in the domestic economy.

3.1.4. Investments promotion

The primary legal basis for the current investment incentives program in the country is the Omnibus Investments Code of 1987. It provides access to fiscal and non-fiscal incentives to preferred areas of investments, whether pioneer or non-pioneer, and to export production and the rehabilitation or expansion of existing operations. Each year, the Philippine Board of Investments (BOI) come up with an Investment Priorities Plan that defines the investment thrusts of the country as grouped into four categories, Preferred Activities, Mandatory Inclusions, Export Activities, and ARMM List[v]. The investments promotions initiative in the country is being implemented by a host of agencies in the government in addition to the BOI namely, the Philippine Economic Zone Authority, Subic Bay Metropolitan Authority and Clark Development Corporation.

3.1.5. Export-oriented strategy

The national strategy for sustainable agro-industrial development is embodied in the legal policy framework, Export Development Act of 1994. The law calls upon the private sector to lead the effort in increasing the country’s share in the export market and promotes leading industries or export champions determined every three years.

3.1.6. Industrial clustering strategy

The industrial clustering strategy being pursued in the country can be considered two-pronged. On the one hand, it relates to the establishment and formation of special economic zones in its various forms among locator firms, both local and foreign-owned. On the other, the promotion of industry clusters in different spatial levels, from national to town level. The industrial zones is likewise a mechanism to disperse industrial development to other parts of the country thereby stimulating local economic development, while industry clustering is intended to spur the entrepreneurial spirit among Filipinos through the operation of small and medium enterprises.

3.2. Technology Policy

Sections 10 to 14 of Article 14 of the Philippine Constitution contain specific provisions for the promotion of science and technology (S&T) in the country. The fundamental law of the land recognizes that S&T are essential for national development and progress and essentially dictates the components that should become part of the Philippine technology policy. Patalinghug (2003) defines technology policy as the management and generation of scientific and technological knowledge intended to address specific problems related to the production and delivery of economic, health and social goods and services. Ideally and in close relation to industrial policy, the legal and policy framework, organizational structure, and programs and projects should enable firms to continue producing their products, launch and market new ones, increase their capacities to innovate, raise their productivity, and enhance competitiveness.

3.2.1. S&T system

The Philippine S&T system can be traced as far back as the American colonial period when the Bureau of Science was created. Coverage was limited as it mainly focused on agriculture, health and food processing. Right after the proclamation of independence, the Bureau was reorganized into the Institute of Science in 1946 and was placed under the Office of the President of the Philippines. In 1958, the National Science and Development Board (NSDB) was created in place of the Institute to formulate and implement S&T policies and coordinate S&T agencies. Almost three decades later, the NSDB was reorganized into the National Science & Technology Authority (NSTA) before becoming in 1987 what is now the Department of Science & Technology (DOST). Specifically, the DOST is mandated to provide central direction, leadership and coordination of all scientific and technological efforts in the country, and formulate S&T policies, programs and projects in support of national development priorities. In its current configuration, the DOST is comprised of a national office and fifteen regional offices, five sectoral councils (agriculture and forestry, health, aquatic and marine resources, industry and energy, and advanced science and technology), two collegial bodies, seven R&D institutes (industrial technology, nuclear research, forest products, food and nutrition, textile metals, and advanced science and technology), and seven S&T service institutes (delving on science education and training, information database and networks, adoption and commercialization of technology, weather forecasting, and volcanology and seismology).

In terms of policy framework setting the S&T objectives and detailed guidelines for attaining them, the country has had four major ones so far since 1986. It is apparent that there is one strategic framework every time the presidency changes hands. During the time of President Corazon Aquino, the 10-year S&T Master Plan (STMP) was formulated spanning 1991-2000. Then, with President Fidel Ramos at the helm, the S&T Agenda for National Development or STAND Philippines, 1993 to 1998 came into being. Meanwhile, the less comprehensive but more specific DOST Medium Term Plan, 1999 to 2004 came out during the short-lived administration of President Joseph Estrada. The current President meanwhile, can boast of having the long-term National S&T Plan, 2002 to 2020.

The STMP is said to have correctly diagnosed the problems faced by the S&T system such as low investment in R&D, poor quality of S&T education, lack of private sector participation in R&D, inadequate attention to the needs of the market as basis for R&D and innovation, and lack of technology transfer and commercialization. Though basically sound, the STMP did not receive the resources required to turn its objectives into fruition. Ironically, the same problems that the STMP tried to address are generally the same challenges cited to still being faced by the Philippine S&T system. In fact, the

NSTP targets for 2004 were not met, while the attainment of the 2010 goals does not seem to be optimistic. It remains to be seen whether adjustments for more realistic targets for 2020 will be made.

In his paper tracing public and private expenditures in R&D in the Philippines in agriculture, fishery, manufacturing, education, and health, Cororaton (2002) cited that the technology-related problems are generally common across sectors and could be summarized into four: underinvestment in R&D; lack of adequate R&D manpower; institutional weaknesses; and, policy failures. Patalinghug (2000) meanwhile, declares that there has been a general failure to use technology in the country to gain competitive advantage. According to him, resource-based exports were basically still in their raw, unprocessed form, while traditional exports were likewise exported without infusing much technology-based processing. Even the shift to manufactured exports like garments and electronics merely reflected the changing factor composition, that is, from resource-intensive to labor-intensive. In another study, Patalinghug (2003) further mentions that R&D is not an attractive endeavor in the country, mainly for two reasons: one, capability is lacking and two; incentives meant to induce R&D activities are not attractive enough. Even the recent policy review of the DOST Technical Working Committee on Technology Transfer in 2007 highlighted the flaws of the Philippine innovation system such as: (i) weak public-private collaboration in R&D; (ii) weak technology transfer system; (iii) issues on technology ownership and information sharing; (iv) weak support to S&T and lack of resources for technology transfer; (v) weak intellectual property culture; (vi) declining human capital in R&D; and (vii) policy setbacks.

As previously mentioned, the national innovation system framework also points to the role of universities, particularly research-based universities in promoting innovation. Aside from supplying the educated manpower to industry, Tansinsin (2006) mentions in her paper that universities can collaborate with industry through contractual R&D; support of an industry's R&D activities; licensing and transfer of technology; R&D joint ventures and support for spin-off companies; consultancy by the university faculty; funding graduate or post-graduate students; and the most commonly practiced in the Philippines, apprenticeships or on-the-job training of students in industry. However, in her assessment of each mode of collaboration, the relationship is either weak or gradually emerging. The challenges can be attributed both ways. Some firms tend to regard R&D as expense rather than investment for higher productivity, while others lack confidence on the capabilities of local laboratories and would rather consult their mother companies or buy or license a particular technology. On the other hand, universities themselves are beset with constraints that prevent them from partnering in a more aggressive and sustained manner with industry. It was found that there is a dearth in involvement of full time researchers, scientists and faculty due to teaching loads and lack of research skills and experience. Also wanting is the administrative and financial support from university (Edralin, 2001 as cited in Tansinsin, 2006). According to Patalinghug (2003), some faculty resort to informal arrangements with firms given the limitations imposed by typically, public universities, to accept funds from private entities. Another important concern is the fact that even major universities in the country do not have policies on intellectual property (IP) rights nor have dedicated offices capable of handling these activities. So far, it is only the University of the Philippines that has an office called Technology Licensing Office created in 2004 but was an offshoot of the Intellectual Property Office established as far back as 1995. Even the chief of the Intellectual Property Office of the Philippines laments this situation saying that a lot of work needs to be done in raising awareness about the IP system in universities, which could actually encourage research and innovation.

Still, there were instances in the past and continuing university-industry partnerships in the country despite the constraints. The Manufacturing Linkage Program in 1985 comes to mind, which brought together engineering graduates of the University of the Philippines and manufacturing firms as brokered by DOST's Philippine Council for Industry and Energy Research and Development. Tansinsin (2006) provides a number of examples of past and current university-industry linkages. However, to reach the extent found in developed countries, the challenges earlier cited have to be hurdled.

One of the recent surveys that looked into the innovation activities in the country by both the public and private sectors was done in 1997-1998 by the Philippine Institute for Development Studies (PIDS) under the auspices of the Department of Budget and Management. The one done for the private sector focused on five industry groups, namely food processing; textile and garments; metals and metal fabrication; chemicals; and electronics and electrical machineries. Highlights of the survey results include the following: (i) only large firms engage in innovation and considered to be industry leaders; (ii) government standards and regulations and environmental concerns are not important drivers for innovation activities; (iii) a majority employ only college graduates or lower to conduct their innovation activities, implying a very low level of innovation activity; (iv) government research institutions rank very low as a source of innovative ideas and are perceived to be lagging even in monitoring technology developments in their respective fields; (v) financial constraints such as risk and rate of return, lack of financing and taxation are the major hindrances to innovation; and (vi) Philippine schools do not provide the requisite technical and technological skills and knowledge to meet demands. Also validated was the claim that government limits the amount of expenditure on R&D given its budget constraints; that the system only reaches out to the larger firms to the detriment of small and medium scale firms; and that, since government and private sector linkages are very weak, commercialization of developed technologies has not met adequate success.

3.2.2. Technological competitiveness: Philippine R&D indicators

Almost five years ago, in 2004, there was recognition of the need to strengthen the Philippine R&D statistical system. It was also a response to the call for updating the S&T data of the ASEAN S&T Management Information System (ASTMIS) related to the development of technology competitiveness indicators in ASEAN and based on the OECD recommended indicators. Thus, in 2004, the DOST was able to compile a three-year data of R&D indicators, 1992, 1996 and 2002. Based on this database and updated figures for 2005, total R&D personnel in the Philippines was found to have declined sharply in ten years, from almost 16,000 in 1992 to only 9,325 in 2002. Comparing this with the population size during those years, there were 239 R&D personnel per million population in 1992, 220 per million population in 1996, and 116 personnel per million population in 2002. The figure has slightly increased in 2005 to 127 but remains far from the ideal prescription of UNESCO at 380 per million population for developing countries.

Table 1. Selected Philippine R&D Indicators

	1992	1996	2002	2005
R&D manpower per million population	239	220	116	127
R&D expenditures as % of GDP	0.22	0.19	0.15	0.12
% share of the public sector in total R&D expenditures	71	60	28	-
% share of the private sector in total R&D expenditures	29	40	72	-

Sources: Department of Science & Technology and the ASEAN Science and Technology Management Indicators System.

Meanwhile, the standard of UNESCO in terms of R&D expenditures is 1 percent of the GDP. This has been an elusive goal for the Philippines for decades with the rate posted at 0.22 percent of the GDP in 1992, to 0.19 in 1996, 0.15 in 2002, and 0.12 in 2005. Notice the steady decline in the resources being allocated to R&D. A silver lining in the horizon though, is the increasing participation of the private sector in the conduct of R&D activities, perhaps coming in the heels of the need to gain a foothold in the competitiveness race globally. In 1992 and 1996, the distribution of total expenditures was 71 and 60 percent, respectively from the public sector and 29 and 40 percent, respectively from the private sector. In 2002, public R&D expenditure only reached 28 percent, while those attributed to the private sector was 72 percent (DOST, 2004, 2009). Expenditures on R&D may also come from both public and private higher education institutions with the major spenders coming from the biggest universities in the country. Private, non-profit institutions likewise expend on R&D activities, the bulk of which are spent for agricultural production and technology, social structures and relationships, and control and care of the environment. In a similar manner, higher educational institutions direct their resources to agriculture, health, social structures and relationships, the environment, and then, industrial production and technology. This is another indicator that universities give lesser priority to the needs and concerns of the industrial sector. Government R&D efforts, on the other hand, give much more priority to research on industrial production and technology, which comes in second to agricultural production and technology.

In terms of patents granted to residents, data from ASTMIS show the lamentable low numbers in the case of the Philippines, earning it a ranking of close to the bottom of the ASEAN pile since 2001 (ASTMIS, 2009). Figures from the Intellectual Property Office of the Philippines show that only 15 local patents was granted from a total of 1,653 granted in 2005 and only 28 out of 1, 814 in 2007 (DOST, 2009).

Based on the ASEAN/ASEAN+3 Science & Technology Competitiveness Indicator being maintained by the ASTMIS, in terms of overall ranking, the Philippines is in the middle of the pack from 1996 to 2003. In 2004 however, it was ranked 10th out of 13 economies being evaluated in terms of S&T performance. As expected, Japan is at the top of the heap from when the database was monitored in 1996 up to 2004, followed by Singapore and then Korea. Malaysia and Thailand keep the Philippines company in the middle before the breakaway in 2004 by the latter, effectively improving the rankings of the two. Indonesia was the bottom-ranked economy since 1996, but was ahead only to Lao in 2004, when the membership composition of the sub-regional grouping was completed.

The R&D situation in the country gave the Philippines an overall ranking of 70 out of 134 countries in terms of technological readiness for the period 2008 to 2009 and a rank of 67 out of 134 on innovation and sophistication factors in the latest Global Competitiveness Report of the 2008 World Economic Forum. Along with other indicators, the Philippines was given a rank of 71 out of 134 countries in terms of the global competitiveness index. In terms of stage of development, the country remains at the factor-driven stage and still a bit far from the efficiency-driven level. Much, much farther is the innovation-driven stage. This begs the question, is the Philippines farther from the innovative stage because of its current stage of industrial development or is it in its current stage of development because of dearth in innovation? This is a difficult question to postulate answers for but it seems likely that in terms of innovation, the Philippines is still at a very early stage.

4 HYPOTHESIS

The previous discussion should not preclude the fact that Philippine firms do innovate and there are firms that do have R&D departments or units. Macasaquit (2008) states in her paper the results of the survey of firms done in 2007[vi] indicating the top three innovations undertaken by firms in the Greater Manila Area in the last three years. These were the introduction of new products and services; upgrading of machineries and equipment; and opening of a new market. Those that have undergone the most innovations were those engaged in manufacturing, wholesale trade and retail trade. In terms of technology sources, the survey has shown that the firms themselves were the main drivers, followed by technology transfer from MNCs. Highlighted was the finding that there were weak linkages between industry and R&D generating institutions such as higher education institutions, government agencies and private institutions.

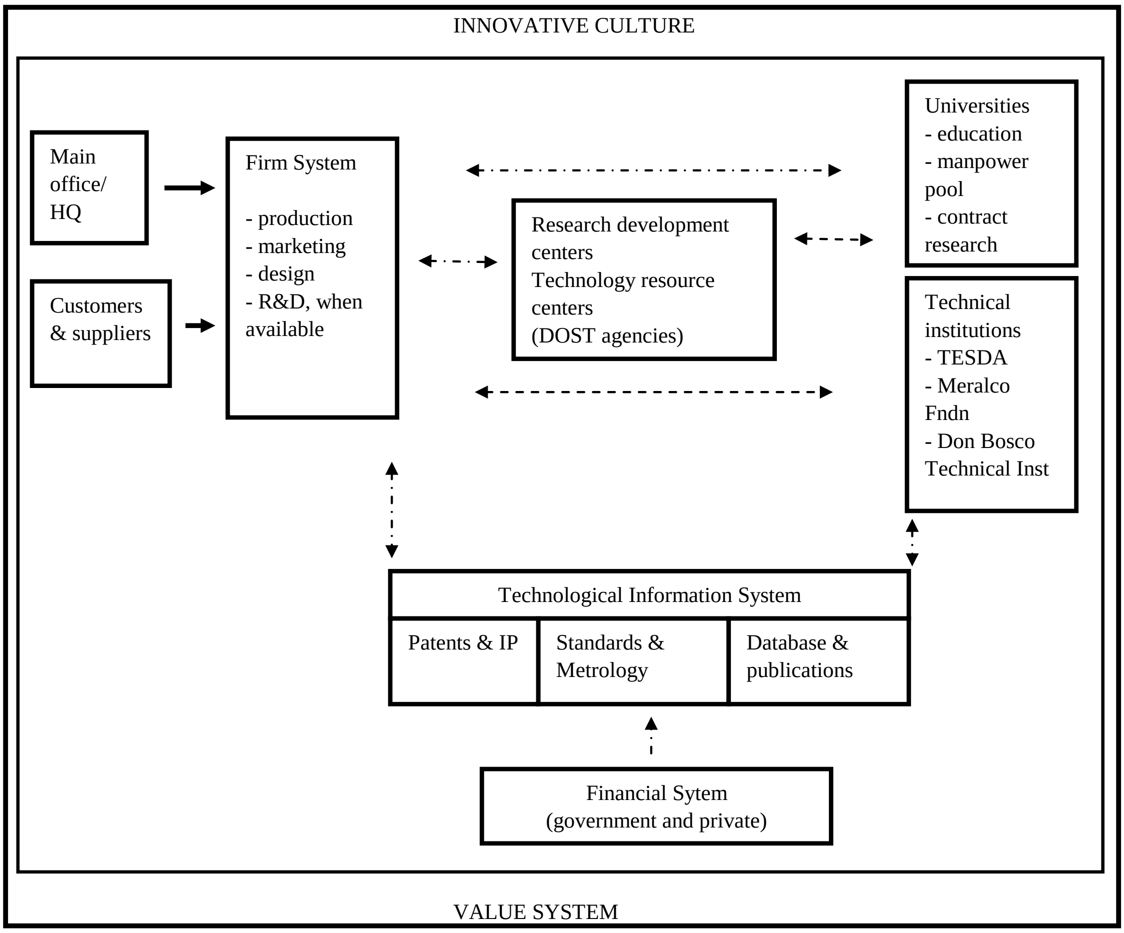
With the review of literature and previous primary data collection, there are evidences that the propensity of firms to innovate in the Philippines, no matter how minimal or how low in terms of value added, is not driven by strong linkages with the knowledge networks comprising of government research institutions, universities, technology resource centers, industry associations, and local public and private supporting institutions. It is quite possible to denote, that the primary sources of technological innovation are the firms and their affiliated firms themselves encompassing the production networks where they belong to and by local firms within the proximate location of the firms where they are engaged in production relationships like buying and selling. Production linkages may be considered part and parcel of how firms operate and therefore, a given knowledge channel. Based on earlier empirical findings of experts, proximity matters due to knowledge externalities. This also denotes an internal orientation of the firms in terms of technological development efforts.

There may be a lack of appreciation of how important intellectual linkages are to innovation. Moreover, the so-called dearth in innovative culture among Filipinos is being perpetuated by an educational system that is not attuned to the demands of local industries. Meanwhile, incentives for joint research and collaboration in technology commercialization seemed flawed as there are still loopholes in the intellectual property rights (IPR) code, not to mention the fact that not too many are aware of the IPR system nor has it been imbibed as part and parcel of the culture for knowledge generation and diffusion.

Though the programs and projects being implemented largely by the public sector are numerous, the applicable design and mix of interventions seem to have not yet been found. Besides, the level of financial resources being attributed may not be enough to reach the magnitude where significant impact would be more evident. These may be the key reasons why the state of R&D in particular and the Philippine innovation system in general, has remained in its stagnant state over the years.

Figure 1 presents a simple diagram of these postulates derived from the current dynamics of the Philippine innovation system, which is quite straightforward. Note that the arrows representing the linkages or relationships with other knowledge stakeholders are in broken form denoting weakness, while the arrows relating to affiliated firms are solid to indicate strong linkages. The system is operating under the backdrop of a still to be developed (or emerging) innovating culture among the Filipinos and the value systems they believe in. It has been pointed out in the literature that there exists a conflict in terms of the public good nature of research and efforts toward commercializing it to generate income.

Figure 1. The Philippine Innovation System



Source: Adopted from Patalinghug (2003).

Validating this scenario would entail the use of primary data collected through a survey of firms located in a specific region of the country. The claim that knowledge flows are geographically-mediated would also be proven to some degree in this case given the limited spatial focus of the case study. The descriptive results of the survey will be derived from the Survey on Production and Logistic Networks (SPLN) of Philippine Manufacturing Industries in CALABARZON conducted in late 2008 by the National Statistics Office, which was commissioned by the PIDS under the auspices of ERIA. This will be supplemented by the learnings from the in-depth interviews of fourteen firms all over the region and selected from the survey respondents. Lastly, an econometrics exercise that was undertaken through the assistance of the Japanese study team involved in the same project would serve to show how and to what extent innovative activities are driven by both production and intellectual linkages; the probability that each of these linkages could lead to innovation; and how better business performance is affected by innovation driven by the intensity of R&D activities and the knowledge linkages.

5 PRODUCTION, LOGISTICS AND KNOWLEDGE NETWORKS IN CALABARZON

5.1. Profile of CALABARZON

CALABARZON, which stands for the iterations from the provinces of Cavite, Laguna, Batangas, Rizal, and Quezon, is considered as one of the fastest-growing region in the Philippines. Partially owed to the region's close proximity to the National Capital Region or Metro Manila, the provinces of CALABARZON have individual and collective attributes that make the region vital to the development of the nation's economy. In terms of population size, CALABARZON has already overtaken Metro Manila as of the latest 2007 Census. The region is home to some 11.74 million people, which is roughly equivalent to 13.3 percent of the country's population or 0.3 percentage points higher than that of Metro Manila. Owing perhaps to the proliferation of housing projects in the area and their proximity to Metro Manila, Cavite has the largest population among the CALABARZON provinces with 2.86 million, followed by Rizal with 2.84 million. But in terms of land area, Quezon province is the biggest with 9,069 square kilometers. All in all, the region has a total land area of 16,289 square kilometers and an estimated population density of 600 persons per kilometer.

Table 2. Proximity to Metro Manila

Province	Distance	Location
CAVITE	30 kilometers	south of Manila
LAGUNA	30 kilometers	southeast of Manila
BATANGAS	60 kilometers	south of Manila
RIZAL	20 kilometers	east of Manila
QUEZON	89 kilometers	south of Manila

The region is vital to the economic fabric of the nation as it contributes around 13 percent to the national domestic output (second only to Metro Manila), and has the largest concentration of manufacturing or industrial activities. Of the 5,024 manufacturing establishments in the country in 2006, 27 percent or 1,397 are located in CALABARZON[vii].

In terms of industrial typology, the region is dotted with industrial parks in various categories. Out of 179 PEZA registered economic zones in the country today, 44 can be found in the CALABARZON provinces, except Quezon, with Laguna hosting 17 of these economic zones. Most of these were created through joint ventures between local and foreign partners.

Table 3. PEZA Registered Economic Zones in CALABARZON

Province	Number	Nature/orientation
CAVITE	13	High tech; electronics/semi-conductor eqpt manufacturers; ship building
LAGUNA	17	High tech; electronics/semi-conductor eqpt manufacturers; auto assembly plants; food processing/manufacturing
BATANGAS	12	agro-industrial processing; shipbuilding; eco-tourism
RIZAL	2	agro-industrial processing; eco-tourism
QUEZON	0	
CALABARZON	**44**	

It is noteworthy that each of the five provinces caters to different types of industrial and manufacturing activities. The province of Laguna for instance, being the home of 17 industrial parks, is host to a number of prestigious motor vehicle manufacturers, food giants and high tech electronics manufacturers like Toyota Motors, Universal Robina, San Miguel Corporation, Amkor, Fujitsu, and many others. Similarly, Cavite finds electronics, automotive parts manufacturing as well as ship building activities as good investment priorities due to the presence of such firms across the 13 economic zones located in the province.

Batangas on the other hand, is excellent for ship-building business activities and agro-industrial processing zones. It can be considered as the logistics hub in the region due to the accessibility provided by Batangas International Port and other smaller jetties utilized by businesses in the area, and its close proximity to the agricultural provinces of Quezon, Mindoro and Palawan. Though Rizal may have the smallest land area among the five provinces, its closeness to Metro Manila makes it the next best alternative site for manufacturing and agro-industrial activities. And as the catchment area for both Metro Manila and Cavite, its growing urban population size may be seen as a favorable market condition by some astute investors. In contrast, the province of Quezon is still largely agricultural. And while there is still, as of the moment, no economic or industrial zone operating in the area, the 1995 Special Economic Act has already identified some areas in the province as potential special economic zones. As the country's leading producer of coconut products like coconut oil and copra, the province's strong points and key areas for development would have to be in the area of ecotourism and agribusiness.

To sustain the region's development path and to maximize its growth potential, production facilities, logistics and infrastructure system are continuously being upgraded and developed. Aside from existing power facilities, several other power projects are underway. These include the 700 megawatt Pagbilao Coal-Fired Thermal Power Plant, Makban Modular Geothermal Power Plant, the Batangas Coal-Fired Power plant, among others. Water is mostly supplied by local water districts but there are also some areas that are serviced by franchise operators of Manila Waterworks and Sewerage System. Industrial zones have their respective water supply system.

In addition to the nearby Ninoy Aquino International Airport and the port of Manila, the region has well functioning ports in Batangas and in Quezon, the Dalahican Port. And with the conversion of the Batangas Seaport into an international container and passenger port, the region is expected not only to double its carrying inbound and outbound cargo capacities but also to ease or share in the load traffic in the Port of

Manila.

In terms of transport and road network, the region is deeply committed to improving its major artilleries like the South Luzon Expressway (which connects the international port of Batangas to Metro Manila and the rest of Luzon), the Infanta-Maharlika Highway and the Maharlika Highway, linking CALABARZON with the Bicol region. The expansion of the LRT Line 1 is also being prioritized to ease and facilitate access and mobility in the Cavite area.

With respect to telecommunication facilities, CALABARZON is at par with Metro Manila. The improvements undertaken by PLDT, which serviced most of the country's telecommunication needs, enabled direct dialing in the area and made telecommunications less costly. Cellular or mobile telephone carriers, broadband and internet providers are all powered by fiber optic cable network infrastructure. Courier services also abound in the area.

In terms of manpower support, CALABARZON has a number of prestigious learning institutions where they can be drawn from, foremost of which is the University of the Philippines in Los Banos, Laguna. It has the best agriculture program in the country and is in close contact with the International Rice Research Institute (IRRI)—the world's premiere rice research center. There is also the APEC Center for Technology Exchange and Training for Small and Medium Enterprises (ACTETSME) in Los Banos—a joint venture of APEC member countries that promotes and offers trainings to small and medium enterprises. And perhaps as pro-active response to the ongoing industry demands, the local governments took it upon themselves to initiate manpower training and skills upgrading programs in their respective jurisdictions. A good example would be the Dual Training Center in Canlubang which offers hands-on factory training in addition to school work, in close coordination with the Laguna Employment and Manpower Development Center (LEMDC). The Batangas State University has similar undertakings like vocational-technollogy programs infused with subjects or trainings that will improve the students' employability in nearby ecozone firms like Babcock-Hitachi Philippines—manufacturer of bonding wires for shipping firms in Japan. The Network of CALABARZON Educational Institutions or NOCEI was recently established to promote collaboration among said institutions and promote knowledge sharing.

Each of the provincial local government units in CALABARZON is actively instituting ways to sustain the economic growth momentum in the region. The Cavite provincial government has business-friendly practices, including the promotion of industrial peace through dialogues and regular meetings between labor and management thru the Cavite Tripartite Industrial Council and the Cavite Industrial Peace Advisory Group. It also implemented local tax incentives programs for locators inside business parks to attract more of them in the numerous industrial parks located in Cavite. On the other hand, Laguna was able to set-up its own version of National Economic Research and Business Assistance Center, a one-stop shop that assist investors interested in investing in the province. The Laguna Investment Promotions Bureau is equipped to guide and assist investors through the province's business application processes, which is a joint project of the Laguna Chamber of Commerce and Industry, the Provincial Office of the Department of Trade and Industry, the German Confederation of Small Business and Skilled Crafts (ZDH) and Ayala Land, Inc.

Boosting the tourism potential of Rizal, is the main thrust of the provincial government as of the moment, as reflected in its 12 Point Development Agenda. On the other hand, Quezon is being touted to be the new economic and investment zone in the region that would be known for being investment- and business-friendly. The approval of its Provincial Investment and Incentives Code, the holding of the summits on agriculture and fishery, business and investment, and tourism are geared toward the realization of the three key areas of development (i.e. agriculture, tourism and economic enterprise) for the province. Marketing Quezon as a viable investment option is the goal of the Quezon-Lucena Chamber of Commerce Inc., the Provincial Government and the Department of Trade and Industry which prompted them to stage the 1st Quezon Business Conference recently. The Batangas provincial government, meanwhile, has preference for promoting further the tourism potential of the area. Given the natural attributes of the province and its accessibility to all sorts of economic pursuits, the rapid pace of industrialization in Batangas is expected to only continue.

Still, it remains to be seen if all these structures and concerted efforts are able to impact on fostering technology generation, adaptation and utilization in the region.

Learnings from close interactions with a sample of firms would prove to be instructive.

5.2. Summary of Findings from the Survey

5.2.1. Profile of respondents

The survey results are derived from the responses of 205 respondent firms where 30 percent is located in Cavite, 29 percent in Rizal, almost 20 percent in Batangas, around 16 percent in Laguna, and 5 percent in Quezon. Table 4 below provides the numbers.

Table 4. Surveyed firms by province

	Freq.	Percent
Batangas	40	19.5
Cavite	62	30.2
Laguna	32	15.6
Quezon	11	5.4
Rizal	60	29.3
Total	**205**	**100.0**

More than half of the firms were established in the 1990s, which coincides with the decade of reforms in the country's industrial structure. Fifteen percent were formed in the 1980s, while 20 percent followed suit in the present decade. A similar pattern can be observed in terms of the tabulation of years when the firms were established in CALABARZON. This implies that most of the firms that were established in the country were originally formed in the region as well.

Table 5. Surveyed firms, by year first started operation in RP

	Freq.	Percent
1930s	1	0.5
1950s	2	1.0
1960s	7	3.4
1970s	9	4.4
1980s	31	15.1
1990s	114	55.6
2000s	41	20.0
Total	**205**	**100.0**

Of the total firms, 33 percent are firm-locators in special economic zones all over the region being managed by the PEZA. The rest are scattered outside of these designated industrial parks.

Table 6. Surveyed firms in PEZA and Non-PEZA areas, by province

	Non-PEZA		PEZA		Total	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**
Batangas	26	19.1	14	20.3	40	19.5
Cavite	27	19.9	35	50.7	62	30.2
Laguna	12	8.8	20	29.0	32	15.6
Quezon	11	8.1	-	-	11	5.4
Rizal	60	44.1	-	-	60	29.3
Total	**136**	**100.0**	**69**	**100.0**	**205**	**100.0**

5.2.2. Distribution of industries: business activity, capital structure, size

At the regional level, it is clear from the survey that there exists industrial clusters of textiles, apparel and leather; food, beverages and tobacco; electronics other than computers; and, chemicals in the region based on the number of firms operating in each category. The rest of the firms are fairly spread out among the other types of industries. However, among those inside the special economic zones, there are more firms engaged in electronics followed by chemicals manufacturing.

Table 7. Surveyed firms in PEZA and Non-PEZA areas, by main business activity

	Non-PEZA		PEZA		Total	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**
Food, beverages, tobacc	31	22.8	4	5.8	35	17.1
Textiles, apparel,leat	37	27.2	6	8.7	43	21.0
Wood, wood products	6	4.4	1	1.4	7	3.4
Paper, paper products,	3	2.2	2	2.9	5	2.4
Chemicals, chemical &	12	8.8	10	14.5	22	10.7
Other non-metallic mi	7	5.1	1	1.4	8	3.9
Iron, steel	5	3.7	-	-	5	2.4
Non-ferrous metals	1	0.7	-	-	1	0.5
Metal products	12	8.8	4	5.8	16	7.8
Machinery, eqpt, tools	4	2.9	4	5.8	8	3.9
Computers, computer pa	-	-	1	1.4	1	0.5
Other electronics, ele	5	3.7	25	36.2	30	14.6
Precision instruments	-	-	1	1.4	1	0.5
Automobile, auto parts	5	3.7	7	10.1	12	5.9
Other transportatn eq	-	-	1	1.4	1	0.5
Others	7	5.1	2	2.9	9	4.4
NA/NR	1	0.7	-	-	1	0.5
Total	**136**	**100.0**	**69**	**100.0**	**205**	**100.0**

In terms of distribution by capital structure, half of the firms are locally owned, 29 percent are foreign-owned and the rest were formed through joint venture arrangements. Locally-owned firms are engaged more in the food sector as well as in textiles and located mostly in non-economic zones. Meanwhile, foreign owned firms are mainly located in special economic zones engaged in the manufacture of electronics. Among the non-Filipino investors, the top three are Japanese (20%), South Korean (10%) and Taiwanese (8%).

Table 8. Surveyed firms by capital structure

	Freq.	**Percent**
100% Locally-owned	104	50.7
100% Foreign-owned	59	28.8
Joint Venture	42	20.5
Total	**205**	**100.0**

Table 9. Surveyed firms, nationality of Non-Filipino investors

	Freq.	Percent
Singaporean	3	1.5
Other ASEAN	2	1.0
Chinese	3	1.5
Japanese	40	19.5
South Korean	20	9.8
Taiwanese	16	7.8
Other Asian	2	1.0
American	8	3.9
European	5	2.4
Others (Canadian, Indian)	2	1.0
Total	**101**	**100.0**

Of the total respondents, 58 percent are comprised of firms with employees below 200, while the rest can be considered large firms.

Table 10. Surveyed firms by number of fulltime employees, as of date of visit

	Freq.	Percent
1-19	17	8.3
20-49	36	17.6
50-99	34	16.6
100-199	32	15.6
200-299	21	10.2
300-399	11	5.4
400-499	9	4.4
500-999	31	15.1
1,000-1,499	7	3.4
1,500-1,999	4	2.0
2,000 & above	3	1.5
Total	**205**	**100.0**

5.2.3. Main target markets and suppliers

For 57 percent of the firms, the most important target market is the Philippines, with 48 percent geared towards the National Capital Region and close to 45 percent catering to the regional market. Based on the total firms surveyed, the most important market to almost 20 percent of firms is the U.S., followed by Japan at 13 percent. Meanwhile, about 5 percent of firms cater to the European market, with the remaining considering other countries in ASEAN and Asia as target markets.

Table 11. Surveyed firms' 1st most important target markets

	Freq.	Percent
RP (NCR)	56	27.3
RP (CALABARZON)	52	25.4
RP (other regns)	8	3.9
Thailand (greater BKK)	1	0.5
Malaysia	1	0.5
China	1	0.5
Japan	27	13.2
S. Korea	3	1.5
Taiwan	3	1.5
U.S.	39	19.0
Europe	10	4.9
Others	4	2.0
Total	**205**	**100.0**

For almost half of the firms, their most important suppliers are located in the country and of these, 50 percent go to suppliers from NCR while a substantial 34 percent get raw materials from within the region. After the local suppliers, the next most important providers of raw materials is Japan (16%), China (11%), South Korea (6%), and Taiwan (5%).

Table 12. Surveyed firms' 1st most important source of raw materials

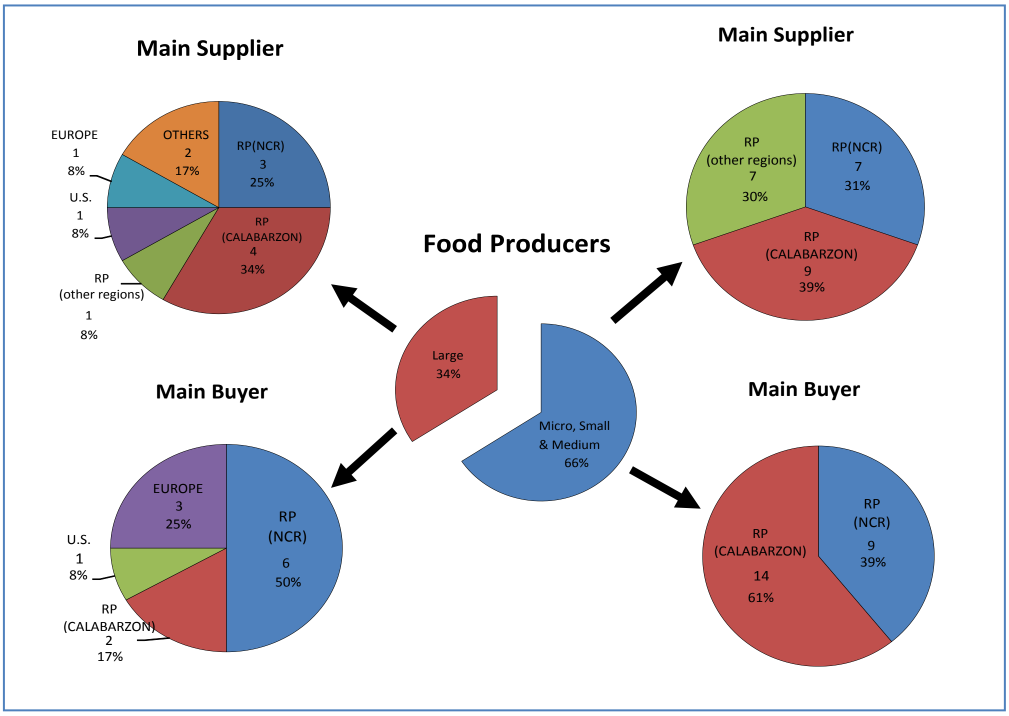
	Freq.	Percent
INDO(other regns)	1	0.5
RP(NCR)	50	24.4
RP(CALABARZON)	34	16.6
RP(other regns)	16	7.8
Singapore	3	1.5
Malaysia	2	1.0
Other ASEAN	2	1.0
China	22	10.7
Japan	33	16.1
S. Korea	13	6.3
Taiwan	10	4.9
Other Asia	2	1.0
U.S.	6	2.9
Europe	6	2.9
Others	5	2.4
Total	**205**	**100.0**

These results imply that the manufacturing firms in CALABARZON are closely integrated within the region considering it as a most important market and source of supplies. Logistics-wise, these firms are able to take advantage of proximity and an indication of seamless transport of goods to and from the firms. Outside of the country, while the U.S. remains the most important market for Philippine-made goods, Japan is the main source of raw materials. It is noted that Philippine manufacturing firms as represented by those located in CALABARZON, depend more on the countries in East Asia like China, South Korea and Taiwan for their supplies needs than the countries in ASEAN.

5.2.4. Production networks

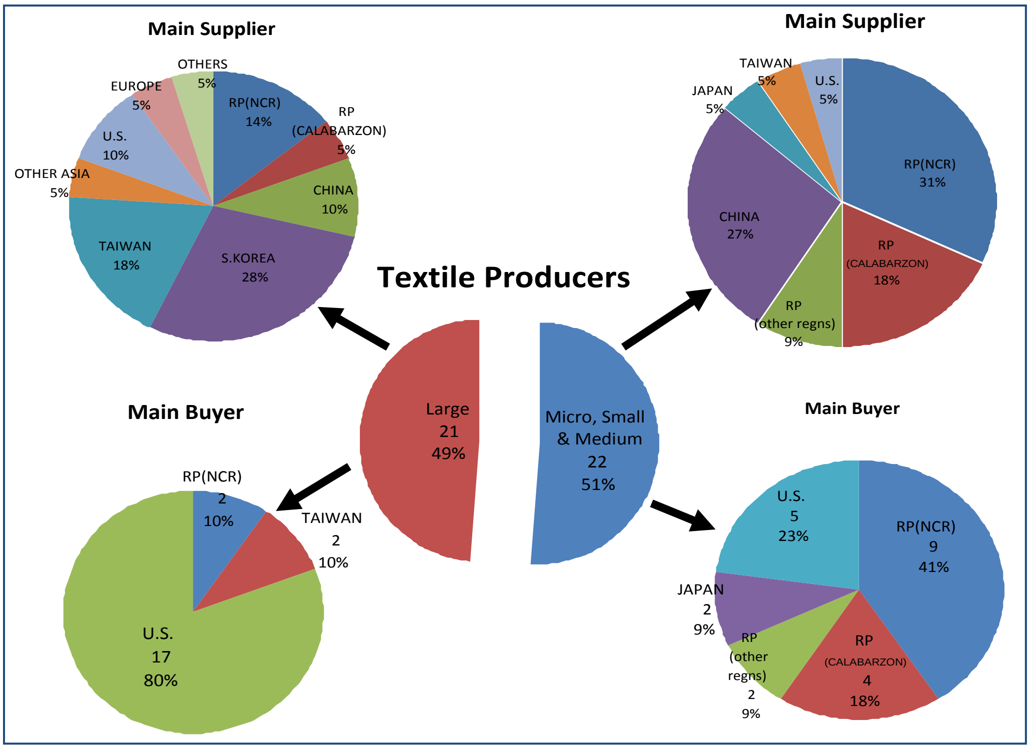
On an industry basis, it is interesting to trace the production route of the firms surveyed in the region albeit on general categories of customers and suppliers only. Among food producers, two-thirds are smaller firms catering only to the domestic market, 60 percent within the same region and 30 percent to NCR. Suppliers likewise entirely come from the country particularly from within CALABARZON, NCR and other regions. Of the large food producers, more than half gets their supplies from within the country, a few from other countries, from Europe and the U.S. Meanwhile, there are few firms catering to Europe and the U.S. but almost three-fourths of the firms cater to domestic needs. This inward orientation of food producers in CALABARZON may have something to do with the high transportation cost of the product owing to its perishability or for the reason that they are catered more to domestic tastes and consumption.

Figure 2. Production Network of Food Producers



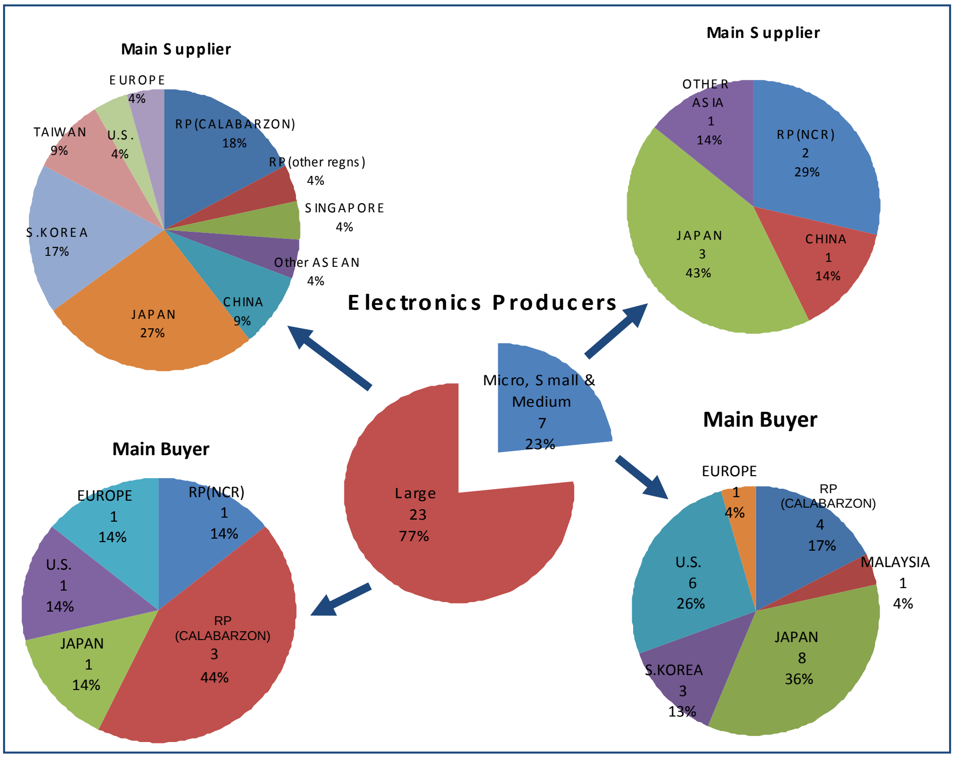
Of the total firms surveyed, those engaged in textiles comprise 21 percent and they are almost equally divided in terms of size with smaller firms edging the larger ones by one firm. The smaller textile firms are again, more domestically oriented comprising more than half of their buyers. The rest are taken up by customers in the U.S. and Japan. Majority of suppliers of these smaller firms is composed of other domestic firms mainly from NCR. Supplies from outside the country substantially come from China, then to a lesser degree from the U.S., Taiwan and Japan. As expected, the larger textile firms are more entrenched outside of the country and considerably latched on to the U.S. market for its sales. A few firms have customers from Taiwan and from within the country. As for sources of raw materials, large firms are more diversified with supplies coming from South Korea, Taiwan, China, the U.S., Europe, and other Asia. Supplies are also sourced domestically. Compared to the food sector, the textiles group appears to be more entrenched to the external production value chain, which may have something to do with the relatively low cost of labor in the country, ability to produce quality outputs and in order to maintain traditional business relationships.

Figure 3. Production Network of Textile Producers



Another sector that is more integrated into the regional and global production network is electronics. Among the total firms surveyed, 30 come from the electronics industry and are mostly large firms and located in special economic zones. The smaller firms are mainly outside the industrial parks. Large electronics firms are being supplied by quite a number of sources and appear to be more diverse. Main supplier is Japan, followed by South Korea, China, Taiwan, Singapore and other countries in ASEAN, while those from outside Asia come from the U.S. and Europe. There are also suppliers from within the country and interestingly, mainly from within the same region which could be pointing to agglomeration effects. Among their customers, large electronics producers cater mainly to the Japanese and the U.S. markets, then to the domestic market within CALABARZON, to the Asian market as represented by South Korea and Malaysia, and then Europe. Customers from within CALABARZON could be buyers of intermediate electronics inputs, which characterize the composition of the industry.

Figure 4. Production Network of Electronics Producers



5.2.5. Business performance of firms

Firms were likewise asked to indicate their current business performance, in comparison with that of 2007. Based on the tabulation, the three most common indicators of improved business performance experienced by firms in the last year are: improvement in the quality of products, reduction in product defects, and increase in the productivity of operations. Since this question entails multiple answers, the responses culled were more than the total of surveyed firms. It could not be said that based on the survey results alone that these improved performances can be directly attributed to the innovative activities undertaken by the firms, yet it can be assumed considering that product quality, flushing out defects and increasing productivity could also take place due to the technology factor.

Table 13. Current Business Performance of Firms

	100% Foreign-owned		100% Locally-owned		Joint Venture		Grand Total	
	Freq	% Share	Freq	% Share	Freq	% Share	Freq	% Share
Sales amount increased	26	7.76	50	11.04	23	10.13	99	9.75
Profit increased	17	5.07	42	9.27	14	6.17	73	7.19
No. of employees increased	21	6.27	23	5.08	16	7.05	60	5.91
Value of exports increased	27	8.06	17	3.75	17	7.49	61	6.01
Value of exports to developed countries increased	22	6.57	15	3.31	13	5.73	50	4.93
No. of exports destination increased	14	4.18	12	2.65	12	5.29	38	3.74
Productivity of operation increased	44	13.13	67	14.79	32	14.10	143	14.09
Quality of products improved substantially	51	15.22	76	16.78	39	17.18	166	16.35
Product defects were reduced substantially	50	14.93	70	15.45	31	13.66	151	14.88
Production cost decreased substantially	28	8.36	27	5.96	11	4.85	66	6.50
Lead time was reduced	35	10.45	54	11.92	19	8.37	108	10.64
Total	**335**	**100.00**	**453**	**100.00**	**227**	**100.00**	**1015**	**100.00**

5.2.6. Functions

When it comes to functions, the one with the most number of responses is production of final products, followed by procurement of raw materials, parts and supplies and production of raw materials.

Table 14. Three major functions carried out by surveyed firms in 2008

	Freq	Percent
Production (raw materials processing)	76	16.7
Production (components & parts)	60	13.2
Production (final products)	159	34.9
Procurement of raw matls., parts, or supplies	103	22.6
IT systems development, maintenance	6	1.3
After sales services	10	2.2
Marketing, sales promotion	39	8.6
Others	2	0.4
Total	455	100.0

5.2.7. Business linkages with most important customer and supplier

Among the surveyed firms, six have identified that their most important customer is located within the same industrial park where they are locators, while this is also true for the most important supplier of seven firms. Meanwhile, 51 firms indicated that their most important customer is in CALABARZON and 37 stated the same for their most important supplier. For 84 firms, their most important customer is actually located in another country, which is the same situation for 94 firms when it comes to their most vital supplier. These results show that the location of most important market and suppliers is varied with about a quarter of the total firms surveyed reliant on those in their immediate proximity and almost half looking outwards to other countries.

5.2.8. Technological capacity of firms

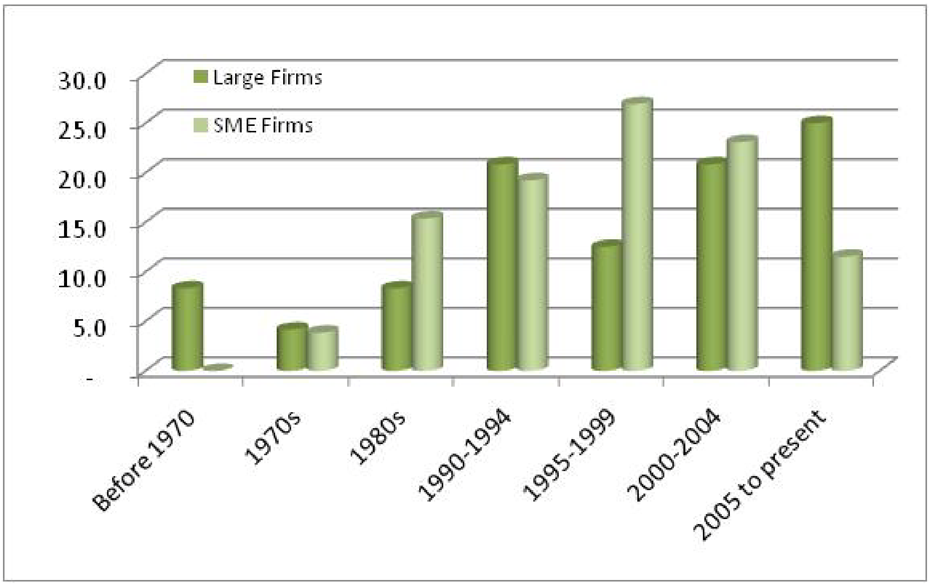
Fifty of the total 205 firms surveyed undertake R&D activities. Among them, 52 percent are small and medium firms and the rest of the 48 percent are large firms. In the previous surveys, the results point to the larger firms as those with more propensities to undertake R&D. This can be explained by the result that more firms engaged in food manufacturing are the ones doing the most R&D at 36 percent of the total firms conducting R&D. There are more of the smaller firms in the food sector than larger ones.

Table 15. Firms that carry out R&D activities, by size

	Yes		No		Grand Total	
	Freq	**% Share**	**Freq**	**% Share**	**Freq**	**% Share**
Large Firms	24	48.0	56	36.1	80	39.0
SME Firms	26	52.0	99	63.9	125	61.0
Grand Total	**50**	**100.0**	**155**	**100.0**	**205**	**100.0**

On the period when these firms started R&D activities, 62 percent commenced in the 1990s towards the middle of 2000 and with almost the same pattern between large and small firms, except in 1995 to 1999, when more small and medium-sized firms started doing R&D than large firms. Refer to figure 5 to observe the pattern.

Figure 5. Year Started R&D Operations



When it comes to R&D manpower, survey results show that the majority, at 58 percent, maintain 1 to 5 employees dedicated to such specialized activities. Among the large firms, 38 percent has 6 to 10 employees doing R&D, while among the small firms, 81 percent can only afford to have 1 to 5 employees in their R&D roster. Meanwhile, 16 percent of the large firms have more than 20 R&D personnel but not higher than 50.

Table 16. Number of R&D Employees

	Large Firms		SME Firms		Grand Total	
	Freq	**% Share**	**Freq**	**% Share**	**Freq**	**% Share**
1-5 employees	8	33.3	21	80.8	29	58.0
6-10 employees	9	37.5	2	7.7	11	22.0
11-15 employees	3	12.5	2	7.7	5	10.0
21-25 employees	2	8.3	1	3.8	3	6.0
26-50 employees	2	8.3		-	2	4.0
Grand Total	**24**	**100.0**	**26**	**100.0**	**50**	**100.0**

In terms of R&D intensity, measured by getting the ratio of R&D expenditure over total sales, 53 percent of the firms with R&D devote between 0.01 to 0.5 percent of total sales to this. The pattern is not so different between large and small firms.

Table 17. Share of R&D to Total Sales

	Large Firms		SME Firms		Grand Total	
	Freq	% Share	Freq	% Share	Freq	% Share
0.01 - 0.50%	13	54.2	13	52.0	26	53.1
0.51 - 1.0%	4	16.7	2	8.0	6	12.2
1.01 - 1.5%	3	12.5	4	16.0	7	14.3
1.51 - 2.0%	1	4.2	2	8.0	3	6.1
2.01 - 2.5%		-	1	4.0	1	2.0
4.01 - 5.0%	1	4.2	1	4.0	2	4.1
5.01% - above	1	4.2	2	8.0	3	6.1
No expenditure	1	4.2		-	1	2.0
Grand Total	**24**	**100.0**	**25**	**100.0**	**49**	**100.0**

5.2.9. Innovation

Majority of the firms surveyed has undergone product innovation or in other words, has introduced new products to the market in the last three years. Among these firms, 54 are large, while the remaining 51 are small and medium. However, though new products were introduced, these are mostly for existing markets and produced through existing technologies. In terms of industries undertaking this innovation, 21 percent were found to be firms in electronics, 20 percent engaged in food manufacturing and 13 percent into textiles and apparel production. Meanwhile, 66 percent of total firms that have undergone product innovation were able to increase total sales with the introduction of new products.

Table 18. Product Innovation

	Total		Large Firms		SME Firms	
	Freq	% Share	Freq	% Share	Freq	% Share
Introduced new products to the market in the recent 3 years	105	100.0	54	51.4	51	48.6
Are these products introduced in new or existing market?						
Existing market	85	81.0	46	85.2	39	76.5
New market	20	19.0	8	14.8	12	23.5
Are these products based on new or existing technologies?						
Existing technology	75	71.4	43	79.6	32	62.7
New technology	30	28.6	11	20.4	19	37.3
Intro.of new products increased total sales	69	65.7	38	70.4	31	60.8

In terms of process innovation or improvements undertaken in operations, production procedures and/or management systems, majority of respondent-firms bought new machines, 72 percent improved existing machines and 65 percent introduced new know-how. The differences between large and small firms in terms of these three types of process innovation are not too wide. Moreover, nearly half of the respondent-firms adopted an ISO, while more than 60 percent instituted other internal improvements. However, only 29 percent introduced ICT in their operations, which could also mean that many of the firms are already ICT-based.

Table 19. Process Innovation

	Total		Large Firms		SME Firms	
	Freq	**% Share**	**Freq**	**% Share**	**Freq**	**% Share**
Improved production/operations						
Bought new machines	118	57.6	59	50.0	59	50.0
Improved existing machine	148	72.2	69	46.6	79	53.4
Intro new know-how	134	65.4	66	49.3	68	50.7
Improved operations/management systems						
Adopted an ISO	99	48.3	54	54.5	45	45.5
Intro ICT	59	28.8	35	59.3	24	40.7
Intro other internal activities	125	61.0	61	48.8	64	51.2

5.2.10. Sources of information and new technologies

Firms have a number of sources of new information and technologies, which could only be tapped through establishing linkages with them. These channels can be categorized into three: own efforts, production linkages (denoting a relationship with other firms, whether as buyer or seller or as competitors) and intellectual linkages (universities, public and private research institutions). In total, 42 firms indicated that they get information and new technologies from their own R&D departments; 51 from their sales departments; and 61 from the production units. There are 35 firms that have technical agreements with their mother companies or headquarters.

Table 20. Sources of New Technologies: Internal Sources

	100% Foreign-owned		100% Locally-owned		Joint Venture		Grand Total	
	Freq	% Share	Freq	% Share	Freq	% Share	Freq	% Share
Internal sources of info and own R&D efforts	51	100.0	92	100.0	46	100.0	189	100.0
1. Own R&D	11	21.6	20	21.7	11	23.9	42	22.2
2. Own sales dept	12	23.5	28	30.4	11	23.9	51	27.0
3. Own production	15	29.4	33	35.9	13	28.3	61	32.3
4. Technical agreement w/ Headquarters	13	25.5	11	12.0	11	23.9	35	18.5

A total of 92 types of linkages have been denoted by respondent-firms with other local firms, out of which, 22 percent were with local suppliers or customers and another 22 percent with local consultants hired. More than 18 percent referred to licensing technology from other firms. Meanwhile, a total of 97 types of linkages were forged with foreign firms and/or multinational corporations. Of these, 27 percent were with foreign owned suppliers or customers, about 18 percent via joint ventures with other foreign owned firms and 14 percent each with foreign competitors in the same business, foreign competitors in the same business but neither customer nor supplier, and with international consultants.

Table 21. Sources of New Technologies: Production Linkages

	100% Foreign-owned		100% Locally-owned		Joint Venture		Grand Total	
	Freq	% Share	Freq	% Share	Freq	% Share	Freq	% Share
Technology Transfer from Local firms	20	100.0	36	100.0	36	100.0	92	100.0
1. Joint Venture with other local firms	3	15.0	2	5.6	6	16.7	11	12.0
2. Local supplier or customer	3	15.0	10	27.8	7	19.4	20	21.7
3. Local competitor	3	15.0	8	22.2	3	8.3	14	15.2
4. Local firm in different business with neither supplier nor customer	3	15.0	4	11.1	3	8.3	10	10.9
5. Licensing technology from other local firms	3	15.0	5	13.9	9	25.0	17	18.5
6. Local consultant hired	5	25.0	7	19.4	8	22.2	20	21.7
Technology Transfer from Firms or Cooperation w/ MNCs	34	100.0	21	100.0	42	100.0	97	100.0
1. Joint Venture with other Foreign firms	6	17.6	3	14.3	8	19.0	17	17.5
2. Foreign supplier or customer	7	20.6	9	42.9	10	23.8	26	26.8
3. Foreign competitor	5	14.7	3	14.3	6	14.3	14	14.4
4. Foreign competitor in the same business (neither supplier or customer)	5	14.7	3	14.3	6	14.3	14	14.4
5. Licensing technology from other MNCs	5	14.7	2	9.5	5	11.9	12	12.4
6. International consultant	6	17.6	1	4.8	7	16.7	14	14.4

Local organizations were the sources of technologies based on 80 responses by the surveyed firms. These were through the assistance of government, local business organizations and via participation in business consortium with support of local business organizations. There were however, only 28 types of linkages identified by the respondent firms under the category of university-industry linkages. Of these, 46 percent were with local universities or R&D institutes, 32 percent via membership in academic societies or subscription in academic journals and the remaining 21 percent were with foreign universities or R&D institutes.

Table 22. Sources of New Technologies: Intellectual Linkages

	100% Foreign-owned		100% Locally-owned		Joint Venture		Grand Total	
	Freq	% Share	Freq	% Share	Freq	% Share	Freq	% Share
Technical assistance by local organizations	27	100.0	28	100.0	25	100.0	80	100.0
1. Technical Assistance by government	7	25.9	7	25.0	5	20.0	19	23.8
2. Technical Assistance by local business organizations	5	18.5	5	17.9	5	20.0	15	18.8
3. Research consortium w/ government support	3	11.1	3	10.7	5	20.0	11	13.8
4. Research consortium w/ local business organization support	4	14.8	3	10.7	3	12.0	10	12.5
5. Business consortium w/ government support	4	14.8	4	14.3	3	12.0	11	13.8
6. Business consortium w/ local business organization support	4	14.8	6	21.4	4	16.0	14	17.5
Linkages w/ universities, R&D institutes and academic society	10	100.0	3	100.0	15	100.0	28	100.0
1. Technical cooperation with local university or R&D institute	3	30.0	2	66.7	8	53.3	13	46.4
2. Technical cooperation with foreign university or R&D institute	3	30.0		-	3	20.0	6	21.4
3. Academic Society and academic journal	4	40.0	1	33.3	4	26.7	9	32.1

There are other sources of information and new technologies aside from the three general categories mentioned above, and these pertain to personnel mobility such as mid-class personnel and those retired from MNCs and large firms, and from technical information derived from patents, foreign made equipment and software, and via reverse engineering. There were 44 responses culled for human resources and 43 for other sources.

Table 23. Sources of New Technologies: Others

	100% Foreign-owned		100% Locally-owned		Joint Venture		Grand Total	
	Freq	% Share	Freq	% Share	Freq	% Share	Freq	% Share
Human Resources	14	100.0	11	100.0	19	100.0	44	100.0
1. Recruitment of mid-class personnel	9	64.3	5	45.5	13	68.4	27	61.4
2. Recruitment of personnel retired from MNCs	5	35.7	6	54.5	6	31.6	17	38.6
Other sources	19	100.0	10	100.0	14	100.0	43	100.0
1. Technical information obtainable from patents	6	31.6	4	40.0	3	21.4	13	30.2
2. Introduction of "foreign-made" equipment and software	8	42.1	4	40.0	7	50.0	19	44.2
3. Reverse engineering	5	26.3	2	20.0	4	28.6	11	25.6

5.2.11. Important partners for innovation

The survey likewise asked the firms to indicate their most and second most important partners for innovation and whether they are actual or potential partners at the moment. Of the total firms surveyed, majority (60%) of those who responded consider their respective departments, headquarters and affiliates as their most first important partners, and second will be their local customers and/or suppliers (21.2%). This trend is true across provinces and sectors. This tendency to rely on own departments becomes even more pronounced in large firms engaged in joint ventures (100%) that claim to rely on their own offices and affiliates for their innovative activities. The same can be said of foreign firms, with 55 out of the 59 surveyed firms admitting to depend more on their own departments and affiliates when it comes to innovative undertaking. In terms of proximity, 30% of those that responded are less than 11 kilometers away from their actual partners, while the other 30% are more than 200 kilometers away from their network partners. The latter could refer to their local customers/suppliers in other regions and/or foreign affiliates abroad. When it comes to the duration of the relationship, most of the firms that respondent indicated the longest tenor in the questionnaire options, which is, more than three years. These results denote that among the firms that have actual partners for innovation, other than their own or referring to local firms (customers and/or suppliers), duration of the relationship also matters.

In terms of potential partners for innovation, these are mostly confined or limited to identified local customers and/suppliers.

5.2.12. Obstacles to innovation

The respondents were likewise asked about the hindrances to innovation that they have been experiencing. This question directly pinpoints the obstacles that should be removed by policy interventions or overcome through the efforts and cooperation of the various stakeholders in the innovation system. Based on the survey, the most serious obstacles to innovation as indicated by surveyed firms in CALABARZON are: lack of R&D supporting industry; high price of R&D support services; high tariffs on equipment and materials necessary for innovation; no business organization or chamber of commerce which can provide training courses, seminar or testing facilities in the neighborhood; and, no tax break or accelerated depreciation system.

Table 24. Most Serious Obstacles for Innovation

	Large Firms		**SME Firms**		**Grand Total**	
	Freq	**% Share**	**Freq**	**% Share**	**Freq**	**% Share**
No R&D supporting Industry	10	19.6	23	23.5	33	22.1
Price of R&D support services is high	14	27.5	19	19.4	33	22.1
No university or public institute in the neighborhood	1	2.0	0	-	1	0.7
Tech. capabilities of universities or public institutes located in the neighborhood too weak to collaborate	2	3.9	1	1.0	3	2.0
No business organization or chamber of commerce which can provide training courses, seminar or testing facilities in the neighborhood	6	11.8	10	10.2	16	10.7
Protection of IPR not sufficient	1	2.0	2	2.0	3	2.0
High tariffs on eqpt & materials necessary for innovation	9	17.6	23	23.5	32	21.5
No tax break or accelerated depreciation system	4	7.8	12	12.2	16	10.7
Establishment not familiar with public support programs & procedures to apply for support measures	1	2.0	2	2.0	3	2.0
Public support programs are not designed appropriately for innovation	0	-	2	2.0	2	1.3
Labor mobility is too rigid for workers to bring with them technologies acquired from previous employer or from previous training	3	5.9	4	4.1	7	4.7
Grand Total	**51**	**100.0**	**98**	**100.0**	**149**	**100.0**

5.3. In-depth Interviews of Firms

5.3.1. Profile of interviewed firms

In order to get more insights on the linkages dynamics occurring among firms in the Philippines, in-depth interviews were undertaken successfully covering fourteen firms located all over the region. Their location and sectoral distributions are as follows: four firms come from Cavite comprising of three electronics firms and one engaged in apparel; two from Laguna, both undertaking food production; two from Batangas, each engaged in the oleochemicals industry and electronics; four firms from Rizal with one each representing the food and electronics sector and two engaged in apparel production; and, two firms in Quezon, both of which are into food manufacturing. Of the fourteen, half are locators in special economic zones, eight are locally-owned, and all except two are large firms. Six of these firms have R&D departments, three are reliant on their parent companies and the rest do not have R&D capabilities.

5.3.2. Relationships with Customers and Suppliers

At least eight of these firms mentioned that their relationships with customers and suppliers are important for them to come up with differentiated products whether slightly improved or entirely new. Customers provide the specifications and/or changes to details and it is up to the firms to determine and find ways if they could meet these demands. This is especially true for firms without R&D departments. This textile company that was interviewed specializing on dyeing yarns mentioned that the customers specify the colors and combinations, which they try to comply with. The company engaged in processing desiccated coconut follows the signal of their customers, all from Europe, that typically just give them information as to the cut of the product and chemical content. Meanwhile, given that the machinery being used is almost always imported, the suppliers of these machines provide the training to the firms to enable them to operate said machines.

5.3.3. Owners/management as key

While customers are major sources of information and new technologies, there are firms among the roster interviewed that has a pro-active stance in coming up with new ways of utilizing their products in a producer-driven manner, that is, even without receiving requests for firms to do so. According to respondents from this firm engaged in coconut oil production for residential and commercial use, the overall drive of the firm to innovate is inspired by the owner who established the R&D department, sends R&D personnel to training and subscribes to an international industry-related journal. The firm is also more receptive to cooperate with the programs and technical assistance provided by the government-run Philippine Coconut Authority, which has offices in the region. This same drive can be found as one of the traits of the operations manager of a company making biscuits for domestic consumption. This particular firm does not have an R&D department though its sister company has. Nevertheless, the operations manager still goes on his own to search for new product lines that the company can introduce to the market.

The same innovative mind-set was mentioned to be possessed by the owner of the shoe company interviewed in Rizal. Said shoe company is 100 percent locally owned and came from the tradition of shoe manufacturers in the area. With the designs in shoes good only for three months, the owner is said to frequent different countries to undertake scanning of latest and upcoming trends, particularly in Italy and China. The company does its own designs and undertakes market research afterwards via focus group discussions. The company also has exclusive designs for clients and for its own line. When asked if they have plans to secure ISO certification, the representative of the company said that it is very expensive to be certified by them and more than that, the requirements are numerous.

5.3.4. Other stimulants of innovation

Meanwhile, securing an ISO certification was the turning point for a tool and die company (considered electronics) to improve their overall operations and management systems. This was first demanded by their customers which are ISO certified themselves. So as not to lose these clients and be competitive, the company sought the certification and in the process improved the company itself. The company also has a good quality control system that is able to catch defects at the outset. The engineering department, which is also integrated with the R&D activities, designs their own template enabling them to send proposals to prospective clients.

Among food manufacturers, it was found that product upgrade or introduction of new products is imperative, at least every two years. By the nature of their products, in the case of the interviewed firms – breads, cookies, biscuits, candies – and the very competitive environment by which they operate, keeping up with rivals and coming out with new and improved products are necessary. This could also be the reason why they maintain R&D departments or units. In one of the three firms interviewed engaged in manufacturing such products, it was found that they benchmark their competitors so they would know what they are up against. They are also aware of the need to patent their products. On the other hand, the biggest baking company in the country has been able to patent a process in the preparation of one of their best-selling products. Though wholly foreign owned, the company is not dependent on the head office for R&D activities and are able to conduct their own research. This is because the local affiliate knows better the tastes and preferences of the population they are trying to serve.

5.3.5. University-industry linkages

The most common joint undertakings between the interviewed firms and universities within and outside the region are in terms of apprenticeships or on-the-job (OJT) training and hiring of graduates. The biggest baking company in the country has had some experience collaborating with the University of the Philippines in Los Banos and in the University of the Philippines in Diliman. The firm sought consultancy services from the Colleges of Food Technology and Nutrition for product and vitamin development. The firm approached the university and the arrangement, informal. In fact, there have been some other instances in the past where product testing and partial research were initiated with individuals in the University, like faculty and students. Meanwhile, the arrangement with UP Diliman is on environmental concerns rather than technology oriented. The firm also has Dual Tech arrangements with Don Bosco Technical Institute. The same is true for the tool and die manufacturer in Rizal, which has OJT agreements with Meralco Foundation, which incidentally, also has a course offering on tool and die. Some of the firms subscribe to the Dual Training System of the government-run Technical Education and Skills Development Authority (TESDA), with one firm preferring to hire those with TESDA certificates.

Firms in the region source their manpower from graduates and residents within the region, which gives them ample supply. Some have, however, expressed fears that engineers would soon run-out if they are not given enough incentives as they would just opt to get pecuniary income from abroad instead where they are also in-demand.

5.3.6. Other linkages

Electronics firms interviewed are all members of the Semiconductors and Electronics Industries in the Philippines, Inc. (SEIPI) and get benefits from their services. Food firms are members of either the Philippine Baking Industry Group or the Philippine Food Processors and Exporters Organization, Inc., while the coconut desiccators are members of the Desiccators Association and the umbrella organization, United Coconut Associations of the Philippines, Inc. However, not much knowledge exchange is happening in these associations as they are mainly geared towards advocating for the advancement of their sectors or to fix prices as with the desiccators. One interviewee did mention that being a member of the Philippine Association of Food Technologists enabled her to attend seminars and learn about updates on new technologies.

As for the interactions with government agencies other than TESDA, limited technological linkages were found even with instrumentalities of the DOST. Those engaged in electronics go to them for calibration only. When asked if they knew of any programs being offered by them, most of the interviewees were not aware. Meanwhile, one of the food firms mentioned that they go to the Bureau of Food and Drugs and the Food Nutrition Research Institute for technical assistance, but it comes with a fee. Another food firm worked with the DOST for the development of a drier equipment but was not successful. Local government units, despite having their own investment promotional drives and incentives offerings to firms and industries in their jurisdiction, are not yet a channel for the exchange of information and new technologies. Interactions with firms are still limited though an isolated case of support was cited by one firm.

In sum, the more in-depth interviews of select firms has succeeded in clarifying and specifying the information asked through the questionnaire, particularly in terms of the linkages they actually have with various sources of new information and technologies. For all firms, with or without R&D, their customers are the primary sources. Meanwhile, for firms whose owners, management in general, have imbibed an innovative mindset, they themselves source out information and new trends in their industry. These firms are also more prone to having R&D departments and in continuous improvements and industrial upgrading, with or without encouragement by their customers. Linkages with the universities and public research institutions were confirmed to be weak and limited at best. Still, OJT arrangements and Dual Training Systems are concrete steps toward matching needs and manpower supply to industries. So far, despite their pronouncements and programs, the local government units are not yet a factor in the local innovation system.

6 ECONOMETRICS RESULTS

Using dataset collated from the 2008 SPLN survey, the econometrics analysis will try to trace out the correlation between innovation and sources of information and new technology. Innovation in this regard will be measured by the number innovative activities undertaken by manufacturing firms in CALABARZON in the last three years, while sources of technology will be determined by the number of linkages that has taken effect between the firms and the various sources. Such linkages can be grouped into two categories, the production and intellectual linkages. In this model, the dependent variable is the number of innovation while the independent variables are the total number of linkages and by type of linkages. Control variables are the firms' capital structure, age, size in terms of count of full-time employees, and selected industries which were found to be agglomerated in the region (food, apparel and electronics).

6.1. Innovation and Linkages

This relationship was tested using three models: all firms, firms with R&D units and firms without R&D units. Number of linkages was found to be positively correlated to the number of innovations both among all firms and among those without R&D units at the 5 percent and 1 percent significance levels, respectively. The results indicate that an additional linkage taking effect likely leads to an increment in the number of innovative activities for all firms and for those firms without R&D departments. Having more sources of technology makes it conducive for the conduct of more innovation, while firms without R&D capabilities would most likely rely on other sources of information and new technology. The result for the model pertaining to firms with R&D was positive but not significant.

Among the control variables, the coefficient for local firms was found to be negative and significant at the 5 percent level denoting that local firms are less likely to innovate than foreign firms. Larger firms are positively correlated to the number of innovations in all the models indicating that they are more likely to conduct innovative activities. Among the three sectors, the coefficient for food is significant only among firms without R&D (at 10% level) and was found to be negative. This denotes that food producers without R&D departments are less likely to contribute to innovative activities. Firms engaged in producing apparel likewise show negative coefficients in all three models and significant at the 1 percent level. Apparel firms are less likely to conduct innovative activities, which are reflected in actual scenarios since many of them are engaged in low value added activities and rely much on the specifications of the mother companies. The coefficients for electronics are found to be insignificant.

Table 25. Number of Linkages and Number of Innovations by R&D

OLS Dependent variables: Number of Innovations	(1) All	(2) With R&D	(3) Without R&D
Number of Linkages	0.154*	0.019	0.217**
	[0.072]	[0.086]	[0.079]
Local	-1.605*	-0.885	-1.429+
	[0.720]	[1.673]	[0.793]
Age	0.046	0.073	-0.014
	[0.034]	[0.054]	[0.057]
Full-time Employees	0.003**	0.006**	0.002*
	[0.001]	[0.002]	[0.001]
Food	-0.329	-0.316	-2.071+
	[0.889]	[1.442]	[1.135]
Apparel	-4.160**	-5.368**	-3.944**
	[0.704]	[1.905]	[0.731]
Electronics	-0.603	-1.85	0.044
	[1.097]	[3.781]	[1.042]
Constant	7.593**	8.507**	8.124**
	[0.754]	[1.860]	[0.902]
Observations	204	50	154
R-squared	0.29633	0.40051	0.2869

Note: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%.

6.2. Innovation and Types of Linkages

Using the same model above but focusing only on production linkages, results show that the coefficients, both among all firms and among firms without R&D, are positive and significant at the 5 percent level. The results imply that firms having production linkages add to the instances of innovative activities. In the same manner, firms that do have intellectual linkages are more likely to contribute to innovation based on the positive signs of coefficients attributed to all firms and those without R&D, which are significant at 5 percent and 1 percent levels, respectively. However, it cannot be claimed that having intellectual linkages has more or stronger effect on innovation than production linkages or vice versa due to the issues of endogeneity. It can only be stated in certain terms that linkages in all forms, among the stakeholders of knowledge, are positive and significant drivers of technological upgrading among firms.

Table 26. Number of Production Linkages and Number of Innovations by R&D

OLS Dependent variables: Number of Innovations	(1) All	(2) With R&D	(3) Without R&D
Number of Production Linkages	0.207*	-0.003	0.300*
	[0.101]	[0.128]	[0.119]
Local	-1.613*	-1.026	-1.405+
	[0.723]	[1.670]	[0.789]
Age	0.048	0.074	-0.015
	[0.034]	[0.054]	[0.057]
Full-time Employees	0.003**	0.006**	0.002*
	[0.001]	[0.002]	[0.001]
Food	-0.316	-0.258	-2.057+
	[0.892]	[1.438]	[1.131]
Apparel	-4.173**	-5.387**	-3.929**
	[0.705]	[1.878]	[0.728]
Electronics	-0.554	-1.65	0.081
	[1.108]	[3.773]	[1.055]
Constant	7.577**	8.662**	8.112**
	[0.755]	[1.889]	[0.901]
Observations	204	50	154
R-squared	0.29341	0.39982	0.28787

Note: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%.

Table 27. Number of Intellectual Linkages and Number of Innovations by R&D

OLS Dependent variables: Number of Innovations	(1) All	(2) With R&D	(3) Without R&D
Number of Intellectual Linkages	0.473*	0.16	0.528**
	[0.212]	[0.232]	[0.191]
Local	-1.630*	-0.705	-1.416+
	[0.715]	[1.662]	[0.813]
Age	0.044	0.071	-0.012
	[0.034]	[0.055]	[0.057]
Full-time Employees	0.003**	0.006**	0.002*
	[0.001]	[0.002]	[0.001]
Food	-0.315	-0.38	-2.115+
	[0.888]	[1.446]	[1.145]
Apparel	-4.163**	-5.273**	-4.004**
	[0.701]	[1.898]	[0.740]
Electronics	-0.653	-2.21	0.043
	[1.073]	[3.831]	[1.017]
Constant	7.668**	8.344**	8.136**
	[0.760]	[1.793]	[0.905]
Observations	204	50	154
R-squared	0.29804	0.40603	0.27881

Note: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%.

6.3. Innovation and Internal Sources

The more recent surveys of firms have indicated that Philippine firms have tendency to rely more on their in-house capacities for technological development. Results of the econometrics give validity to these efforts as coefficients denoting correlation between number of internal sources and number of innovations is positive both among all firms and those without R&D departments at 1 percent and 5 percent levels of significance, respectively. Said coefficients have high values, suggesting that the more internal capabilities firms have, the more innovation they are able to generate.

Table 28. Number of Internal Sources and Number of Innovations by R&D

OLS Dependent variables: Number of Innovations	(1) All	(2) With R&D	(3) Without R&D
Number of Internal Sources	0.969**	0.218	0.822*
	[0.208]	[0.394]	[0.353]
Local	-1.820**	-0.982	-1.506+
	[0.679]	[1.641]	[0.778]
Age	0.038	0.072	-0.011
	[0.034]	[0.055]	[0.056]
Full-time Employees	0.003**	0.006**	0.002*
	[0.001]	[0.002]	[0.001]
Food	-0.791	-0.371	-2.064+
	[0.842]	[1.434]	[1.152]
Apparel	-4.202**	-5.301**	-4.073**
	[0.697]	[1.918]	[0.734]
Electronics	-0.878	-1.997	-0.204
	[1.054]	[3.960]	[1.043]
Constant	7.420**	8.238**	7.940**
	[0.727]	[2.090]	[0.874]
Observations	204	50	154
R-squared	0.34687	0.40428	0.29867

Note: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%.

6.4. Innovation and Linkages by Functions of the Firms

Another indicator of R&D capacity of firms is the so called intensity of R&D derived from computing actual R&D expenditures over total sales. Said variable was plugged in into the model, this time by functions of the firms whether raw materials processing, parts and components production, final assembly, procurement, and marketing. Interestingly, the R&D sales ratio is found to have significant coefficients only in procurement and marketing, both with negative signs. This denotes that procurement functions of firms are less likely to drive innovation than those performing other functions. Likewise, the same connotation can be made among firms doing marketing. The results could find validation in actuality considering that firms are more likely to direct R&D efforts towards production than procurement and marketing functions.

In terms of total number of linkages vis-à-vis number of innovation, all coefficients show positive results but only those among all firms, as well as those engaged in parts assembly and procurement are found to be significant. This can be interpreted to mean that the number of linkages that parts assemblers and those having procurement functions have adds to the likelihood of undertaking innovative activities. Similar results are obtained when linkages are specified into production but slightly different when intellectual linkages are used. Results show that having intellectual linkages are positively correlated to the number of innovations taking place among all firms, those engaged in raw materials processing, parts assembly, procurement, and marketing. This could denote that intellectual linkages are able to bring in more diverse knowledge that can be applied into various functional levels. On the other hand, in terms of the number of internal sources that firms have, which is a proxy for technological capabilities, all the signs are positive in various levels of significance among all firms and in all functions. This brings to mind the argument under the national innovation system framework that industrial development requires technological capability in industry and the use of technology is most crucial at the firm level. Econometrics results indeed show that when firms have the technological capacities, innovation takes place and their capacities could be built up more with the promotion of stronger intellectual linkages.

Table 29. Number of Linkages and Number of Innovations by Functions

OLS Dependent variables: Number of Innovations Last 3 years	(1) All	(2) Raw materials	(3) Parts	(4) Final Assembling	(5) Procurement	(6) Marketing
R&D Sales ratio	-1.321	26.197	-5.603	-1.626	-2.598+	-4.616*
	[1.421]	[19.719]	[29.830]	[1.371]	[1.491]	[2.167]
Number of Linkages	0.154*	0.111	0.299**	0.149	0.246**	0.124
	[0.072]	[0.067]	[0.087]	[0.097]	[0.074]	[0.077]
Local	-1.623*	-3.072*	-0.182	-1.508+	-2.653*	-1.848
	[0.727]	[1.260]	[1.659]	[0.796]	[1.190]	[1.420]
Age	0.046	0.037	-0.043	0.069+	0.026	0.047
	[0.034]	[0.078]	[0.074]	[0.035]	[0.045]	[0.042]
Full-time Employees	0.003**	0.004+	0.002	0.004**	0.003*	0.007**
	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.002]
Food	-0.284	0.175	-7.244**	-0.399	-0.598	-1.905
	[0.913]	[1.300]	[1.589]	[1.040]	[1.259]	[1.788]
Apparel	-4.162**	-5.284**	-3.846+	-3.966**	-4.052**	-4.196**
	[0.705]	[1.227]	[1.962]	[0.793]	[1.222]	[1.469]
Electronics	-0.620	-2.686	-0.845	-2.188	-1.471	3.243
	[1.104]	[2.586]	[1.171]	[1.538]	[1.656]	[2.021]
Constant	7.616**	9.018**	9.249**	7.103**	8.767**	8.898**
	[0.761]	[1.756]	[1.386]	[0.864]	[1.125]	[1.130]
Observations	204	75	59	159	103	39
R-squared	0.297	0.405	0.385	0.285	0.330	0.573

Note: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%.

Table 30. Number of Production Linkages and Number of Innovations by Functions

OLS Dependent variables: Number of Innovations Last 3 years	(1) All	(2) Raw materials	(3) Parts	(4) Final Assembling	(5) Procurement	(6) Marketing
R&D Sales ratio	-1.319	26.768	-6.371	-1.597	-2.548+	-4.627*
	[1.438]	[19.751]	[29.270]	[1.389]	[1.492]	[2.200]
Number of Production Linkages	0.206*	0.137	0.422**	0.214	0.352**	0.178
	[0.101]	[0.093]	[0.130]	[0.136]	[0.104]	[0.115]
Local	-1.631*	-3.062*	-0.078	-1.508+	-2.666*	-1.836
	[0.730]	[1.256]	[1.652]	[0.797]	[1.186]	[1.413]
Age	0.047	0.041	-0.043	0.070*	0.028	0.049
	[0.034]	[0.077]	[0.074]	[0.035]	[0.045]	[0.042]
Full-time Employees	0.003**	0.004+	0.002	0.004**	0.003*	0.007**
	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.002]
Food	-0.270	0.167	-7.270**	-0.390	-0.624	-1.865
	[0.916]	[1.305]	[1.572]	[1.041]	[1.255]	[1.786]
Apparel	-4.175**	-5.329**	-3.884+	-3.969**	-4.032**	-4.184**
	[0.707]	[1.228]	[1.946]	[0.796]	[1.219]	[1.486]
Electronics	-0.572	-2.627	-0.727	-2.147	-1.432	3.512+
	[1.114]	[2.621]	[1.168]	[1.538]	[1.682]	[1.898]
Constant	7.600**	8.948**	9.167**	7.066**	8.682**	8.813**
	[0.762]	[1.751]	[1.386]	[0.862]	[1.123]	[1.161]
Observations	204	75	59	159	103	39
R-squared	0.294	0.401	0.384	0.285	0.332	0.572

Note: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%.

Table 31. Number of Intellectual Linkages and Number of Innovations by Functions

OLS	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables: Number of Innovations Last 3 years	All	Raw materials	Parts	Final Assembling	Procurement	Marketing
R&D Sales ratio	-1.429	24.691	-3.444	-1.749	-2.805+	-4.845*
	[1.397]	[19.772]	[31.070]	[1.343]	[1.499]	[2.039]
Number of Intellectual Linkages	0.471*	0.386+	0.816**	0.397	0.679**	0.335+
	[0.213]	[0.213]	[0.274]	[0.285]	[0.237]	[0.192]
Local	-1.649*	-3.068*	-0.404	-1.553+	-2.637*	-1.934
	[0.721]	[1.266]	[1.708]	[0.790]	[1.196]	[1.424]
Age	0.043	0.028	-0.038	0.068+	0.024	0.041
	[0.034]	[0.082]	[0.075]	[0.035]	[0.045]	[0.041]
Full-time Employees	0.003**	0.004	0.002+	0.004**	0.003*	0.007**
	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.002]
Food	-0.266	0.168	-7.252**	-0.378	-0.540	-1.867
	[0.911]	[1.292]	[1.666]	[1.038]	[1.279]	[1.762]
Apparel	-4.165**	-5.251**	-3.805+	-3.979**	-4.176**	-4.337**
	[0.702]	[1.216]	[2.026]	[0.789]	[1.231]	[1.475]
Electronics	-0.672	-2.775	-0.988	-2.231	-1.476	2.906
	[1.080]	[2.501]	[1.185]	[1.512]	[1.611]	[2.170]
Constant	7.692**	9.168**	9.348**	7.210**	8.943**	9.112**
	[0.766]	[1.788]	[1.402]	[0.876]	[1.135]	[1.099]
Observations	204	75	59	159	103	39
R-squared	0.298	0.410	0.366	0.281	0.317	0.571

Note: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%.

Table 32. Number of Internal Sources and Number of Innovations by Functions

OLS	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables: Number of Innovations Last 3 years	All	Raw materials	Parts	Final Assembling	Procurement	Marketing
R&D Sales ratio	-1.031	12.189	-23.651	-1.113	-1.355	-3.940+
	[1.007]	[15.837]	[22.984]	[1.094]	[1.427]	[1.987]
Number of Internal Sources	0.967**	0.626+	1.495**	0.987**	1.438**	0.717+
	[0.209]	[0.360]	[0.393]	[0.237]	[0.307]	[0.364]
Local	-1.833**	-2.855*	-1.958	-1.729*	-2.635*	-2.054
	[0.685]	[1.267]	[1.468]	[0.762]	[1.138]	[1.351]
Age	0.038	0.032	-0.062	0.061+	0.015	0.056
	[0.034]	[0.079]	[0.062]	[0.035]	[0.045]	[0.044]
Full-time Employees	0.003**	0.004+	0.002	0.004**	0.003*	0.007**
	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.002]
Food	-0.754	-0.286	-5.282**	-1.056	-1.308	-2.281
	[0.864]	[1.271]	[1.593]	[0.993]	[1.253]	[1.598]
Apparel	-4.203**	-5.177**	-2.216	-3.988**	-4.174**	-4.592**
	[0.698]	[1.288]	[1.960]	[0.776]	[1.144]	[1.669]
Electronics	-0.892	-2.842	-1.468	-2.455	-1.614	2.615
	[1.060]	[2.400]	[1.131]	[1.509]	[1.433]	[1.827]
Constant	7.437**	8.729**	9.466**	6.862**	8.533**	8.584**
	[0.734]	[1.749]	[1.250]	[0.841]	[1.092]	[1.192]
Observations	204	75	59	159	103	39
R-squared	0.347	0.417	0.469	0.341	0.395	0.588

Note: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%.

6.5. Linkages and Probability of Innovation

Econometric results demonstrated the effect of linkages on the probability of firms to innovate, i.e. introduce new products, using three models: all firms, those with R&D and those without R&D. The resulting coefficients are positive both for all firms and those with R&D but negative among those without R&D. However, they are not significant. The same is true even with only the number of production linkages was used. However, when the number of intellectual linkages is used, the coefficients become positive and significant among all firms and among those with R&D. Simply put, the number of intellectual linkages has positive and significant effect on the probability that all firms will introduce new goods in the market. Among firms with R&D units and having intellectual linkages, the effects are likewise positive and significant for the likelihood of this type of innovation to take place.

In terms of the number of internal sources alone, the coefficient is positive among all firms and among those with R&D but only the former is significant. Thus, firms with internal technological capacities in terms of the number of sources of new knowledge it has from within positively affects the probability that said firms would introduce new products.

Table 33. Number of Linkages and Introduction of New Product by R&D

Probit, Marginal Effects Dependent variables: Introduction of New Good (Yes/No)	(1) All	(2) With R&D	(3) Without R&D
Number of Linkages	0.011	0.01	-0.012
	[0.007]	[0.008]	[0.012]
Local	-0.123	0.022	-0.153
	[0.084]	[0.145]	[0.095]
Age	-0.001	-0.007	0.002
	[0.004]	[0.004]	[0.005]
Full-time Employees	0.000+	0	0
	[0.000]	[0.000]	[0.000]
Food	0.134	0.17	-0.105
	[0.101]	[0.123]	[0.137]
Apparel	-0.194*	-0.018	-0.232*
	[0.095]	[0.189]	[0.094]
Electronics	0.088		0.118
	[0.122]		[0.134]
Observations	204	45	154

Note: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%.

Table 34. Number of Production Linkages and Introduction of New Product by R&D

Probit, Marginal Effects Dependent variables: Introduction of New Good (Yes/No)	(1) All	(2) With R&D	(3) Without R&D
Number of Production Linkages	0.011	0.007	-0.016
	[0.010]	[0.011]	[0.017]
Local	-0.125	0.006	-0.154
	[0.083]	[0.147]	[0.095]
Age	0	-0.007	0.002
	[0.004]	[0.004]	[0.005]
Full-time Employees	0.000+	0	0
	[0.000]	[0.000]	[0.000]
Food	0.136	0.174	-0.105
	[0.101]	[0.124]	[0.138]
Apparel	-0.196*	-0.028	-0.232*
	[0.094]	[0.192]	[0.094]
Electronics	0.093		0.116
	[0.122]		[0.133]
Observations	204	45	154

Note: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%.

Table 35. Number of Intellectual Linkages and Introduction of New Product by R&D

Probit, Marginal Effects Dependent variables: Introduction of New Good (Yes/No)	(1) All	(2) With R&D	(3) Without R&D
Number of Intellectual Linkages	0.048*	0.080*	-0.024
	[0.023]	[0.040]	[0.036]
Local	-0.122	0.027	-0.154
	[0.083]	[0.125]	[0.095]
Age	-0.001	-0.007+	0.002
	[0.004]	[0.004]	[0.005]
Full-time Employees	0.000+	0	0
	[0.000]	[0.000]	[0.000]
Food	0.132	0.154	-0.104
	[0.102]	[0.115]	[0.136]
Apparel	-0.191*	0.024	-0.229*
	[0.095]	[0.139]	[0.094]
Electronics	0.079		0.115
	[0.123]		[0.135]
Observations	204	45	154

Note: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%.

Table 36. Number of Internal Sources and Introduction of New Product by R&D

Probit, Marginal Effects Dependent variables: Introduction of New Good (Yes/No)	(1) All	(2) With R&D	(3) Without R&D
Number of Internal Sources	0.063*	0.006	-0.003
	[0.027]	[0.034]	[0.040]
Local	-0.140+	-0.016	-0.159+
	[0.083]	[0.145]	[0.095]
Age	-0.001	-0.007+	0.002
	[0.004]	[0.004]	[0.005]
Full-time Employees	0	0	0
	[0.000]	[0.000]	[0.000]
Food	0.111	0.177	-0.103
	[0.103]	[0.124]	[0.137]
Apparel	-0.201*	-0.027	-0.228*
	[0.095]	[0.189]	[0.094]
Electronics	0.069		0.107
	[0.124]		[0.135]
Observations	204	45	154

Note: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%.

6.6. Technological Linkages and Business Performance

Innovation affects the business performance of firms in a number of ways. It could lead to increases in sales amount, profit and value of exports, increased ability to employ more and tap into more markets, improve productivity and the quality of products, reduce product defects and lead time, and decrease production costs. Looking at the empirical relationship among them and the number of innovations undertaken yields the following results: (i) the number of innovations has positive and significant correlation with the probability of improved business performance among those that reported increases in sales amount, value of exports, value of exports to developed countries, and number of export destinations; (ii) the number of innovations affects the probability of heightened business performance positively among those firms whose productivity of operations improved, with better quality of products, and with reductions in product defects and lead time. This outcome validates exactly the results from the survey cited in previous sections, which enumerated the three most common business performance improvements experienced by firms in CALABARZON.

Table 37. Number of Linkages and Current Business Performance

Probit, Marginal effects	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
Dependent variables: Current Business Performance Compared to FY2007 (Q6.1-Q6.11)	**Sales amount increased**	**Profit increased**	**Number of employees increased**	**Value of exports increased**	**Value of exports to developed countries increased**	**Number of export destination increased**	**Productivity of operation improved**	**Quality of products improved**	**Product defects were reduced**	**Production cost decreased**	**Lead-time was reduced**
Number of Innovations	0.020*	0.002	0.002	0.026**	0.017*	0.025**	0.023**	0.016**	0.021**	0.009	0.018*
	[0.009]	[0.008]	[0.007]	[0.008]	[0.007]	[0.007]	[0.008]	[0.006]	[0.008]	[0.008]	[0.009]
R&D Sales Ratio	2.914	1.001*	1.039	1.869	2.556	2.317	0.335	0.145	0.237	-4.104	-2.599
	[2.706]	[0.486]	[1.694]	[2.482]	[2.332]	[1.729]	[0.291]	[0.213]	[0.266]	[2.721]	[3.043]
Number of Production Linkages	0.031	0.006	-0.003	0.023	0.017	0.017	0.031	0.006	-0.014	0.017	0.005
	[0.020]	[0.019]	[0.017]	[0.017]	[0.015]	[0.012]	[0.024]	[0.016]	[0.017]	[0.019]	[0.021]
Number of Intellectual Linkages	-0.039	0.018	0.044	-0.052	-0.027	-0.022	-0.067	0.019	0.050+	-0.004	0.008
	[0.038]	[0.039]	[0.037]	[0.038]	[0.032]	[0.026]	[0.041]	[0.027]	[0.030]	[0.039]	[0.042]
Local	0.084	0.165*	-0.054	-0.114	-0.087	-0.042	0.038	-0.109+	-0.013	-0.032	0.104
	[0.090]	[0.081]	[0.076]	[0.075]	[0.072]	[0.064]	[0.077]	[0.063]	[0.075]	[0.076]	[0.083]
Age	-0.003	-0.001	-0.010*	0.000	-0.001	-0.005+	-0.003	-0.002	-0.004	-0.005	-0.005
	[0.004]	[0.004]	[0.004]	[0.004]	[0.003]	[0.003]	[0.003]	[0.002]	[0.003]	[0.004]	[0.004]
Full-time Employees	0.000	0.000	0.000*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Food	0.101	-0.001	0.021	-0.219**	-0.043	-0.035	0.039	-0.065	0.018	-0.147+	-0.146
	[0.110]	[0.097]	[0.099]	[0.064]	[0.084]	[0.074]	[0.092]	[0.092]	[0.089]	[0.083]	[0.105]
Apparel	-0.347**	-0.274**	-0.215**	0.019	0.022	0.032	-0.148	-0.042	-0.018	0.063	-0.111
	[0.090]	[0.076]	[0.071]	[0.096]	[0.098]	[0.085]	[0.094]	[0.071]	[0.083]	[0.096]	[0.101]
Electronics	-0.042	-0.074	-0.130	0.143	0.290*	0.062	0.137	-0.217+	-0.041	-0.090	0.117
	[0.118]	[0.105]	[0.085]	[0.117]	[0.118]	[0.096]	[0.100]	[0.123]	[0.115]	[0.094]	[0.119]
Observations	204	204	204	204	204	204	204	204	204	204	204

Note: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%.

7 KEY FINDINGS

The results of this paper's methodology, such as secondary data, literature review, survey results, in-depth interviews of firms, and econometrics, confirm the hypotheses earlier postulated. Indeed, for firms in the Philippines as represented by manufacturing firms located in CALABARZON, production linkages or interactions with buyers and sellers and other local firms do matter for innovation to transpire. While there are evidences of weak linkages with the intellectual community, i.e., universities and public and private research institutes, econometrics results show that intellectual linkages do have positive and significant effects on innovation and should be acknowledged as evidence-based information for aggressively promoting these types of knowledge flows. It was also clearly highlighted that internal resources or the technological capacities of the firms affect innovation positively and efforts toward building up capabilities of firms to do so should be undertaken. Evidences were also provided, based on the survey results and the econometrics analysis, that innovation does affect business performance positively. At this moment, these characterize the national innovation system in the country. The following provide more details on the key findings.

7.1. The Philippines' technology policy is drawn from the mandates enshrined in the constitution on S&T. The national innovation system consists of the government through the cabinet-level Department of Science and Technology and its instrumentalities; the private sector through their R&D efforts; the higher education system; non-profit private institutions; and, other supporting institutions.

7.2. The diffusion of technology via adoption, utilization and commercialization is not widespread, despite the numerous programs that aim to achieve these objectives. Lack of resources, dearth in a critical mass of R&D human resources and the private sector's cautious regard of the capacities of research development institutions to diffuse the technology are possible culprits for this condition.

7.3. University-industry linkages are occurring but weak, characterized by informal arrangements rather than more formal agreements due to the absence of internal IPR policies in universities. The main role of universities is to produce the manpower that would comprise the workforce of the industry. A common type of collaboration between universities and industry is apprenticeship/on-the-job training.

7.4. Due to lack of appropriate IPR policy within the universities, scientists and researchers fear that their novel body of works would only get "pirated" or ripped off when publicly disseminated. Ironically, their adherence to the "publish or perish" belief systems forces them to publicize their findings in scientific or academic journals.

7.5. Policy frameworks and priorities change every time a new administration is sworn into office, casting doubts on the continuity and sustainability of strategies, plans and programs. Though it cannot be said that the contents of these policy pronouncements are invalid, thrusts and priorities do change in the political succession. The long term National S&T Plan is no guarantee that strategies and plans would not change when the new administration is sworn into office in 2010.

7.6. Based on the survey, manufacturing firms in CALABARZON are well integrated into the regional economy as far as production goes. Customers and suppliers are in close proximity and many of them get new ideas from them. Some firms in the region also have production links with other countries, particularly the U.S., Europe, Japan, Korea, China, and Taiwan. Almost 3 out of 10 firms have foreign parent companies and derive new technological knowledge from them.

7.7. However, these firms on the average have stronger technological linkages within their internal organizational structure and with their local customers and suppliers. Linkages with knowledge networks are weaker whether in terms of accessing technical assistance from the government or participating in research consortium organized with support from government or from local business organizations. Also found to be low is the cooperation between the firms and local universities or R&D institutes.

7.8. The most important actual partners for innovation and upgrading are own departments, headquarters and affiliates, and local customers and suppliers. They are also considered as most important potential partners. Logistics-wise, these important partners are very accessible and duration of the relationship, long-term.

7.9. The five most serious obstacles faced by the firms in CALABARZON are: lack of R&D supporting industry; high price of R&D support services; high tariffs on equipment and materials necessary for innovation; no business organization or chamber of commerce which can provide training courses, seminar or testing facilities in the neighborhood; and, no tax break or accelerated depreciation system. However, in the Investment Priorities Plan for 2008 (and presumably, in previous years), R&D activities are one of the so-called preferred activities where incentives can be tapped. It is not clear if such incentives offered include importation of equipment for innovation. Meanwhile, experts claim that there are very few-takers of these incentives for R&D activities. On the second obstacle, it is found that while national business/industry associations are actively cooperating with government and academe on R&D related activities, there are no such active associations at the regional level though there may be chapters. There are provincial chambers or business associations but membership may not be that widespread as of yet or has not really been active in terms of knowledge exchange. The consortium of educational institutions in CALABARZON has more academe-related pursuits than R&D related.

7.10. The in-depth interviews of firms confirmed many of the above findings, while adding insights on what drives innovation among them. A key finding is that the innovative mind-set of the firms' leadership (management or owner) is a strong driver or facilitator for innovative pursuits.

7.11. Econometrics results indicate that the firms' own technological capacities and number of intellectual linkages have positive and significant impact on the occurrence and number of innovations. Number of production linkages was also proven to be positive and significant. The number of innovations was also found positive and significant predictor of improved business performance particularly those related to sales, value of exports, productivity, quality of products, reduction of product defects and lead time. Intellectual linkages were also found to be particularly important for reducing product defects. Thus, it can be concluded that indeed, linkages are essential to firms' innovation in the region and efforts should be extended towards tracing out and strengthening the ties that bind leading to innovation as this in turn, affect positive performance of firms.

8 RECOMMENDATIONS FOR POLICY AND PRACTICAL STRATEGIES

The overall goal of the proposed interventions is to emphasize less the differences on how each stakeholder of the innovation system performs but more on how they can work together, strengthening their linkages, given the resources that each can offer.

8.1. At the national level

8.1.1. On intellectual property rights and the need to provide incentives for researchers to conduct R&D and disseminate their findings

The Intellectual Property Code of the Philippines does not have an explicit provision on how to assign ownership or copyright to government funded research activities. In fact, the Code has conflicting provisions: Section 30 states that the "person who commissions the work shall own the patent, unless otherwise stipulated in the contract," while Section 176 mandates, "No copyright shall subsist in any work of the Government of the Philippines. However, prior approval of the government agency or office wherein the work is created shall be necessary for exploitation of such work for profit. Such agency or office may, among other things, impose as a condition the payment of royalties."

To address this concern, the recently filed legislation aimed at clarifying the assignment of IP on commissioned work of the government should be supported. Said proposed legislation refers to House Bill 5208 titled, "An Act Promoting the Transfer of Technologies and Knowledge from R&D Funded by Government." This is also hoped to facilitate further technology transfer, particularly of public funded R&D outputs.

In terms of the lack of familiarity with IPR protection in general, and the IPR Code in particular, it is suggested that a more aggressive information campaign on IPR be conducted. Strengthen the capacities of universities and private research development institutes to protect their R&D outputs by helping them formulate internal policies on

IPR. Example: University of the Philippines has a Technology Licensing Office, which can serve as model for the others. The Intellectual Property Office of the Philippines should endeavor to have a registry of patented inventions that can easily be accessible in order to disseminate the information and inspire the conduct of R&D.

8.1.2. On policy frameworks for S&T

The ever-changing national S&T framework for plan, policy formulation and program development should be strategically fixed to enable better monitoring of progress and to plug in problems in the process. It would also be best to acknowledge and aggressively pursue the national innovation strategy recently launched and branded as FilipINNOVATION. This notion developed multi-sectorally, serves as a battle cry that Filipinos could support and aspire for and an updated version of the National S&T Plan, 2002-2020. Conducting the National Conference on Innovation regularly could help sustain awareness and interest. Also, formal agreements fostered in the last conference should be tracked and monitored, like the open technology and business incubation partnership between DOST and the Philippine Economic Zone Authority for start-up companies in the ICT industry and the works of the Engineering Research and Development for Technology Consortium comprised of 7 engineering schools in the country and includes policy research and scholarship offerings as major activities. In fact, many of the actions recommended in this paper are also part of the action agenda that came out from the first national conference on innovation.

8.1.3. On fostering heightened UILs

Create a forum where the academe and industry can share ideas for possible collaboration. Universities can pool their studies and make them available online or send to firms they could include in their mailing list. This is also one way of marketing their outputs! On the other hand, firms can disseminate their R&D requirements through their websites or directly to universities and even, private R&D institutions (RDIs). In CALABARZON, tap the consortium of educational institutions to publicize information.

Government, national or subnational or both, could offer tax or non-tax incentives to firms for partnering with universities and/or RDIs.

8.1.4. On the high cost of R&D equipment and supporting services

This has been explicitly identified in the survey as most serious obstacles, together with high tariffs on equipment and materials necessary. With the high cost of R&D related capital equipment and supporting services a given and while the public sector could not afford to allocate funds for this, alternative scenarios can be pursued. (a) Foster bilateral cooperative agreements with nations or industries in other countries that supply R&D equipment in order to lower tariffs and/or other transaction costs (requirements and procedures). (b) Establish common R&D related facilities that are prohibitive and impractical to purchase by firms on their own. Examples are testing facilities and laboratories. Industry clusters in industrial parks may be able to pull this through more than those outside since space can be made available and basis for joint action and sharing of facilities already in place, i.e. common utilities, common services, and typically, a locators' association is established in each industrial park that can manage collective action.

8.1.5. Lack of local business organization or chamber of commerce in the area

There are business organizations that are active in the country such as the Philippine Chamber of Commerce and Industry (PCCI), Semi-conductors and Electronics Industry Philippines, Inc. (SEIPI), Philippine Baking Industry Group, Desiccators' Association of the Philippines, PhilFoodex, Philippine Footwear Federation, Inc., among others. Regional, provincial and other local chapters should be established in order to cater to the needs of member firms in these areas. There are provincial based associations like the Cavite Tripartite Industrial Council, Laguna Chamber of Commerce and Industry and the Quezon-Lucena Chamber of Commerce Inc. However, the fact that they were not mentioned by any of the firms interviewed suggests that they have not penetrated the collective consciousness of most of the firms in their respective areas and their activities are not yet inclusive. It is laudable that in

Laguna, the provincial government is promoting a "Culture of Excellence" in the province with the private sector as active partners. Data show that representatives from the private sector participate in the Laguna Area and Productivity Council (LAPC) and have co-founded the Laguna Employment and Manpower Development Council (LEMDC). The former seeks to improve the productivity of those currently employed in the business sector, government sector, cooperatives and sectoral associations, and academe. Its most recent project is industry clustering and value chain analysis. LEMDC, on the other hand, provides skills training to out-of-school youth so that they can enter the labor force as well as retraining and upgrading to retrenched or laid off workers.

These associations should also be encouraged to pursue R&D activities. For example, the PCCI’s commitment to FilipINNOVATION was to pass a resolution promoting the establishment of technology business incubators targeting SMEs. They intend to tap the DOST and universities in implementing a national business incubation program, promote the concept in their chapters and include this as a module in the PCCI Development Institute. Evidences of associations of Chinese businessmen/women and among Korean firms in the region were found, which could be encouraged to pursue R&D related activities. The role of local government units in this process should likewise be promoted as they can provide financial and logistic support.

8.2. At the ASEAN+6 Regional Level

8.2.1. On production networks

Production and business linkages are very important for Philippine firms as sources of new ideas and knowledge based on the survey results and was also found to have positive and significant correlation with innovation. A policy suggestion is for the concerned economies in the region to cooperate in pursuing further intra-regional trade among them, with governments facilitating business matching or sourcing out information on regional suppliers and getting information on markets for local products. In the case of the Philippines, these are mandates of the Department of Trade and Industry and other related-instrumentalities of the government and perhaps by the industry associations, but more focus is proposed to be directed to tapping the opportunities specifically found in the region. Information and disseminating it effectively to firms especially in all parts of the country is important.

8.2.2. On costly equipment and supporting services for R&D

Foster regional cooperation agreements that would facilitate lowering the cost of equipment and supporting services such as lowering tariffs, particularly with those economies that are technologically advanced and supplies these kinds of materials. Another possible area of cooperation wherein these more advanced economies could assist the less advanced is through the transfer of technologies that they already consider obsolete or near-obsolete but can still be used by the latter for more practical purposes like reverse engineering and research.

8.2.3. Benchmarking regional centers of excellence in Science education

Facilitate exchange of knowledge and perhaps, even faculties, between local and regional academic institutions, particularly to those located in technology-advanced neighbors. If possible, benchmarking of curriculum (on S&T and others) can be done to upgrade the quality of education in technology-backward countries. Visiting fellowships or researchers' programs can likewise be pursued among public and private R&D institutions.

8.2.4. On Intellectual Property Rights

Countries in the region with weak IPR culture like the Philippines can learn a lot from neighboring countries that have advanced IPR regimes. Sharing of knowledge and technical assistance in this area should well be undertaken in the spirit of cooperation.

8.2.5. On R&D financial resources

More financially-capable neighboring countries and institutions therein with thrusts towards S&T development, could establish a fund that can be tapped by government, universities, industry associations (on behalf of member firms), and RDIs for pursuing R&D activities from less technologically capable countries.

NOTES

[i] The excellent assistance of Ms. Fatima del Prado in the writing of this paper is gratefully acknowledged. A big thank you also goes to Melalyn Cruzado-Mantaring and Michael Cabalfin for their inputs.

[ii] Reference is being made here to the ten country-members of the Association of South East Nations (ASEAN) and its partners, Japan, China, Korea, and India, plus Australia, and New Zealand.

[iii] Feldman (1999) provides an exhaustive review of approaches for measuring knowledge spillovers and proving that it is indeed, geographically mediated.

[iv] The succeeding discussion draws heavily from Macasaquit (2008).

[v] List of priority investment areas determined by the Regional Board of Investments of the Autonomous Region of Muslim Mindanao (ARMM).

[vi] Also done by PIDS in collaboration with the National Statistics Office under the auspices of the Economic Research Institute for ASEAN and East Asia and the Institute of Developing Economies.

[vii] Firms with an average total employment of 20 and over; as of 2006 CPBI.

REFERENCES

Asia Technology Management Center (2008).“How Innovation Linkages in Asia Unlock Value: A VC’s Perspective,” School of Engineering, Stanford University.

ASTMIS, ://aseank.kisti.re.kr/sntind, (Accessed on February 19, 2009)

Board of Investments (2008). Investment Priorities Plan, 2008

Cristobal, Adrian S. (2006). “What’s in a Name?” Business Mirror, Dec. 7, 2006

Cororaton, Caesar B. (2002). “Research and Development and Technology in the Philippines”. PIDS Discussion Paper No. 2002-23. Makati City, Philippines: Philippine Institute for Development Studies.

De La Pena, Fortunato T. “National Innovation Systems, Policy Framework and Programs for the Philippines: Issues Identification.” ://202.90.141.226/news/National%20Innovation.pdf (Accessed February 2009).

Department of Science and Technology (2004). “Improving the Philippine Research and Development (R&D) Statistical System,” Paranaque, Philippines: DOST.

____ (2002). National Science and Technology Plan, 2002-2020.

Export Development Council (2008). Philippine Export Development Plan, 2008-2010

Feldman, Maryann P. (2000). “Location and Innovation: The New Economic Geography of Innovation, Spillovers and Agglomeration” in G. Clark, M. Feldman and M. Gertler, eds. *Oxford Handbook of Economic Geography*. Oxford: Oxford University Press. pp. 373-394.

Fujita, Masahisa and Jacques-Francois Thisse (2002) *Economics of Agglomeration: Cities, Industrial Location, and Regional Growth*. Cambridge, MA: MIT Press.

Hersberg, Eric, Kaoru Nabeshima and Shahid Yusuf (2007) “Opening the Ivory Tower to Business: University-Industry Linkages and the Development of Knowledge-Intensive Clusters in Asian Cities,” *World Development* Vol, 35, No. 6: pp 931-940.

Macapanpan, Tristan H. (1999). “Private Sector Activities on Research and

Development" PIDS Discussion Paper Series No. 99-19, Makati City, Philippines: Philippine Institute for Development Studies.

Macasaquit, Mari-Len R. (2008). "Industrial Agglomeration in the Philippines." ERIA Research Project Report 2007 No. 3, *Analyses of Industrial Agglomeration, Production Networks and FDI Promotion*, edited by Mohamed Ariff.

Patalinghug, Epictetus E. (2003). "The Philippine Innovation System: Structure and Characteristics." Research Paper Series No. 2003-04, Makati City, Philippines: Philippine Institute for Development Studies.

____ (2000). "Competition Policy, Technology Policy, and Philippine Industrial Competitiveness." Social Science Diliman 1:1: pp 31-59

Policy Advocacy Group (2009) "Boosting Filipinnovation." Philippine Council for Agriculture, Forestry and Natural Resources Research and Development, Department of Science and Technology. ://www.dost.gov.ph. (Accessed February 2009).

Philippine Economic Zone Authority

Tansinsin, Lydia G. (2006). "Development of University-Industry Partnerships for the Promotion of Innovation and Transfer of Technology: Philippines." ://www.wipo.int/export/sites/www/uipc/en/partnership/pdf/ui_partnership_ph.pdf. (Accessed from the internet, January 29, 2009.)

World Economic Forum (2008). "The Global Competitiveness Report, 2008-2009."

Yap, Josef T. (2009). "The Philippine Economy in 2008 and prospects for 2009." Development Research News Vol. 27, No. 1. Makati City, Philippines: Philippine Institute for Development Studies.

3

Development of Regional Production and Logistics Networks in East Asia: The Case of Thailand

Wanwiwat Ketsawa

Abstract

Globalization leads to free flows of capital, labor, technology and information, which have beneficial impacts to the Thai industry. Under the new economic era and trade liberalization, the Thai economy and industry have dramatically improved in terms of new information and communication technologies, transportation and the fostering of regional economic cooperation, which have enticed and sustained the flows of capital and labor. Accordingly, there have been many attempts from manufacturers to shift their emphasis from the conventional business approach (in which links and cooperation with external firms are perceived to be not too significant) toward a proactive business strategy (in which hub firms or institutions have substantial links to external suppliers, competitors and customers) to remain competitive in an integrated market, especially with regards to the development of industrial technology, information and innovation. Hence, industrial linkages and agglomeration have played a crucial role in achieving industrial maturity and regional economic cooperation.

In this paper, I argue that there is a relationship among industrial clusters, intra and inter cluster, university-industry linkages, agglomeration, generating innovation and

enhancing firm's performance. The Thai industry, which is mostly composed of small and medium enterprises, has demonstrated significant linkages which considerably created innovation and improved the industrial performance. Both industrial linkage/agglomeration and product/process innovation were the most remarkable consequences which not only enhanced the efficiency of production but have also contributed to initiating new products, improving the quality of products, reducing production costs and improving the productivity of the Thai industry as whole.

1. INTRODUCTION

The world of business has changed tremendously from the past. This includes how business is conducted and the level of competition and marketing, which through new technology has enabled entrepreneurs to seek new markets more easily without limitations. These factors have caused competition to become quite fierce in almost every business. However, there is one method that could assist the Thai industry to survive and this is to cooperate among themselves in the form of industrial clusters and linkage in order to boost the potential to create innovation. Cooperation in the form of clusters and linkage both domestically and internationally can affect industry in various ways. Most important is innovation. Linkage can support the flow of information and knowledge which are the sources of innovation. Another is marketing and production. It is also important for firms who are engaged in similar business to band together in purchasing raw materials to lower production costs and to expand their business in a sustainable way.

The formation of industrial clusters and linkages are an essential step for developing countries to stabilize the industrial structure, foster local firms and entrepreneurs, and nurture the advanced society with the dynamism of innovation. Furthermore, effective links among industrial clusters should be established to narrow development gaps, both domestic and international.

Having said this, the objective of this research is to study Thailand's development of regional production and logistics networks. My aim is to scrutinize the mechanism of industrial clusters in generating innovation and intra and inter-cluster linkages. I will examine the effects of infrastructure development and agglomeration on innovation in Thailand by conducting qualitative and econometric analyses and case studies. I will focus on industrial linkages and networks, intra and inter-clusters, knowledge linkages, and innovation resulting from agglomeration to enhance firms' performance.

1.1. Objectives of the study

1) To study the recent development of regional production and logistics networks in Thailand especially that of industrial clusters, intra and inter-clusters, university-industry linkages, agglomeration, generation of innovation and performance.
2) To support country studies of Japan, Brunei, Indonesia, Philippines, and Vietnam.

1.2. Research methodology

This study was conducted using both quantitative analysis through a mail survey and qualitative analysis through a country study of Thailand.

Scope of mail survey

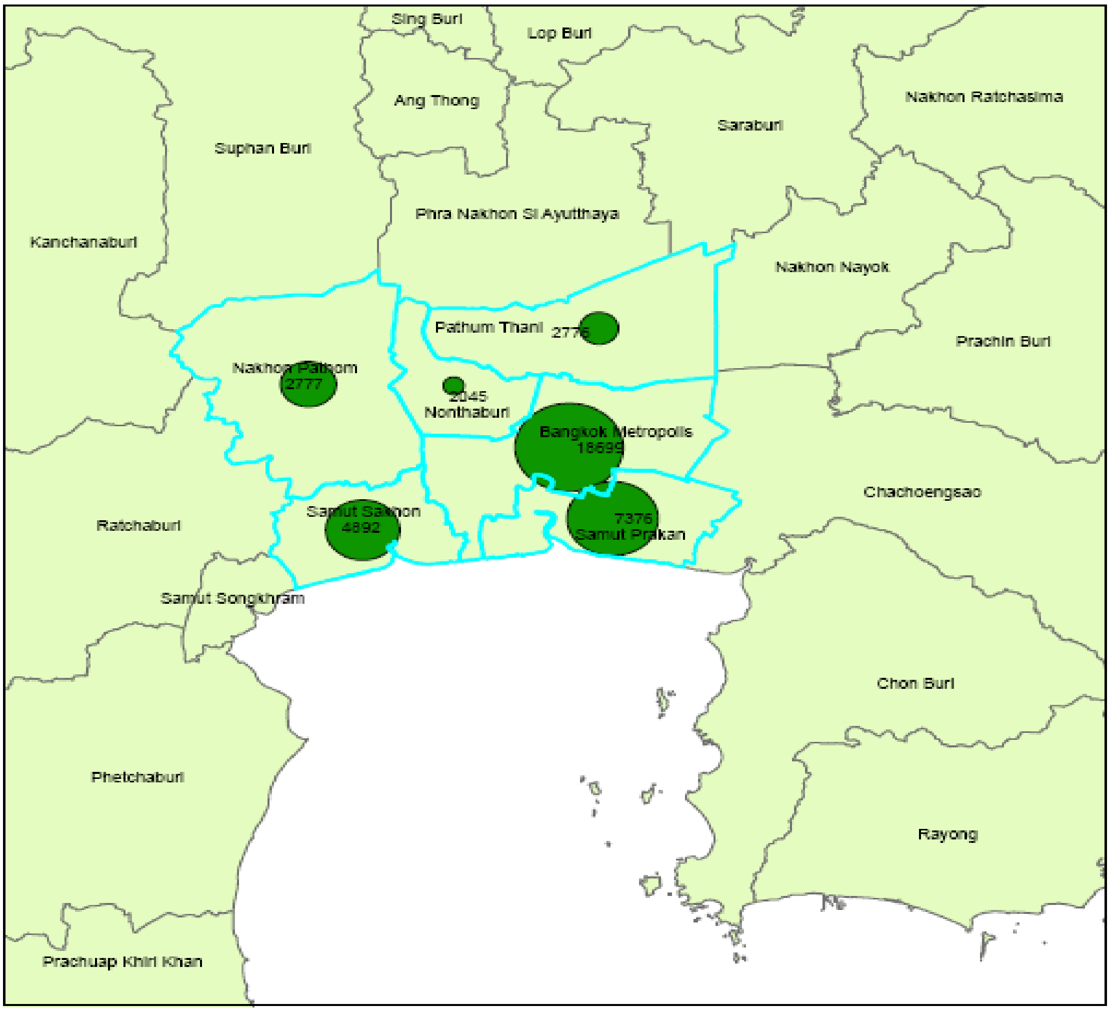
a. Metropolitan Bangkok and the five boundary provinces of Nakornpathom, Nonthaburi, Pathumthani, Samutprakarn and Samutsakhon.
b. Manufacturing industries according to statistics data from the Department of Industrial Works, Ministry of Industry.

Population and sample

Based on statistics from the Department of Industrial Works, Ministry of Industry, the population is the total amount of listed factories by each industrial area (Map 1).

1) Total number of population	**38,565**	factories
Bangkok	18,699	factories
Nakornpathom	2,777	factories
Nonthaburi	2,045	factories
Pathumthani	2,776	factories
Samutprakarn	7,376	factories
Samutsakhon	4,892	factories
2) Total sample	**124**	factories

Map 1. Number of Factory in Bangkok and 5 Boundary Provinces



Source : Author with supported by IDE Bangkok, 2009

Definition of firm size

Following the definition of the Ministry of Industry, firm size for the Thai industry is classified as follows:

- Firms which have 1-49 employees is grouped as Small
- Firms which have 50-199 employees is grouped as Medium
- Firms which have 200-999 employees is grouped as Large
- Firms which have 1,000 or up employees is grouped as Very large

Method of mail survey and case study

1) Mail survey (quantitative analyses) for various selected industries in metropolitan Bangkok and boundary provinces and case studies on agglomeration and related policies (qualitative analyses).
2) For the mail survey (questionnaire)
    (1) Constructed a mailing list of factories located in the selected area
    (2) Translated the questionnaire from English to Thai.
    (3) Requested the Director General, Department of Industrial Promotion, Ministry of Industry, to issue a letter (using the official stationary) by mail and email to the intended participants to ask for their support in the survey
    (4) Conducted a follow-up survey (by phone) to increase valid responses.
    (5) Constructed a dataset in Excel format and delivered it to the WG Coordinator.
    (6) Produced a paper on the results of the survey (based on descriptive statistics).
3) For the case study of the survey area,
    (1) Conducted a historical and quantitative analytical review of the present situation of industrial development in Thailand and the survey area, based on secondary statistics and previous studies
    (2) Produced a report including policy suggestions as conclusions of the case study.
4) Based on the case studies, firm and plant visits, in-depth interviews, and the data collected through the questionnaire survey, the WG members analyzed the levels of progress and the factors that promoted industrial agglomerations in the areas and tested the original hypothesis on the relationship between agglomeration and innovation, and drafted policy suggestions.

Questionnaire & Code of variables

Questionnaire

The questionnaire consisted of 4 parts (7 pages);

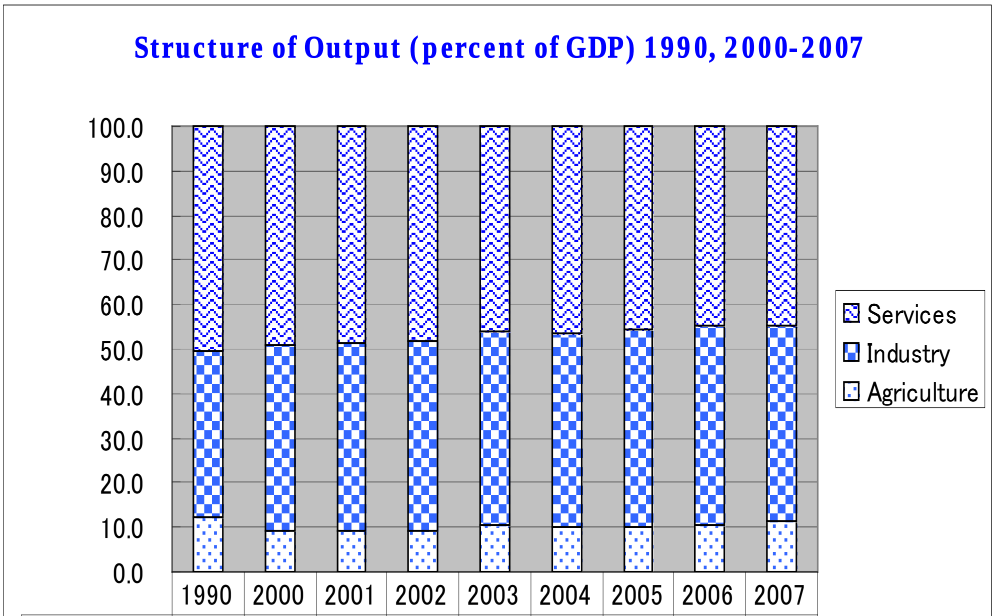
A: Profile of operations	8 questions
B: Innovative activities for businesses upgrading in the past three years	5 questions
C: Business linkages with main customer and supplier at present	2 questions
D: Sources of information and new technologies for innovation and business upgrading	3 questions

2. BACKGROUND

Review of the Thai industry and structural changes during the past decade

The emergence of industrial clusters and agglomeration for sharing of resources (e.g., ICT infrastructure, R&D facilities) and knowledge can help link the country's production processes to the world's production processes. This can cut down the cost of production, management, logistics and production factors and help develop the country to become a hub (e.g., production hub, services hub or innovation hub). This will enhance the country's development by helping it to climb up the global industrial value chain, to leap from being merely a production base to being a production, services and innovation hub. Such leap can increase the share of the country's industrial export products in the global industrial value chain. The production processes of industries are scattered in countries in different regions all over the world, and are linked by ICT infrastructure created by each individual country.

Figure 1. Structure of Output (Percent of GDP) 1990, 2000-2007



	1990	2000	2001	2002	2003	2004	2005	2006	2007
Services	50.3	49.0	48.7	48.1	46.0	46.3	45.7	44.8	44.7
Industry	37.2	42.0	42.1	42.4	43.6	43.4	44.0	44.4	43.9
Agriculture	12.5	9.0	9.1	9.4	10.4	10.3	10.3	10.7	11.4

Source: ADB, 2008

The population is aging. This leads to a declining workforce which will cause stronger competition to acquire younger workers especially in professional fields such as engineering. This trend leads to a demand for foreign workers both skilled and unskilled. Consumption of goods for the senior age group will also become greater, particularly in the areas of health and well-being and traveling.

In Thailand, the change of population structure results in the change of its workforce. This may not be in synch with the trend of the global workforce demand which has changed from being labor intensive to knowledge intensive, technology intensive and R&D intensive.

In 2003, Thailand's key industries can be categorized as follows: (1) food and animal feed, (2) textile and garment, (3) footwear and leather, (4) wood furniture, (5) petrochemical, (6) mold and die, (7) rubber and rubber products, (8) ceramics and glass, (9) iron and steel, (10) electrical and electric supplies, (11) automobile and parts, and (12) gems and jewelries.

Sixty percent of employment comes from the first, second and third industrial categories. Capital-intensive industries (e.g., petrochemicals, automobile and parts, electrical and electronics appliances) do not employ vocational students, science program high school students, engineers, and agriculture, food science and technology graduates.

The labor force survey also indicates that there are only 14.1% of Thai workforce with high school certificate and 11.3% with middle school certificate. In addition, 92% of the Thai workforce are not science and technology graduates.

To maintain and amplify the country's competitive ability, the change in the industrial structure may need to occur sooner than expected. The country should change from producing good and services with low value-added and creativity (sweat and tear industry) to producing goods and services that embody more knowledge (sweat and brain industry) and whose innovation is based on R&D and networks (brain and opportunity industry).

The rapid changes resulting from globalization widely affect not only the economic stream, but also the society, culture, behavior and well-being of the Thai people. Therefore, it is important to empower the people by equipping them with knowledge to decrease any undesired effects. Meanwhile, the knowledge restructuring for the Thai people in all professions is necessary. This is to increase their capabilities to take advantage of the benefits from globalization and to help the Thai society become a learning society that can lead to a knowledge-based economy and society.

Science and technology competitiveness capability

Thailand's science and technology competitiveness capability released by the IMD World Competitiveness shows that between 1997 and 2006, the level of the country's science and technology competitiveness capability continually declined. It plunged 32nd in 1997 to 53rd in 2006. Thailand's technology capability also fell from 32nd in 1997 to 48th in 2006.

For 2003-2004, the World Economic Forum ranked Thailand at the 36th place in terms of technological sophistication among 102 countries, following Singapore, Malaysia and Vietnam which were ranked 5th, 14th and 15th, respectively.

Research and development investment

In 2004, the R&D expenditures of Thailand totaled 16.571 million baht, a 7% increase equivalent to 0.25% of its GDP. About 36% came from private sector investments. This pales in comparison with the expenditures for R&D of developed countries such as Japan (3.35% of GDP, 70% invested by private sector). For that year, in general, developed countries invested 2.1 to 2.9% of their GDP for R&D activities. For Asia Pacific countries, the magnitude of their R&D investments was as follows: Malaysia, 0.69% of GDP, 65% invested by private sector;, Singapore 2.25% of GDP, 64% invested by private sector; Taiwan, 2.54% of GDP, 82% invested by private sector; and South Korea, 2.64% of GDP, 76% invested by private sector.

The National Sciences and Technology Development Agency (NSTDA) reported that in 2003, Thailand's total full-time R&D workforce totaled 32,011 and 42,379. In 2001 and 2003, the total workforce was 17,710 and 18,114 full-time R&D resources. This is equivalent to 5.14 and 6.7 full-time R&D resources per 10,000 populations, 2.87 being researchers per 10,000 populations. This researcher-to-population ratio from the IMD Science and Technology Indicator Information indicates that Thailand needs to develop more R&D resources given the country's imbalanced researcher-to-population ratio. The ratio turned out to be only 0.33 per 1,000 population, which pales in comparison to other Asia Pacific countries such as Japan, Taiwan and Korea, the key producers of technology and innovation goods, whose research-to-population ratios stood at 7.07, 4.77 and 2.92 per 1,000 population, respectively.

Table 1. R&D Expenditure on Industrial Development of Thailand by Types of Industries, Year 2004

(Unit : THB)

Types of Industries	Process Inprovement	Process Development	Product Improvement	New Product Development	Others	Unidentified	Total	Share %
Food and beverages	86,267,044.08	58,084,402.80	171,235,482.83	474,547,963.77	20,952,953.99	-	811,087,847.47	15.71
Garment	12,409,090.91	9,927,272.73	2,481,818.18	-	-	-	24,818,181.82	0.48
Apparels	2,013,541.67	1,013,541.67	3,040,625.00	5,067,708.33	-	-	11,135,416.67	0.22
Shoes and Leather	583,333.33	334,866.67	947,000.00	4,824,800.00	583,333.33	-	7,273,333.33	0.14
Wood	4,255,058.82	5,415,529.41	7,089,966.39	28,088,493.00	-	-	44,849,047.62	0.87
Paper	24,876,250.00	31,706,666.67	68,904,364.41	57,773,100.28	937,500.00	-	184,197,881.36	3.57
Printing	2,605,333.32	5,210,666.67	4,410,666.67	4,160,000.00	-	-	16,386,666.66	0.32
Petroleum	232,747,761.52	13,680,000.00	141,873,384.19	47,399,006.85	39,399,006.85	-	475,099,159.41	9.20
Chemical	149,193,303.52	34,434,116.29	242,841,019.02	508,698,974.04	4,260,555.55	-	939,427,968.42	18.19
Rubber	92,888,030.03	84,738,617.21	265,971,169.38	305,192,198.05	11,241,125.79	-	760,031,140.46	14.72
Non Metal	7,416,686.57	8,622,925.37	94,468,417.91	142,414,059.70	-	-	252,922,089.55	4.90
Basic Metal	26,700,000.00	11,963,709.62	14,619,726.92	55,790,467.31	-	-	109,073,903.85	2.11
Applied Metal	5,075,555.55	4,690,740.74	3,263,925.93	725,500.00	112,500.00	-	13,868,222.22	0.27
Machinery	20,813,736.29	25,262,155.20	72,319,904.45	78,133,697.24	1,018,305.09	-	197,547,798.27	3.83
Electronics	33,387,578.95	47,417,578.95	53,685,578.95	241,245,052.63	-	-	375,735,789.48	7.28
Radio & TV	43,951,414.95	98,290,454.38	165,135,367.01	258,687,760.55	77,200,000.00	12,500,000.00	655,764,996.89	12.70
Automotive	21,392,878.79	9,372,878.79	19,351,212.12	41,063,588.07	1,440,000.00	-	92,620,557.77	1.79
Manufacturing	**766,576,598.30**	**450,166,123.17**	**1,331,639,629.35**	**2,253,812,369.82**	**157,145,280.60**	**12,500,000.00**	**4,971,840,001.25**	**96.28**
Computer	-	-	9,600,000.00	-	2,400,000.00	-	12,000,000.00	0.23
R&D	13,301,966.67	29,811,366.67	8,791,666.66	103,064,200.00	21,030,800.00	-	176,000,000.00	3.41
Other services	2,875,384.62	1,232,307.69	-	-	-	-	4,107,692.31	0.08
Services	**16,177,351.29**	**31,043,674.36**	**18,391,666.66**	**103,064,200.00**	**23,430,800.00**	**-**	**192,107,692.31**	**3.72**
TOTAL	**782,753,949.59**	**481,209,797.53**	**1,350,031,296.02**	**2,356,876,569.82**	**180,576,080.60**	**12,500,000.00**	**5,163,947,693.56**	**100.00**

Sources: NSTDA, Ministry of Sciences and Technology, 2006, Thailand.

Table 2. R&D Expenditure on Industrial Development of Thailand by Type of R&D, Year 2004

(UNIT : THB)

Types of Industries	Basic Research	Apply Research	Testing & Development	TOTAL
Food and beverages	33,231,923.19	228,839,526.94	549,016,397.34	811,087,847.47
Garment	-	4,963,636.36	19,854,545.46	24,818,181.82
Apparels	5,067,708.33	3,533,854.17	2,533,854.17	11,135,416.67
Shoes and Leather	3,572,000.00	1,047,800.00	2,653,533.33	7,273,333.33
Wood	2,780,470.59	8,567,126.05	33,501,450.98	44,849,047.62
Paper	4,133,333.33	3,700,000.00	176,364,548.03	184,197,881.36
Printing	144,000.00	7,744,000.00	8,498,666.66	16,386,666.66
Petroleum	4,000,000.00	440,190,068.50	30,909,090.91	475,099,159.41
Chemical	47,900,828.29	205,591,562.28	685,935,577.85	939,427,968.42
Rubber	126,163,935.41	413,572,544.26	220,294,660.79	760,031,140.46
Non Metal	31,600,746.27	100,148,656.72	121,172,686.56	252,922,089.55
โลหะขั้นมูลฐาน	248,325.00	13,786,786.54	95,038,792.31	109,073,903.85
โลหะประดิษฐ์	2,711,111.11	3,325,925.93	7,831,185.18	13,868,222.22
Machinery	3,975,416.67	21,617,789.54	171,954,592.06	197,547,798.27
Electronics	43,512,000.00	73,476,631.58	258,747,157.90	375,735,789.48
Radio & TV	19,308,810.94	152,302,865.62	484,153,320.33	655,764,996.89
Automotive	5,893,939.39	20,441,818.18	66,284,800.20	92,620,557.77
Manufacturing	**334,244,548.52**	**1,702,850,592.67**	**2,934,744,860.06**	**4,971,840,001.25**
Computer	1,200,000.00	8,400,000.00	2,400,000.00	12,000,000.00
Research and Development	2,450,000.00	86,789,700.00	86,760,300.00	176,000,000.00
Other services	-	-	4,107,692.31	4,107,692.31
Services	**3,650,000.00**	**95,189,700.00**	**93,267,992.31**	**192,107,692.31**
TOTAL	**337,894,548.52**	**1,798,040,292.67**	**3,028,012,852.37**	**5,163,947,693.56**

Sources: NSTDA, Ministry of Sciences and Technology, 2006, Thailand.

Government R&D Expenditure and Networks

There are some organizations that grant R&D budget to support public and private needs, such as the National Research Council of Thailand (NRCT), the Thailand

Research Fund (TRF), and the National Innovation Agency (NIA). NIA is an autonomous organization operating under the policy guidance of the National Innovation Board, by utilizing the Innovation Development Fund and the Revolving Fund of Research and Technology Development which totaled about 3 billion baht in 2006**.** During the first period, the NIA focused on developing strategic innovation projects in five branches: food and herbs, indigenous rubber and products, software and mechatronics, automotives and parts, and engineering and industrial designs. This organization has integrated government R&D budget and fund, which is allocated to universities, public institutes, non-government organizations and industry.

Patent Acquisition and Registration

The number of patents in Thailand is as low as 65 while countries that invest continually in R&D such as Japan and Korea own as many as 123,978 and 34,052 patents, respectively. Possessing patents especially ones that relate to innovation and technology can increase the country's competitiveness capability and the value of its products.

There seems to be some data inconsistency, however. Based on the research of IMD, there are sources that indicate Thailand's patents totaled 13,991 as of March 2003. Among 2,978 Thai patents, only 375 items are inventions. Most of the patents are inventions that utilize primary level of technology (e.g., fish scale remover, mango fruit collector, juice maker). Such patents cannot create high value as they require only a low level of technology.

Meanwhile, the NSTDA reported that in 2005, there were 10,885 requests for patent acquisition, of which 4,258 were filled by Thai people. Patent registration totaled 1,322 items, of which 505 were made by Thai nationals. In addition, there were 28 requests for patent acquisition by Thai people in the United States and 17 in Japan. There were 3,000 print editions and 27,795 science articles used as reference 1,445 and 1,403 times, respectively, both nationally and internationally.

Table 3. Number of Granted Patent by Type

(Unit : patents)

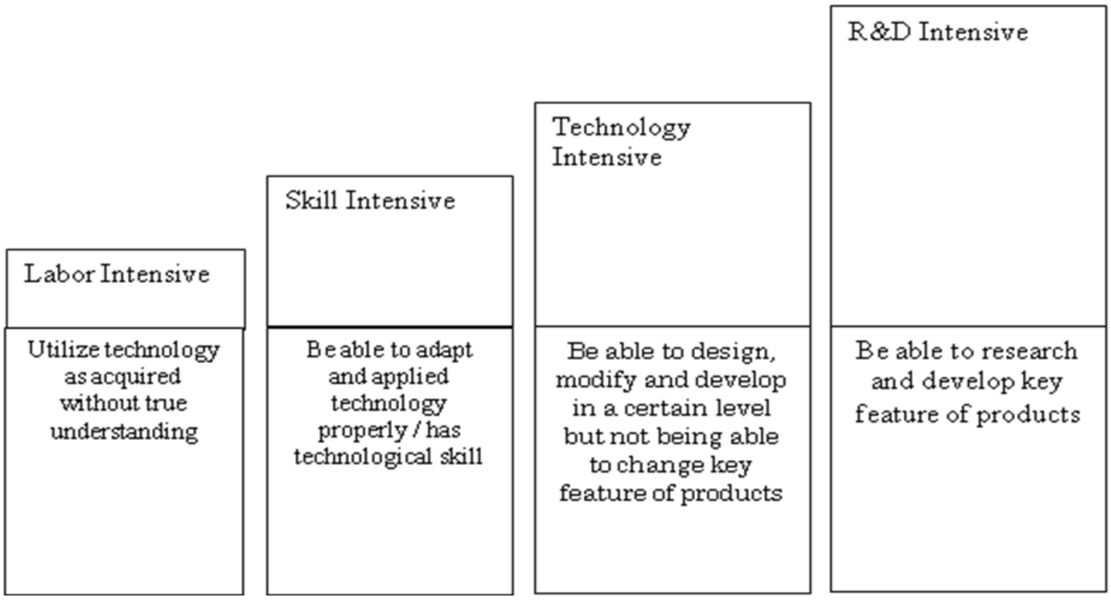
Year	Number of granted patent		
	Total	**Design**	**Innovation**
1981	**4**	4	0
1985	**84**	79	5
1990	**86**	79	7
1995	**101**	100	1
2000	**164**	119	45
2004	**867**	810	57

Source: Department of Intellectual Property, Ministry of Commerce, Thailand, 2006.

Level of Production Technology

The private sector of Thailand, most of them being small and medium enterprises (SMEs), utilize the first level of technology which is labor intensive and/or the second level of technology which is skill intensive. Some are only producers of goods that have been designed by others. Few have sufficient capability level to design and develop products utilizing the third level of technology (technology intensive) and the fourth level of technology (R&D intensive).

Diagram 1. Levels of Production Technology



Source: National Strategy of Science and Technology (2004-2013) adapted from World Bank 2000.

ICT Development and Virtual Networks

NSTDA reported that Thailand has 2,609 computer units (unit: 1,000 computers) or a ratio of 4 computers per 100 population. There were 10 internet users per 100 population and 51.3 mobile phone users per 100 population in 2006. It appears there had been significant improvements since 2004 based on the report of the National Statistic Office, Ministry of Sciences and Technology, Thailand.

Table 4.1. ICT Diffusion and Utilization in Thailand, 1979-2004

(Unit : % per household)

ITEMS	1979	1984	1989	1994	1999	2000	2001	2003	2004
Personal Computer	n.a	n.a	n.a	n.a	n.a	**5.0**	**5.1**	**8.2**	**11.1**
Television	**17.0**	**33.0**	**50.0**	**75.0**	n.a	n.a	n.a	**92.0**	n.a
Radio	**79.0**	**75.0**	**73.0**	**74.0**	n.a	n.a	n.a	**51.0**	n.a
Faximile	n.a	n.a	n.a	n.a	n.a	**1.6**	n.a	n.a	n.a
Internet User (% of population)	n.a	n.a	n.a	n.a	**2.4**	**3.7**	**5.6**	**10.4**	**11.9**
Basic Telephone Unit (per 100 household)	n.a	n.a	n.a	n.a	**12.3**	**12.4**	**12.5**	**13.5**	**13.6**
Mobile Phone User (% of population)	n.a	n.a	n.a	n.a	n.a	**5.6**	**11.8**	**34.1**	**36.3**

Source: National Statistic Office, Thailand.

Table 4.2. Internet User by Country Year 2003

Country	Internet User ('000)	Internet User (per 10,000 people)
USA	159,000.0*	5,513.77*
Singapore	2,100.0*	5,043.59*
Hong Kong	3,212.80	4,691.66
Japan	57,200.0*	4,488.56*
Taiwan	8,830.00	3,900.76
Malaysia	8,692.10	3,453.31
Thailand	6,031.30	964.53
China	79,500.00	632.48
India	18,481.00	174.86
Asia	243,405.90	674.25
World	675,677.70	1,107.08

Remark: * Data in Year 2002.
Source: International Telecommunication Union (ITU).

Foreign Direct Investment (FDI) and Market

Within the first 10 months of 2007, Japanese investors had the most number of investments (247), totaling 109,204 million baht. USA was the second biggest source of investment (44), totaling 63,564 million baht. Singapore was third (65) with a total investment value of 14,982 million baht.

During the first 10 months of 2007, the types of businesses that received the highest support are services and utility services (160,700 million baht), chemicals, paper and plastic business (156,500 million baht), electronics and electrical appliances (94,700 million baht), metal products and equipment (59,600 million baht), agriculture and agricultural products (52,800 million baht), mining, ceramics and metal (44,400), and light industry and textile (14,600 million baht).

Table 5. The Investments Received Support from BOI, classified by Types of Industries, 2007

Economy	2007 (Jan. - Oct.) Number of investment plans	2007 (Jan. - Oct.) Investment value (million baht)
Agriculture and agricultural products	174	52,800
Mining, ceramics and metals	29	44,400
Light industry and textiles	85	14,600
Metal products and equipments	203	59,600
Electronics and electrical appliances	229	94,700
Chemicals, paper and plastics	124	156,500
Services and utility services	282	160,700
Total	1,126	583,300

Source: The Board of Investment of Thailand, 2007.

Table 6. Foreign Investment that Received Support from BOI, Categorized by main East Asian Countries, 2007

(Unit : million baht)

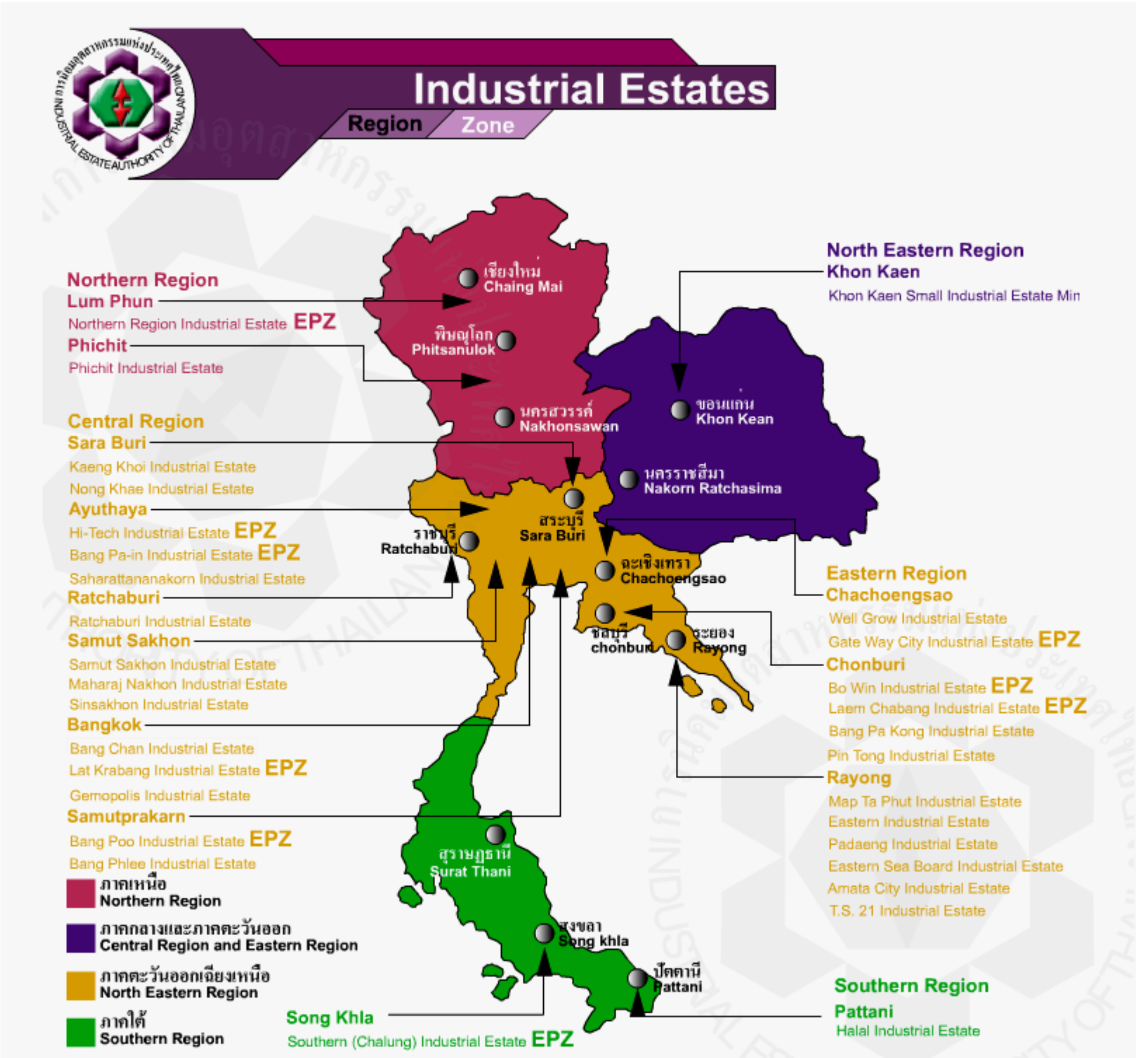
Country	2006		2006 (Jan. - Oct.)		2007 (Jan. - Oct.)	
	Number of investment plan	investment value	Number of investment plan	investment value	Number of investment plan	investment value
Japan	353	115,200	278	66,066	274	109,204
Taiwan	63	10,472	48	9,534	40	7,616
Hong Kong	18	10,031	15	9,767	15	10,103
South Korea	24	4,025	21	3,910	44	5,899
Singapore	62	18,750	50	13,637	65	30,501
Malaysia	35	5,368	29	4,792	25	10,762
Indonesia	5	587	5	587	4	4,031
The Philippines	1	67	1	67	1	90
China	16	2,456	14	2,377	20	5,274

Source: Office of the Board of Investment (BOI), Thailand, 2008.

Industrial Estates in Thailand

The Industrial Estate Authority of Thailand (IEAT) has established 34 industrial estates located in 15 provinces nationwide which consist of two categories: (1) industrial estates developed by IEAT, totaling nine to date, and (2) industrial estates that IEAT jointly developed with the private sector, totaling 25.

Map 2. Industrial Estate in Thailand by Region, 2008



Source : Industrial Estate Authority of Thailand, 2008.

Map 3. Industrial Estate in Thailand by Zone, 2008

Source: Industrial Estate Authority of Thailand, 2008.

The industrial estates were developed and managed by the IEAT. The industrial zones are under the Ministry of Industry (MOI) and aim to support regional development and specific industrial sectors. The industrial parks are established entirely by the private sector. The total land must be at least 500 Rai (or 800,000 M^2), with 60-70 percent allocated to factories. All required facilities are provided in the industrial parks. Most industrial parks are promoted by the Board of Investment.

An industrial estate in Thailand resembles an industrial town or industrial city providing complete infrastructure necessary for industrial operations such as ample electricity, water supply, flood protection, waste water treatment and solid waste disposal. It is accessible to seaports, airports and other transportation centers. Besides providing communication facilities and security systems, an industrial estate also contains commercial banks and a post office. Some have customs offices, schools, hospitals, shopping centers and other facilities needed by investors and workers. It is just like a self-contained community.

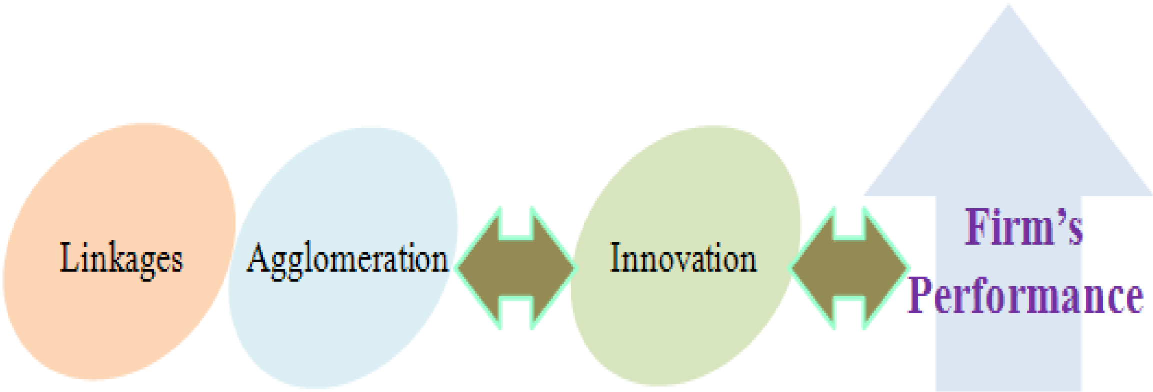
3. HYPOTHESIS

Following globalization, the Thai industry became more open to the global market, making it more susceptible to market fluctuations. Hence, the Thai industry needs to adjust to a knowledge-based economy by enhancing the industrial clusters and linkages to initiate innovation in order to increase its performance while maintaining its comparative advantages and competitiveness. Clustering and public-private linkages are being implemented by various public organizations that act as service providers. Budget and resources, however, remain limited in many developing countries like Thailand.

This study seeks to determine the sources of innovation and explain the relationship among R&D linkages, industrial linkages, innovation, and firm's performance. This is illustrated as follows:

Linkages / Agglomeration → Innovation → Performance

Figure 2. Hypothesis of the Study



Source: Author and team.

The different variables and their definitions are as follows:

- *Linkages* is any linkage or contact between firms and customers or suppliers in terms of local or foreign firm, university and industry R&D linkages, government or public organizations and industry (Q16), receiving or dispatching engineers with customers/suppliers (Q14.12, Q14.13), capital tie-up with customer/suppliers (Q14.9) and duration of the relationship with the customer/supplier (Q14.11).
- *Agglomeration* is any benefit from activities that firms obtain when locating close to each other or in the same industrial estate or as industrial clustering. This study referred to distance (Q14.6) and travel time from firms to customer/supplier (Q14.7) and just-in-time distribution system adopted by the customer/supplier (Q14.8).
- *Innovation* refers to either: (1) product innovation or new products/services introduced in the market (Q9, Q9.1, Q9.2, Q9.3), or (2) process innovation or new production methods adopted by the firm (Q10) such as newly bought machines or facilities with new functions, (Q10.1), improved existing machines, equipment or facilities (Q10.2), or introduced new know-how on production methods (Q10.3). In addition, innovation could also mean securing new suppliers (Q11), seeking new market/customers (Q12) and improving business processes or organization (Q13).
- *Performance* refers to business performance of firm in comparison with the last year (Q6), for instance, increase in sales, (Q6.1), increase in profit (Q6.2), increase in

number of employees (Q6.3), increase in the value of exports (Q6.4), increase in the value of exports to developed countries (Q6.5), increase in the number of export destinations (Q6.6), improvement in productivity of operation (Q6.7), substantial improvement in quality of products (Q6.8), substantial reduction in product defects (Q6.9), substantial decrease of production cost (Q6.10) and substantial reduction in lead time (Q6.11).

4. EMPIRICAL RESULTS

4.1. Descriptive Analysis and Key Findings

The structure of the Thai industry can be summarized as follows:

Capital Type, Year of Establishment, Foreign Investors

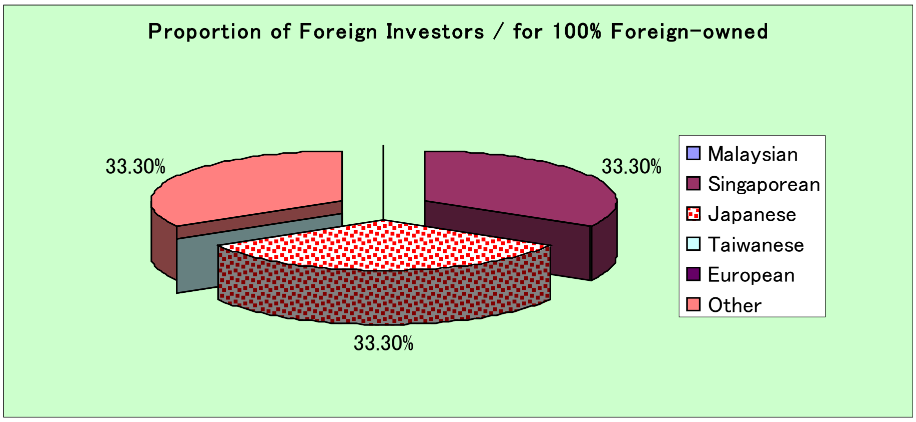
Eighty-one percent of the respondents are wholly owned Thai SMEs by middle-aged entrepreneurs established after the 1990s. On joint venture and foreign firms in Thailand, the most important partners of the Thai industry in the last decade are Japanese and Singaporeans.

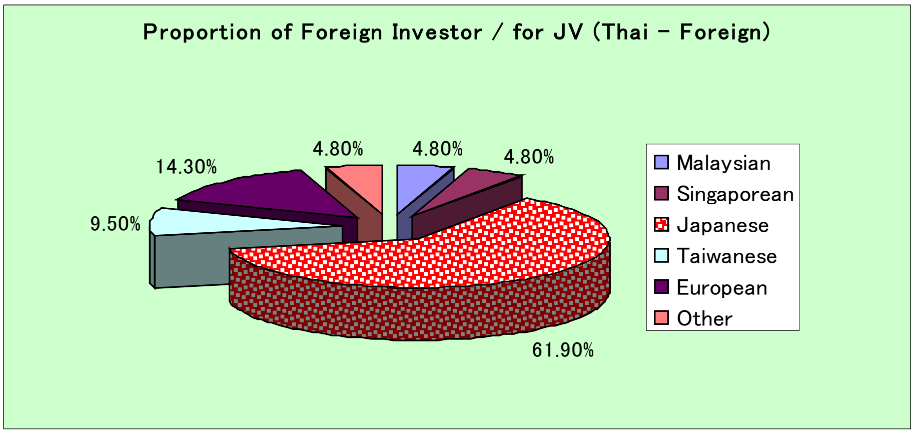
Table 7. Characteristics of Respondents

Characteristics	N	Minimum	Maximum	Mean
Age of Firms	115	2	58	16.99
Number of Full-time Employees	122	10	2500	239.59
100% Local-owned Firm	124	0	1	0.81
Joint-ventured Firm	124	0	1	0.17
100% Foreign-owned Firm	124	0	1	0.02
Production (raw material processing)	123	0	1	0.24
Production (components and parts)	123	0	1	0.17
Production (final products)	123	0	1	0.51
Procurement of raw materials, parts or supplies	123	0	1	0.09
Marketing, sales promotion	123	0	1	0.07
Does your establishment carry out R&D at present?	124	0	1	0.39

Source: Survey 2009, Author and team.

Figure 3. Proportion of Foreign Investors



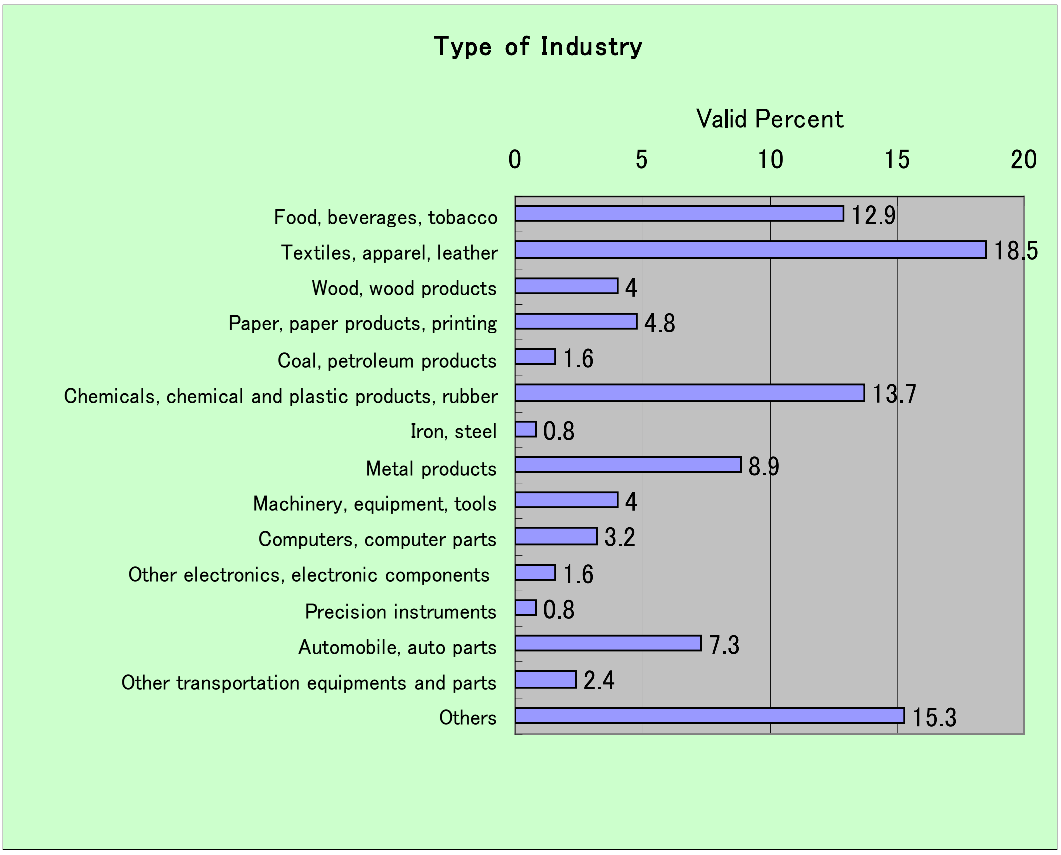


Source: Survey 2009, Author and team.

Proportion and Type of Industry

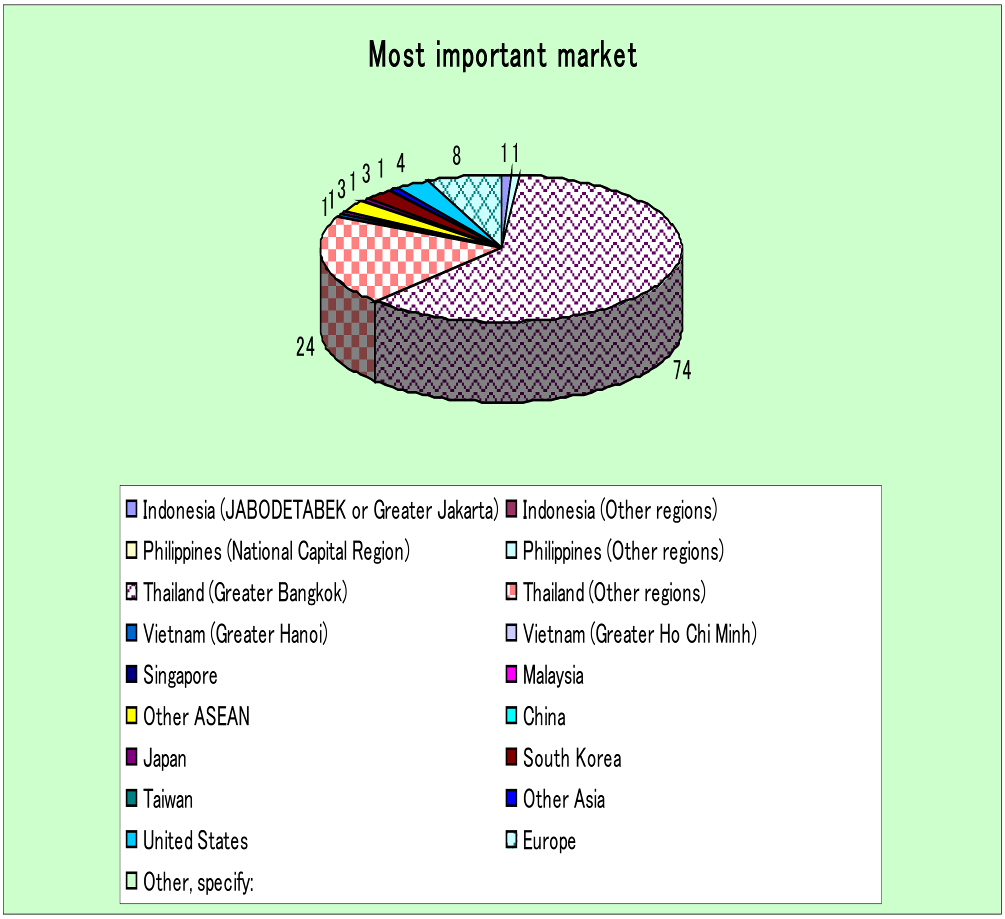
The combined textile, apparel and leather industry was the largest industry (18.5%). This industry is labor intensive and needs to utilize low-wages workers and migrants from neighboring areas. To compete with China, the adoption and utilization of innovations in designing, branding and differentiating new products should be taken into account. The industry of chemical and plastic products, and rubber has also played a significant role (13.7%). The third largest industry is food, beverages, and tobacco (12.9%). For other industries (15.3%), since the Kyoto Protocol was implemented, industries related to recycling, re-conditioning, energy-saving and others that are environmentally related have become more concentrated. Advancements in environmental technology have resulted in newcomers entering this industry. Overall, most of Thai SMEs still rely on domestic suppliers and customers especially in Bangkok area and boundary provinces (60%) and other provinces (20%).

Figure 4.1. Type of Industries



Source: Survey 2009, Author and team.

Figure 4.2. Most Important Market or Customers/Suppliers (Unit Frequency)

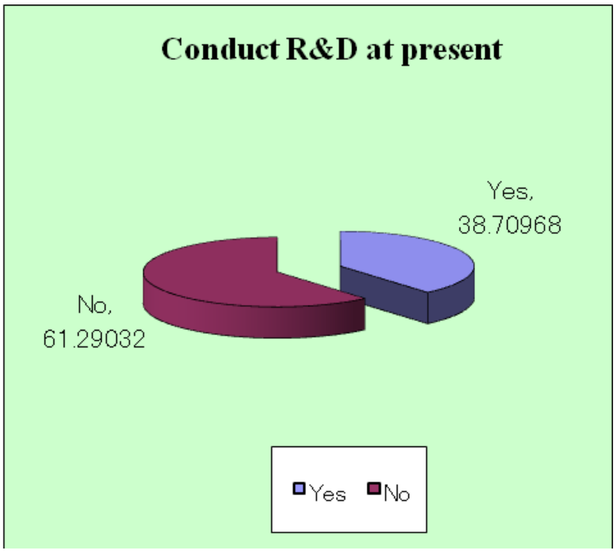


Source: Survey 2009, Author and team.

Carrying Out R&D Activity

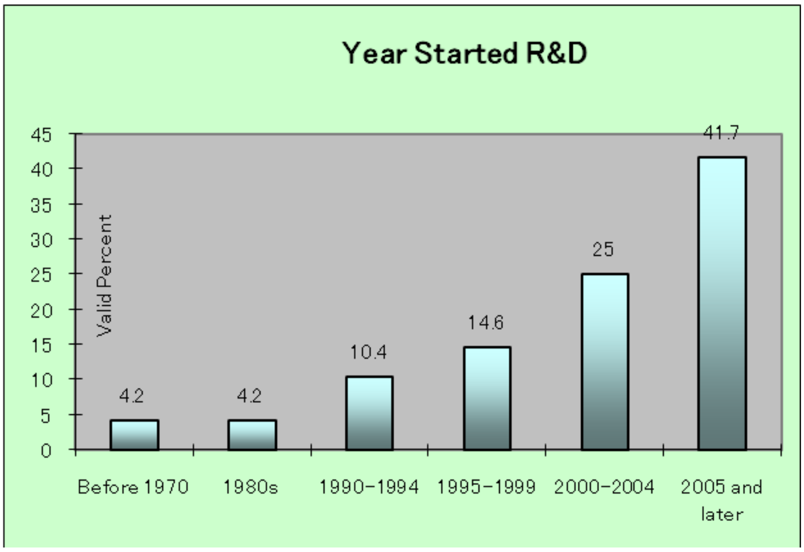
Only around 40 percent of Thai industry has carried out R&D activities. These activities were mostly focused on basic research and applied research which were started after the 2000s. As a result of the 1997 world economic crisis, the Thai currency was depreciated or devalued sharply. Exporters benefited from this depreciation thus exports increased. Firms were forced to improve their production efficiency to maintain their competitiveness and had to put more efforts on implementing R&D activities. In general, however, they rely mostly on their own internal R&D capacity which is usually a small section or department consisting of one to five researchers.

Figure 5.1. Conduct R&D at Present



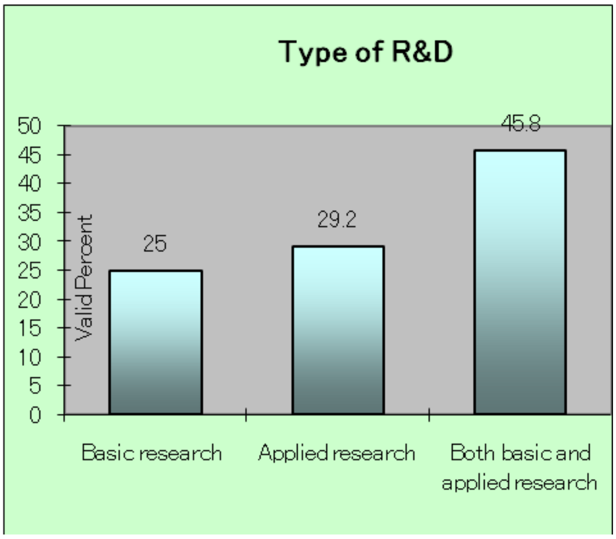
Source: Survey 2009, Author and team.

Figure 5.2. Year Started R&D



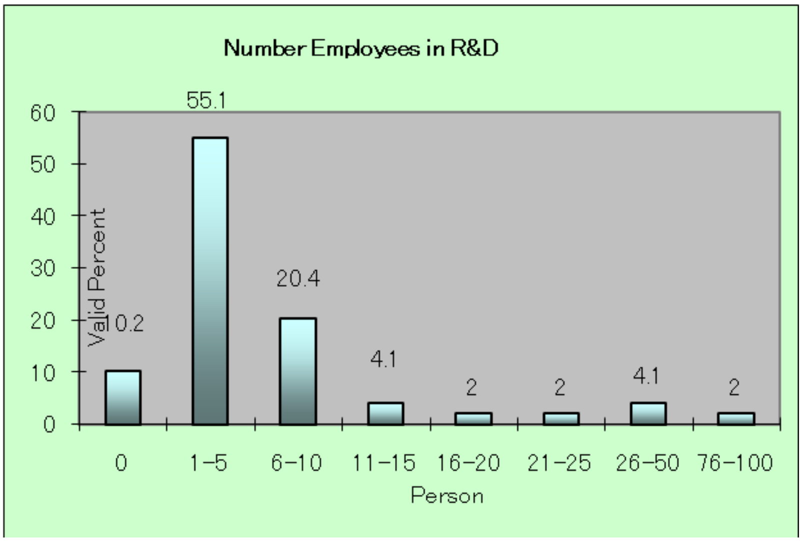
Source: Survey 2009, Author and team.

Figure 5.3. Type of R&D



Source: Survey 2009, Author and team.

Figure 5.4. Number of Employees in R&D

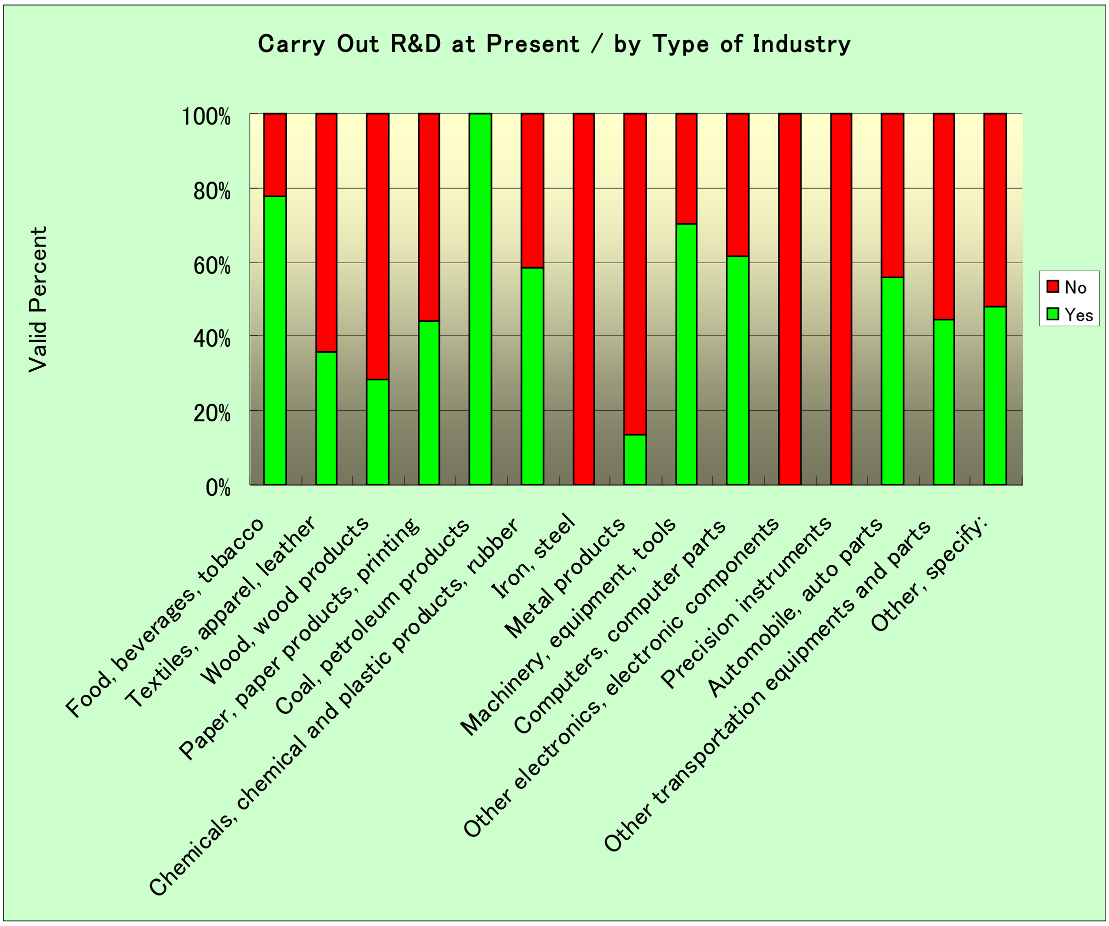


Source: Survey 2009, Author and team.

R&D by Industry

Among the 15 surveyed industries, the top three industries in terms of high rate of conducting R&D and innovation are high-technology-intensive industries or knowledge-based industries such as (1) coal and petroleum products, (2) food, beverages, and tobacco, and (3) machinery, equipment and tools.

Figure 6. Carry out R&D at Present by Type of Industry

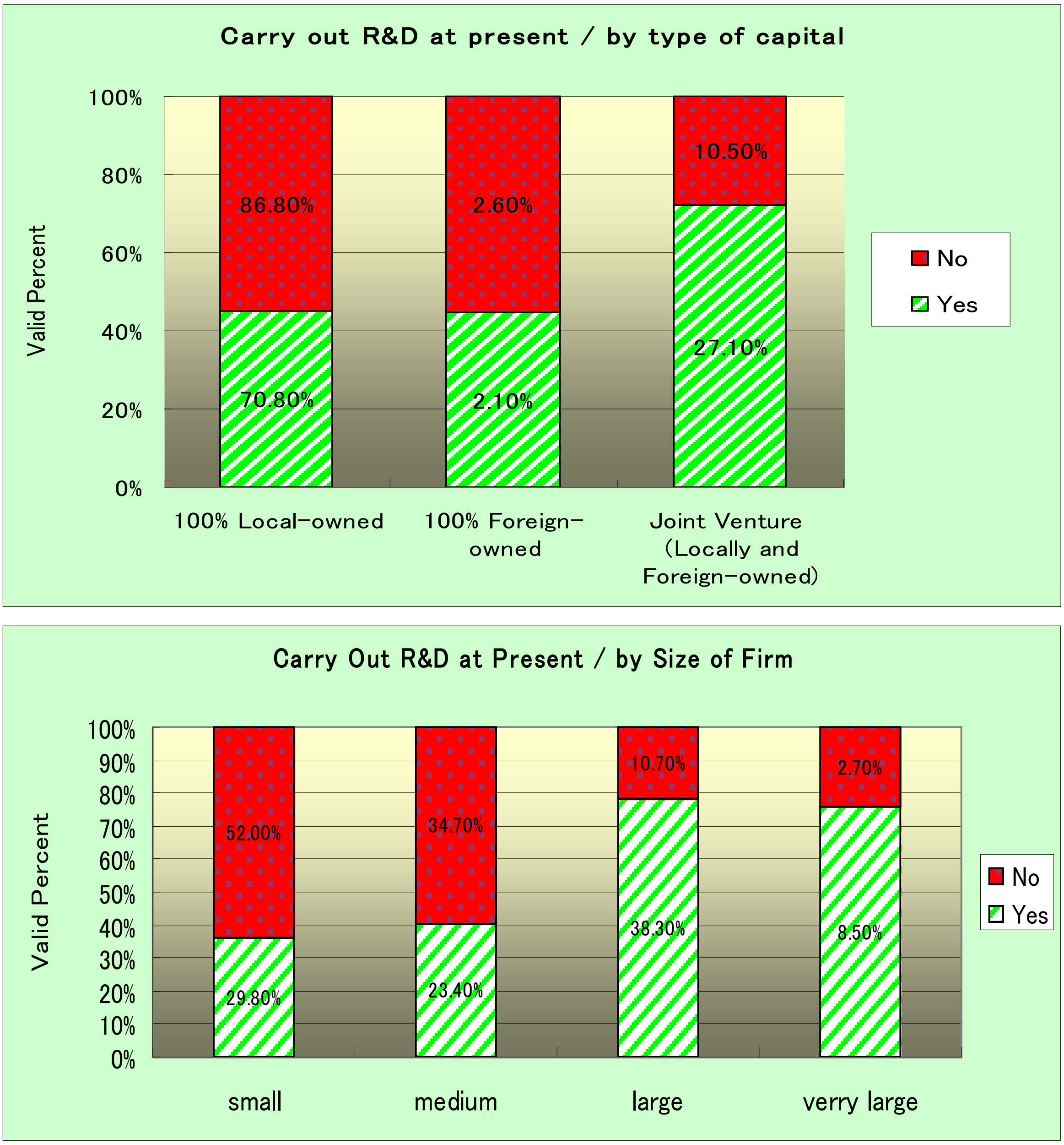


Source: Survey 2009, Author and team.

R&D by Size and Capital

Firms realize the importance of R&D in creating innovation and accordingly, the need to invest on resources such as money, time, experienced researchers and linkages. Mostly large and very large or joint-venture firms could afford to do this. Based on the survey, they have had a comparatively high rate of carrying out R&D activities. In contrast, the 100% locally owned Thai enterprises, which are mostly SMEs, have limited resources especially financial support and knowledge inventory.

Figure 7. Carry out R&D at Present by Type of Capital and Size of Firm

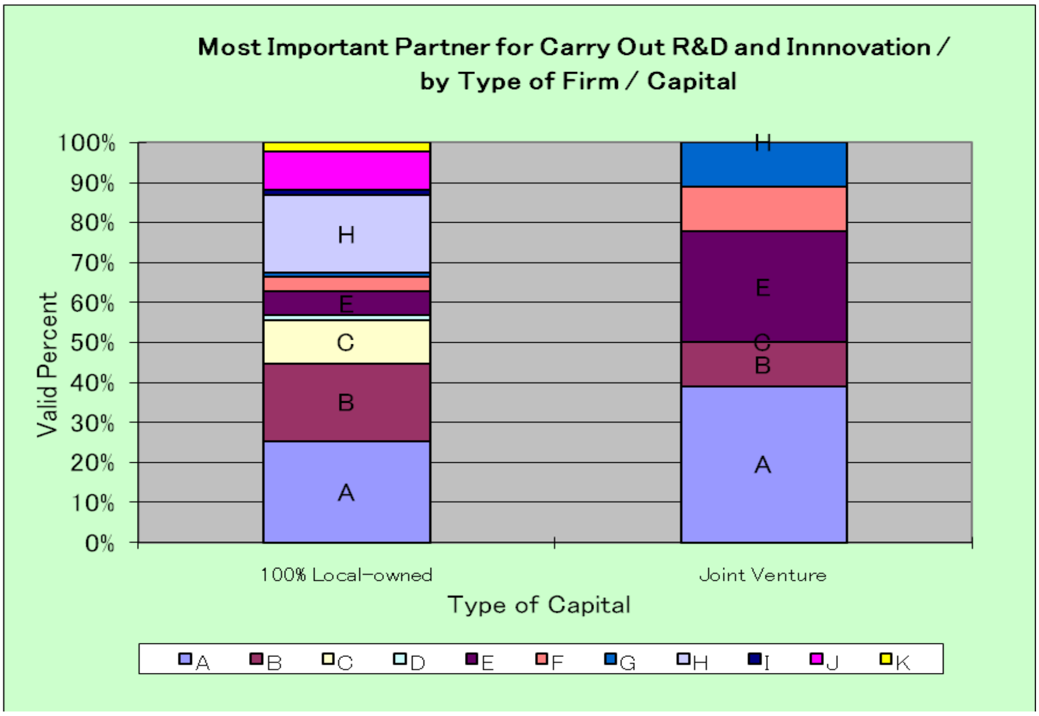


Note: Small (up to 49 employees); Medium (50-199); Large (200-999); Very large (1000 up).
Source: Survey 2009, Author and team.

Most Important Partner for R&D

The government budget on R&D expenditure is always limited unlike in the developed nations. The most important partners for innovation and upgrading—the private sector—would normally rely on their own resources, department, headquarter or affiliated company (25.3%). Some firms dealing with local customers or suppliers are forced to maintain and improve the quality of their products, hence they are also perceived to be another important partner for R&D (19.3%). Only a few of them, however, could access government and public agencies' grants and link to local universities or R&D institutes.

Figure 8. Most Important Partner for Carrying Out R&D and Innovation

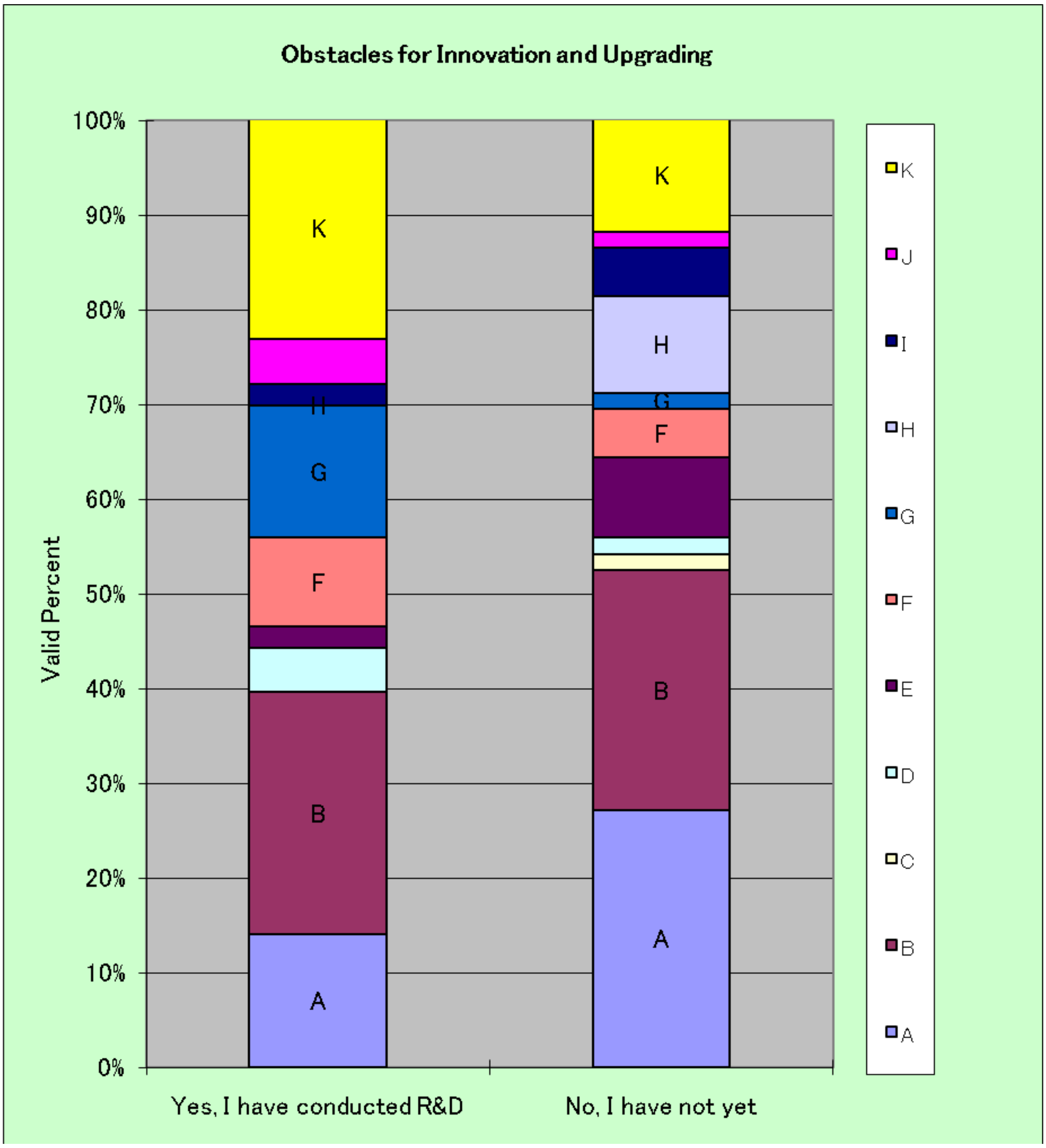


Note 1: A (Own department, headquarters, affiliates); B (Local firm (customers or supplier)); C (Local firm (competitor)); D (Local firm in different business field); E (MNC or JV (competitor or supplier)); F (MNC or JV (competitor)); G (Foreign International Cooperation Agencies); H (Government, Public Agencies); I (Local business organization); J (Local universities, R&D Institutes); K (Consultants, financial institutions)
Note 2: Analysis excluded 100% Foreign-owned because too low respondents
Source: Survey 2009, Author and team.

Most Serious Obstacles for R&D

The most serious obstacles to R&D identified by the firms are the high cost of R&D equipment which is usually highly dependent on imported items (25.6%) and the highly rigid labor mobility which constrains workers to bring the technology they acquired from previous employers or firm (23.3%). Most private firms require their employees to sign a clause in their employment contracts specifying that after they resign, they shall not be able to apply for any jobs within the same industry especially in competitor firms. This is to prevent the flow of technology or utilization of previous know-how and some significantly important business secrets. Other serious obstacles are the lack of R&D supporting infrastructures such as financing and consulting which can provide support services (14%) and high tariffs on equipment and materials necessary for innovation (14%).

Figure 9. Obstacles for Innovation and Upgrading



Note: A(No R&D supporting industry such as consulting, financing.); B (Price of R&D support services is high.); C (No university or public institute in the neighborhood.); D (Technological capabilities of universities or public institutes located in the neighborhood are too weak to collaborate.); E (No business organization or chamber of commerce which can provide training courses, seminar or testing facilities.); F (Protection of intellectual property right (IPR) is not sufficient.); G (High tariffs on equipments and materials necessary for innovation.); H (No tax break or accelerated depreciation system.); I (My establishment is not familiar with public support programs and procedures to apply for support measures.); J (Public support programs are not designed appropriately for innovation); K (Labor mobility is too rigid for workers to bring with them technologies acquired from previous employer or from previous)

Source: Survey 2009, Author and team.

Improvement of ICT and International Standard

During the last three years, more than half of the firms surveyed have utilized better ICT networks and industrial clusters. They developed new products by improving their existing machinery, equipment or factory instead of purchasing new and costly machines. The supply chain of Thai exporter has been under great pressure to follow various international standards such as the ISO. Thus, firms adapted and implemented more complicated and advanced ICT systems while, at the same time, keeping the firm's resilience in check against economic uncertainties and market fluctuations.

Table 10. Adopted a New Production Method in Recent 3 years VS Type of Industries (Process Innovation)

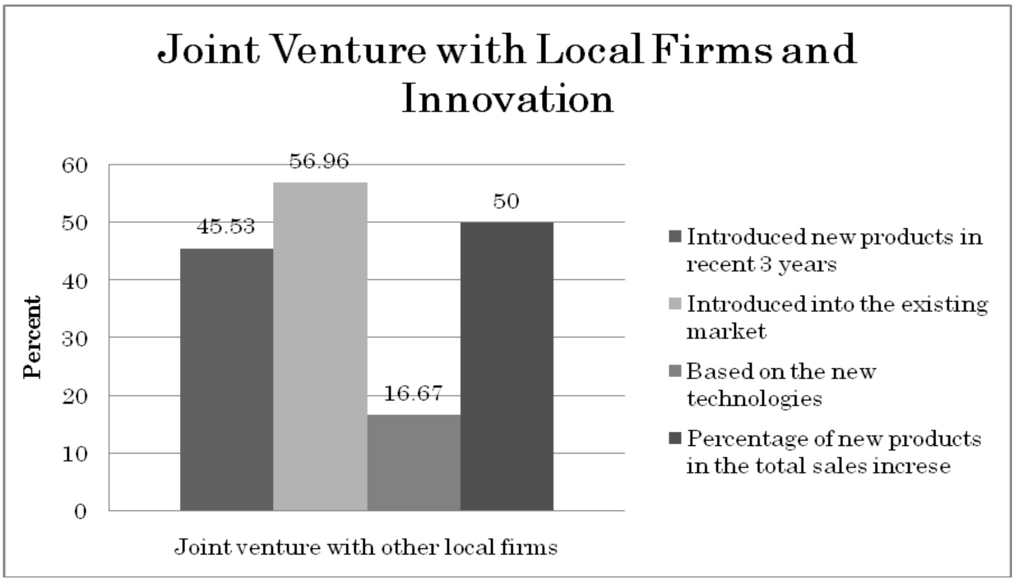
Type of Industries	Bought new machines or facilities with new function to operation			
		Yes	**No**	**Total**
Food, beverages, tobacco	Count	11	5	16
	% within Type of Industries	68.80%	31.20%	100.00%
	% within Bought new machines or ….	**14.90%**	10.20%	13.00%
Textiles, apparel, leather	Count	13	10	23
	% within Type of Industries	56.50%	43.50%	100.00%
	% within Bought new machines or ….	**17.60%**	20.40%	18.70%
Wood, wood products	Count	1	4	5
	% within Type of Industries	20.00%	80.00%	100.00%
	% within Bought new machines or ….	1.40%	8.20%	4.10%
Paper, paper products, printing	Count	4	1	5
	% within Type of Industries	80.00%	20.00%	100.00%
	% within Bought new machines or ….	5.40%	2.00%	4.10%
Coal, petroleum products	Count	2	0	2
	% within Type of Industries	100.00%	0.00%	100.00%
	% within Bought new machines or ….	2.70%	0.00%	1.60%
Chemicals, chemical and plastic products, rubber	Count	11	6	17
	% within Type of Industries	64.70%	35.30%	100.00%
	% within Bought new machines or ….	**14.90%**	12.20%	13.80%
Iron, steel	Count	1	0	1
	% within Type of Industries	100.00%	0.00%	100.00%
	% within Bought new machines or ….	1.40%	0.00%	0.80%
Metal products	Count	7	4	11
	% within Type of Industries	63.60%	36.40%	100.00%
	% within Bought new machines or ….	9.50%	8.20%	8.90%
Machinery, equipment, tools	Count	4	1	5
	% within Type of Industries	80.00%	20.00%	100.00%
	% within Bought new machines or ….	5.40%	2.00%	4.10%
Computers, computer parts	Count	1	3	4
	% within Type of Industries	25.00%	75.00%	100.00%
	% within Bought new machines or ….	1.40%	6.10%	3.30%
Other electronics, electronic components	Count	1	1	2
	% within Type of Industries	50.00%	50.00%	100.00%
	% within Bought new machines or ….	1.40%	2.00%	1.60%
Precision instruments	Count	1	0	1
	% within Type of Industries	100.00%	0.00%	100.00%
	% within Bought new machines or ….	1.40%	0.00%	0.80%
Automobile, auto parts	Count	7	2	9
	% within Type of Industries	77.80%	22.20%	100.00%
	% within Bought new machines or ….	9.50%	4.10%	7.30%
Other transportation equipments and parts	Count	2	1	3
	% within Type of Industries	66.70%	33.30%	100.00%
	% within Bought new machines or ….	2.70%	2.00%	2.40%
Other, specify:	Count	8	11	19
	% within Type of Industries	42.10%	57.90%	100.00%
	% within Bought new machines or ….	10.80%	22.40%	15.40%
Total	Count	74	49	123
	% within Type of Industries	60.20%	39.80%	100.00%
	% within Bought new machines or ….	100.00%	100.00%	100.00%

Source: Survey 2009, Author and team.

Linkages with Local Firms

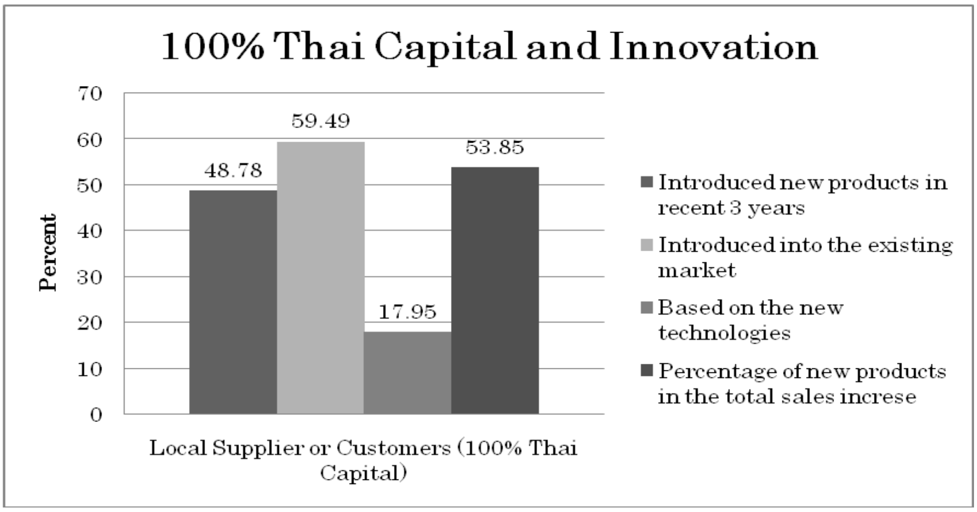
Linkages with local firms have played an important role for the Thai industry. As a result of market liberalization, technologies have developed more rapidly and consumers have become more conscious of product quality and getting value for their money. Therefore, in terms of exchanging information, technology transfer and market expansion, linkages with local firms such as joint venture with other local firms, local suppliers and customers and competitors could facilitate product innovation through the introduction of new products or services in the market.

Figure 11. Linkage with Own Joint Venture with Local Firm (Q16.2.1) vs. Innovation



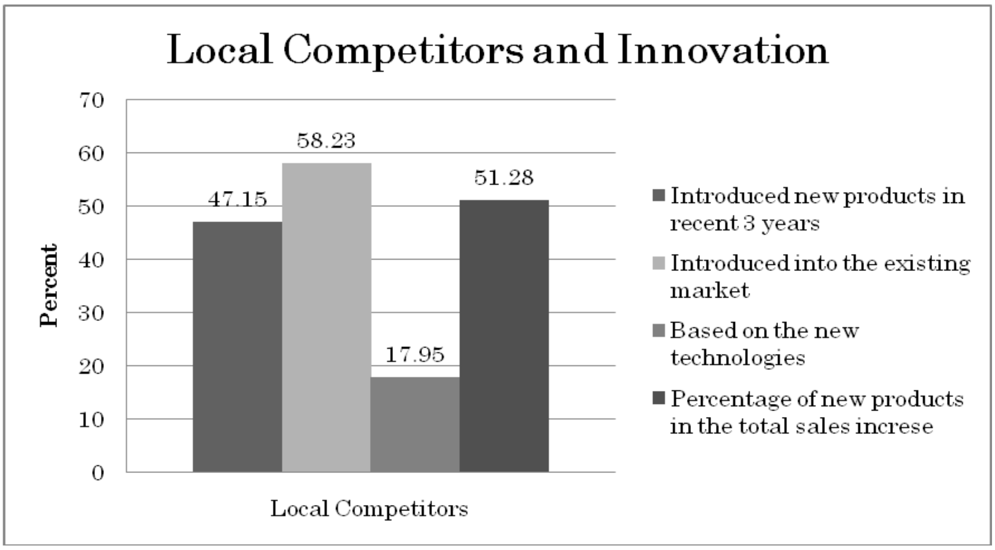
Source: Survey 2009, Author and team.

Figure 12. Linkage with Local Suppliers or Customers (100% Thai) (Q16.2.2) vs Innovation



Source: Survey 2009, Author and team.

Figure 13. Linkage with Local Competitors (Q16.2.3) vs Innovation

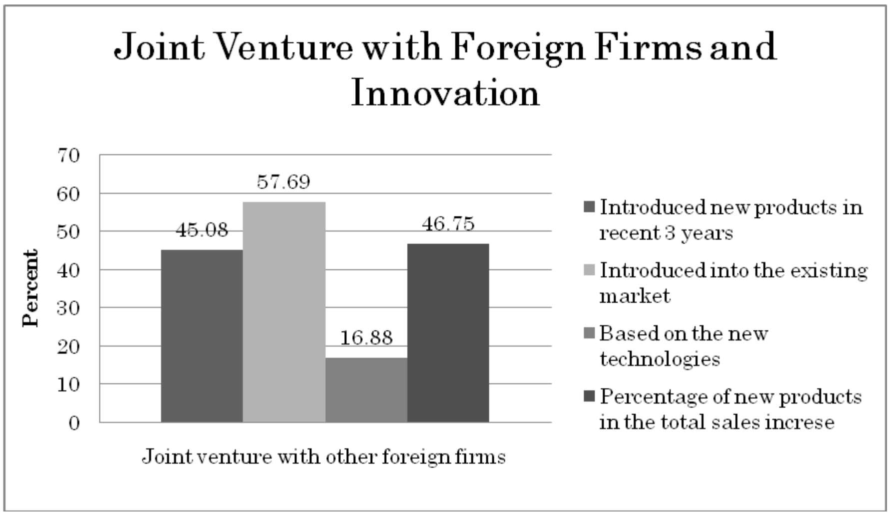


Source: Survey 2009, Author and team.

Linkages with Foreign Firms

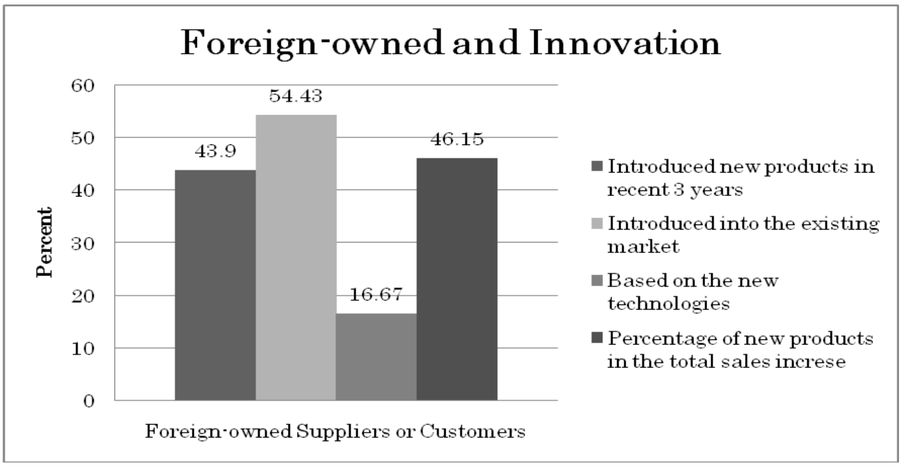
Foreign firms and large firms have a high rate of carrying out R&D activities, innovation and upgrading. Therefore, to obtain benefit from them, linkages with these foreign firms such as through joint venture with other foreign firms, foreign suppliers and customers are ideal. These linkages have shown to significantly result in product innovation by way of new products or services being launched into the market.

Figure 14. Linkage with Own Joint Venture with Other Foreign Firms (Q16.3.1) vs Innovation



Source: Survey 2009, Author and team.

Figure 15. Linkages with Foreign Owned Suppliers and Customers (Q16.3.2) vs Innovation

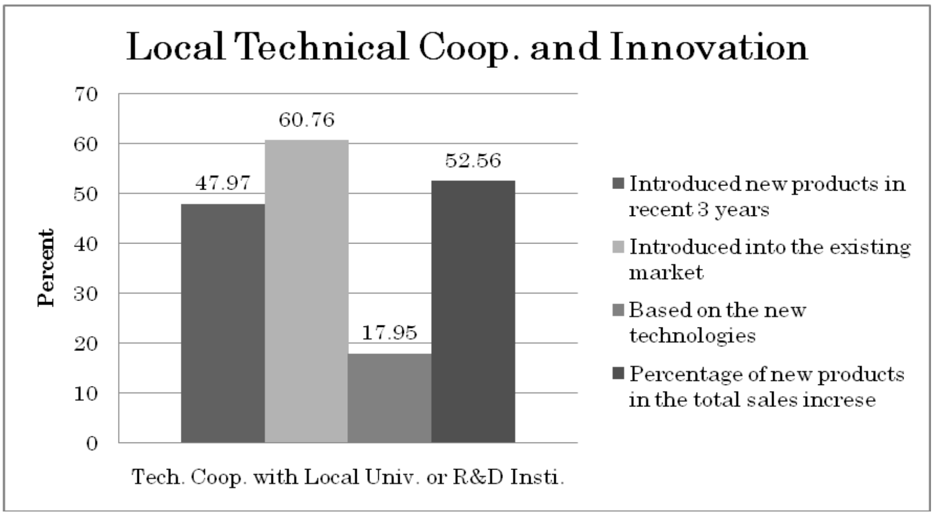


Source: Survey 2009, Author and team.

Linkages with University

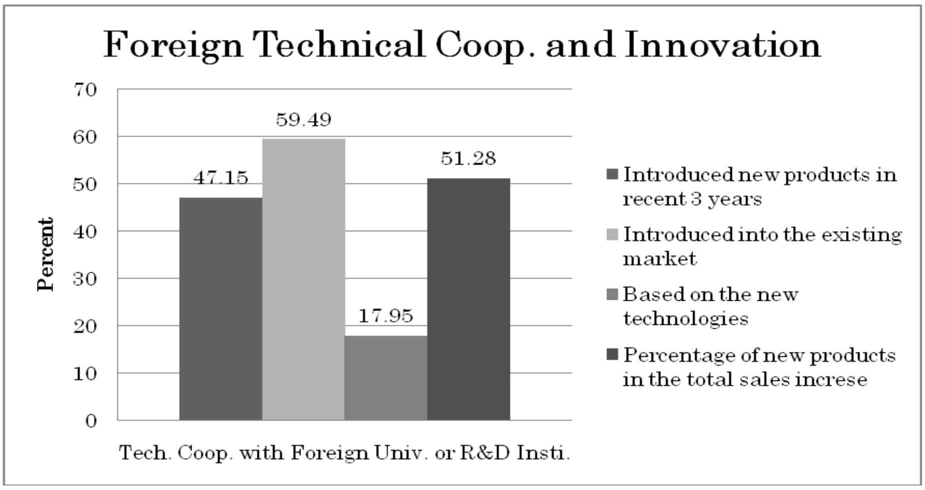
Universities, academic institutes and public agencies play a crucial role in R&D activity, knowledge creation and innovation diffusion. Therefore, linkages with these entities could benefit the industry by bringing about product innovation in the market.

Figure 16. Technical Cooperation with Local University (Q16.5.1) vs Innovation



Source: Survey 2009, Author and team.

Figure 17. Technical Cooperation with Foreign University (Q16.5.2) vs Innovation



Source: Survey 2009, Author and team.

Distance and Travel Time

As related in a study by Masatsugu Tsuji, Shoichi Miyahara, Tomohiro Machikita and Yasushi Ueki (2009) titled "Tentative summary of estimation", the distance from a partner is negatively significant for the Thai industry. This implies that geographical distance is an obstacle to innovation. Moreover, travel time from the establishment to the customer/supplier is negatively significant.

Product Innovation by Industry and Size

As shown in Figures 6 and 8, the textiles, food and plastics industries, which have a high rate of conducted R&D activities, have had a relatively high rate of product innovation, as shown in the introduction of new products/services in the last three year and the increase in percentage of new products/services in the total sales. However, SMEs have a faster rate of adoption in the short term which implies that they have the ability to introduce new products or services in the market more easily in the short term.

Table 8. Introduced New Products/Services to the Market in Recent 3 years VS Type of Industries (Product Innovation)

Type of Industries	**Introduced new products**			
		Yes	**No**	**Total**
Food, beverages, tobacco	Count	11	5	16
	% within Type of Industries	68.80%	31.20%	100.00%
	% within Introduced new products	**13.90%**	11.10%	12.90%
Textiles, apparel, leather	Count	17	6	23
	% within Type of Industries	73.90%	26.10%	100.00%
	% within Introduced new products	**21.50%**	13.30%	18.50%
Wood, wood products	Count	2	3	5
	% within Type of Industries	40.00%	60.00%	100.00%
	% within Introduced new products	2.50%	6.70%	4.00%
Paper, paper products, printing	Count	5	1	6
	% within Type of Industries	83.30%	16.70%	100.00%
	% within Introduced new products	6.30%	2.20%	4.80%
Coal, petroleum products	Count	2	0	2
	% within Type of Industries	100.00%	0.00%	100.00%
	% within Introduced new products	2.50%	0.00%	1.60%
Chemicals, chemical	Count	9	8	17
and plastic products, rubber	% within Type of Industries	52.90%	47.10%	100.00%
	% within Introduced new products	**11.40%**	17.80%	13.70%
Iron, steel	Count	1	0	1
	% within Type of Industries	100.00%	0.00%	100.00%
	% within Introduced new products	1.30%	0.00%	0.80%
Metal products	Count	3	8	11
	% within Type of Industries	27.30%	72.70%	100.00%
	% within Introduced new products	3.80%	17.80%	8.90%
Machinery, equipment, tools	Count	3	2	5
	% within Type of Industries	60.00%	40.00%	100.00%
	% within Introduced new products	3.80%	4.40%	4.00%
Computers, computer parts	Count	3	1	4
	% within Type of Industries	75.00%	25.00%	100.00%
	% within Introduced new products	3.80%	2.20%	3.20%
Other electronics,	Count	2	0	2
electronic components	% within Type of Industries	100.00%	0.00%	100.00%
	% within Introduced new products	2.50%	0.00%	1.60%
Precision instruments	Count	0	1	1
	% within Type of Industries	0.00%	100.00%	100.00%
	% within Introduced new products	0.00%	2.20%	0.80%
Automobile, auto parts	Count	6	3	9
	% within Type of Industries	66.70%	33.30%	100.00%
	% within Introduced new products	7.60%	6.70%	7.30%
Other transportation	Count	1	2	3
equipments and parts	% within Type of Industries	33.30%	66.70%	100.00%
	% within Introduced new products	1.30%	4.40%	2.40%
Other, specify:	Count	14	5	19
	% within Type of Industries	73.70%	26.30%	100.00%
	% within Introduced new products	17.70%	11.10%	15.30%
Total	Count	79	45	124
	% within Type of Industries	63.70%	36.30%	100.00%
	% within Introduced new products	100.00%	100.00%	100.00%

Source: Survey 2009, Author and team.

Table 9. Introduced New Products/Services to the Market in Recent 3 Years VS Size of Factory (Product Innovation)

Size	Introduced new products	Yes	No	Total
small	Count	27	26	53
	% within Size of factory	50.90%	49.10%	100.00%
	% within Introduced new products	**35.10%**	57.80%	43.40%
medium	Count	26	11	37
	% within Size of factory	70.30%	29.70%	100.00%
	% within Introduced new products	**33.80%**	24.40%	30.30%
large	Count	20	6	26
	% within Size of factory	76.90%	23.10%	100.00%
	% within Introduced new products	26.00%	13.30%	21.30%
very large	Count	4	2	6
	% within Size of factory	66.70%	33.30%	100.00%
	% within Introduced new products	5.20%	4.40%	4.90%
Total	Count	77	45	122
	% within Size of factory	63.10%	36.90%	100.00%
	% within Introduced new products	100.00%	100.00%	100.00%

Source: Survey 2009, Author and team.

Process Innovation by Industry and Size

Similar to product innovation, the textiles, food and plastics industries which have a high rate of conducting R&D activities, have had a relatively high rate of process innovation such as buying new machines or facilities or introducing new production methods.

Table 10. Adopted a New Production Method in Recent 3 years VS Type of Industries (Process Innovation)

Type of Industries	Bought new machines or facilities with new function to operation			
		Yes	No	Total
Food, beverages, tobacco	Count	11	5	16
	% within Type of Industries	68.80%	31.20%	100.00%
	% within Bought new machines or ….	**14.90%**	10.20%	13.00%
Textiles, apparel, leather	Count	13	10	23
	% within Type of Industries	56.50%	43.50%	100.00%
	% within Bought new machines or ….	**17.60%**	20.40%	18.70%
Wood, wood products	Count	1	4	5
	% within Type of Industries	20.00%	80.00%	100.00%
	% within Bought new machines or ….	1.40%	8.20%	4.10%
Paper, paper products, printing	Count	4	1	5
	% within Type of Industries	80.00%	20.00%	100.00%
	% within Bought new machines or ….	5.40%	2.00%	4.10%
Coal, petroleum products	Count	2	0	2
	% within Type of Industries	100.00%	0.00%	100.00%
	% within Bought new machines or ….	2.70%	0.00%	1.60%
Chemicals, chemical and plastic products, rubber	Count	11	6	17
	% within Type of Industries	64.70%	35.30%	100.00%
	% within Bought new machines or ….	**14.90%**	12.20%	13.80%
Iron, steel	Count	1	0	1
	% within Type of Industries	100.00%	0.00%	100.00%
	% within Bought new machines or ….	1.40%	0.00%	0.80%
Metal products	Count	7	4	11
	% within Type of Industries	63.60%	36.40%	100.00%
	% within Bought new machines or ….	9.50%	8.20%	8.90%
Machinery, equipment, tools	Count	4	1	5
	% within Type of Industries	80.00%	20.00%	100.00%
	% within Bought new machines or ….	5.40%	2.00%	4.10%
Computers, computer parts	Count	1	3	4
	% within Type of Industries	25.00%	75.00%	100.00%
	% within Bought new machines or ….	1.40%	6.10%	3.30%
Other electronics, electronic components	Count	1	1	2
	% within Type of Industries	50.00%	50.00%	100.00%
	% within Bought new machines or ….	1.40%	2.00%	1.60%
Precision instruments	Count	1	0	1
	% within Type of Industries	100.00%	0.00%	100.00%
	% within Bought new machines or ….	1.40%	0.00%	0.80%
Automobile, auto parts	Count	7	2	9
	% within Type of Industries	77.80%	22.20%	100.00%
	% within Bought new machines or ….	9.50%	4.10%	7.30%
Other transportation equipments and parts	Count	2	1	3
	% within Type of Industries	66.70%	33.30%	100.00%
	% within Bought new machines or ….	2.70%	2.00%	2.40%
Other, specify:	Count	8	11	19
	% within Type of Industries	42.10%	57.90%	100.00%
	% within Bought new machines or ….	10.80%	22.40%	15.40%
Total	Count	74	49	123
	% within Type of Industries	60.20%	39.80%	100.00%
	% within Bought new machines or ….	100.00%	100.00%	100.00%

Source: Survey 2009, Author and team.

Table 11. Adopted a New Production Method in Recent 3 Years VS Size of Factory (Process Innovention)

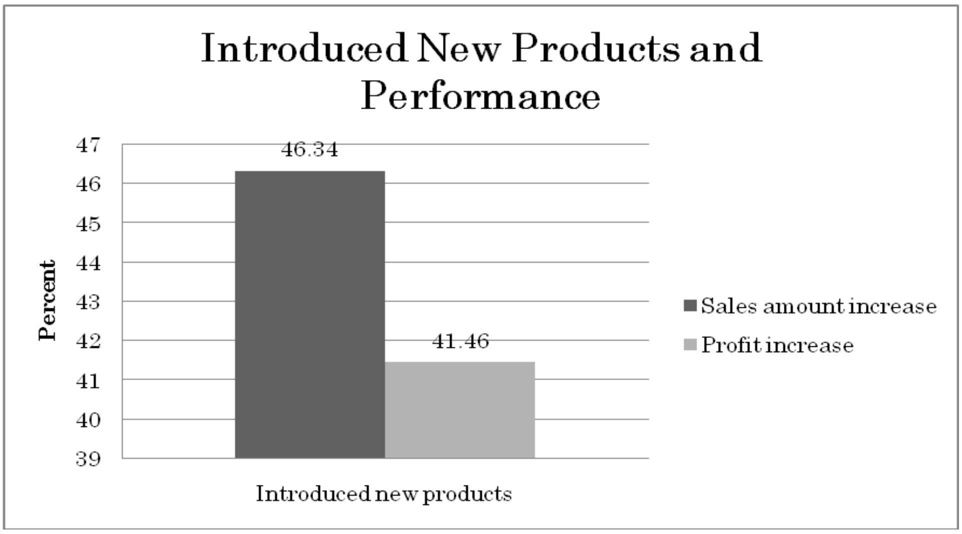
Size	Bought new machines or facilities with new functions to operation			
		Yes	**No**	**Total**
small	Count	25	27	52
	% within Size of factory	48.10%	51.90%	100.00%
	% within Bought new machines or …	34.20%	56.20%	43.00%
medium	Count	21	16	37
	% within Size of factory	56.80%	43.20%	100.00%
	% within Bought new machines or …	28.80%	33.30%	30.60%
large	Count	23	3	26
	% within Size of factory	88.50%	11.50%	100.00%
	% within Bought new machines or …	31.50%	6.20%	21.50%
verry large	Count	4	2	6
	% within Size of factory	66.70%	33.30%	100.00%
	% within Bought new machines or …	5.50%	4.20%	5.00%
Total	Count	73	48	121
	% within Size of factory	60.30%	39.70%	100.00%
	% within Bought new machines or …	100.00%	100.00%	100.00%

Source: Survey 2009, Author and team.

Innovation and Performance

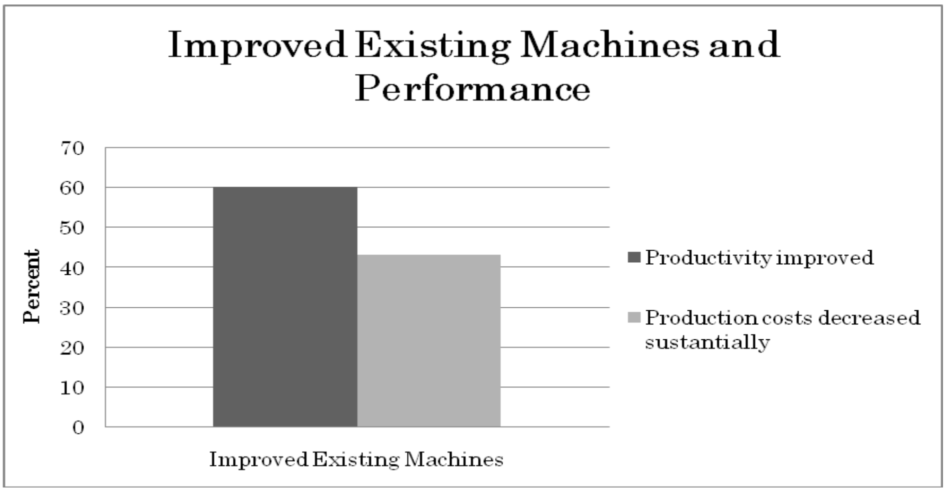
Product innovation or the introduction of new products could lead to performance improvement such as increase in total sales and profit. In contrast, production cost may not be reduced substantially with process innovation (improvement of existing machines). However, process innovation can improve productivity significantly and decrease production cost substantially in the long term.

Figure 18. Product Innovation (Q.9) vs Performance (Q6.1, Q6.2)



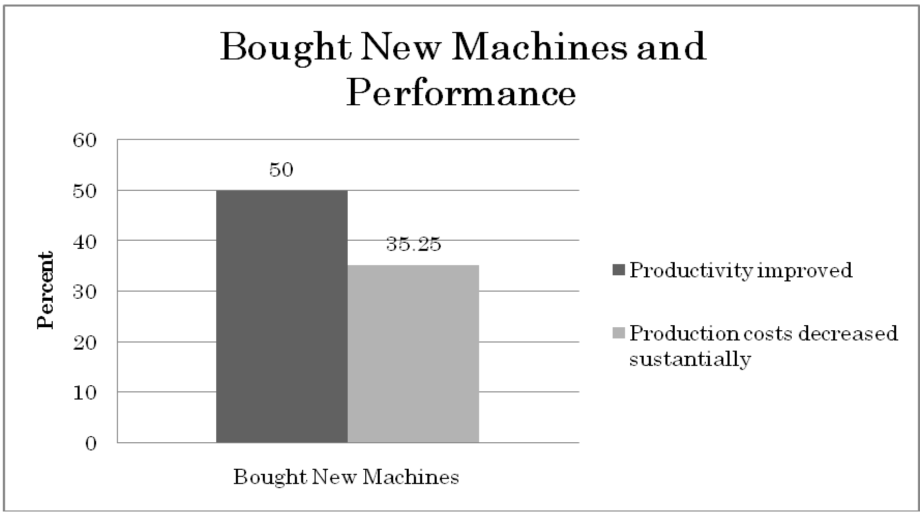
Source: Survey 2009, Author and team.

Figure 19. Process Innovation (Q10.2) vs Performance (Q6.7, Q6.10)



Source: Survey 2009, Author and team.

Figure 20. Process Innovation (Q10.1) vs Performance (Q6.7, Q6.10)

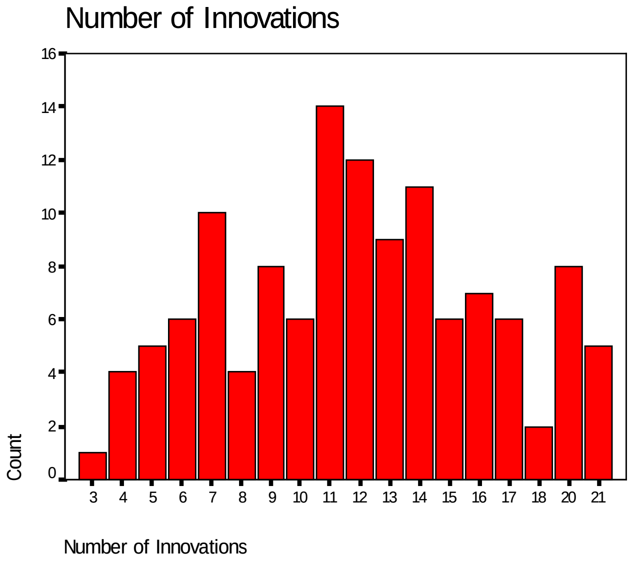


Source: Survey 2009, Author and team.

Number of Innovations

Much of the Thai industry has had some forms of innovation such as introducing new products, adopting new production method, securing new partners, seeking new market, and improving business processes or organizations. From the figure, it can be seen that none of the firms have been operating without any innovation.

Figure 21. Number of Innovation (Q9 - Q13, Excepted Q9.1-Q9.3)

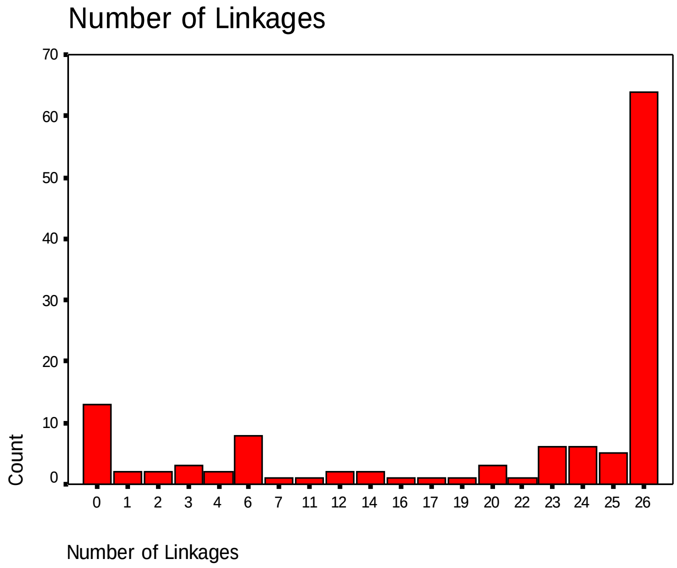


Source: Survey 2009, Author and team.

Number of Linkages

Since the Thai economy has opened up to the global market, much of the Thai industry has come to realize the importance of linkages. In the past decade, the Thai government has actively promoted industrial clustering and agglomeration with local SMEs. It can be seen from the investment promotion policy of the Board of Investment (BOI) that the government has been trying its best to encourage firms to locate their establishments inside the industrial estates or special zones by offering attractive incentives. As can be seen in Figure 22, the number of linkages between industry and local and foreign companies, local support organizations, universities and sources of information and technologies has been quite high.

Figure 22. Number of Linkages (Q16.2-Q16.7)

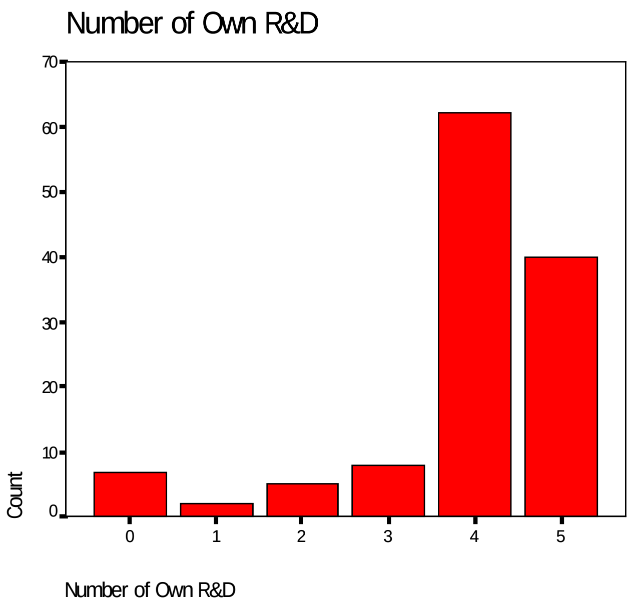


Source: Survey 2009, Author and team.

Importance of Internal Resources

Due to limited resources, the Thai industry relies much on its own resources (R&D departments, headquarters, and affiliates). It perceives internal sources of information and own R&D efforts as the most practical and important sources of information and new technologies for innovation and upgrading.

Figure 23. Important of Internal Resources of Information and own R&D Efforts (Q16.1)



Source: Survey 2009, Author and team.

4.2. Econometric Analysis

4.2.1. Linkages and innovation

Linkages on local firm (Q16.2) and human resource (Q16.6) were positively significantly, while university (Q16.5) and other sources of information (Q16.7) were negatively significant (Table 12.1). Trying to improve the level of confidence, we tried to get rid of insignificant factors such as foreign firms and local organization (Q16.3, Q16.4), and as can be gleaned from Table 12.2, all variables (Q16.2, Q16.5, Q16.6, Q16.7) were significant with the confidence level improved.

Linkages with local customer/supplier, competitor or local firm in the different businesses which is neither supplier/customer, nor even recruitment of mid-class personnel, or personnel retired from MNCs and large firms, could facilitate innovation and upgrading.

Linkages with university (Q16.5) and other sources of information (Q16.7) were negatively significant. This can be because the Thai industry has rarely conducted R&D activities or bought technology or patents from others. In recent years, the Thai government has implemented various support schemes for the Thai industry especially industrial clustering, developing ICT infrastructure and promotion of R&D activities. The government also put much effort on R&D promotion through universities and national research institutes such as the National Research Council and the Thailand Research Fund. The National Research Council stated that the most serious problem for innovation in the Thai industry is not the generation of innovation as the country has a huge stock of innovation created from R&D activities but the lack of proper infrastructure to support knowledge diffusion, utilization, and commercialization of these innovations.

4.2.2. Innovation and performance

Improving business process (Q13) and securing new suppliers (Q11) were positively significant. Therefore, it can be said that the industry's move to secure new suppliers of raw materials, parts or services (Q11), and its efforts to improve business processes or organizations such as ISO standard, and ICT development in the last three years (Q13) have contributed to the firm's performance (Table 13).

Table 12. Result from Econometric Analysis (Linkages vs Innovation)

12.1

Dependent Variable: INNOVATION (Q9-Q13)
Method: Least Squares
Sample: 1 122
Included observations: 122

Variable		Coefficient	Std. Error	t-Statistic	Prob.	
Q16_2	Local firms	0.561793	0.333238	1.685859	0.094534	*
Q16_3	Foreign and MNCs	0.411011	0.29403	1.397851	0.164848	
Q16_4	Local organizations	-0.02694	0.377954	-0.07128	0.943302	
Q16_5	Universities, R&D Institutes	-1.7071	0.981964	-1.73845	0.084807	*
Q16_6	Human resources	3.317454	1.165481	2.846425	0.005237	**
Q16_7	Other sources of information	-1.72683	0.549243	-3.14401	0.002121	**
C	Constant	9.683818	0.925859	10.45928	2.14E-18	

R-squared	0.178066	Mean dependent var	11.37705
Adjusted R-squared	0.135182	S.D. dependent var	4.558758
S.E. of regression	4.239444	Akaike info criterion	5.782406
Sum squared resid	2066.882	Schwarz criterion	5.943293
Log likelihood	-345.727	F-statistic	4.152311
Durbin-Watson stat	1.722938	Prob(F-statistic)	0.000819

Note: ** Significant at 1%, * Significant at 10%.

12.2

Dependent Variable:
INNOVATION (Q9-Q13)
Method: Least Squares
Sample: 1 122
Included observations: 122

Variable		Coefficient	Std. Error	t-Statistic	Prob.	
Q16_2	Local firms	0.805125471	0.268165494	3.002345529	0.003276175	**
Q16_5	Universities, R&D Institutes	-1.972163065	0.814008836	-2.422778448	0.016935613	**
Q16_6	Human resources	3.884372984	1.143685012	3.396366084	0.000933552	**
Q16_7	Other sources of information	-1.482545945	0.550978143	-2.690752737	0.008173038	**
C	Constant	10.01844762	0.876555805	11.42933235	9.00E-21	

R-squared	0.158047019	Mean dependent var	12.01639344
Adjusted R-squared	0.129262302	S.D. dependent var	4.613998833
S.E. of regression	4.305475816	Akaike info criterion	5.797772486
Sum squared resid	2168.843274	Schwarz criterion	5.912691381
Log likelihood	-348.6641216	F-statistic	5.490657324
Durbin-Watson stat	1.777223543	Prob(F-statistic)	0.000436398

Note: ** Significant at 1%, * Significant at 10%.

Table 13. Result from Econometric Analysis (Innovation vs Performance)

13.1

Dependent Variable: PERFORMANCE
Method: Least Squares
Sample: 1 122
Included observations: 122

Variable		Coefficient	Std. Error	t-Statistic	Prob.	
Q10	Process Innocation	0.121152	0.243517	0.497511	0.619771	
Q11	Securing new suppliers	0.219314	0.128762	1.703249	0.091199	*
Q12	Securing new customers	0.185611	0.135766	1.367134	0.174227	
Q13	Improving business process	0.678652	0.236874	2.865028	0.004952	**
Q9	Product Innovation	-0.23653	0.482422	-0.49031	0.624844	
C	Constant	3.328298	0.720124	4.621838	9.94E-06	

R-squared	0.198283	Mean dependent var	6.286885
Adjusted R-squared	0.163726	S.D. dependent var	2.731752
S.E. of regression	2.498133	Akaike info criterion	4.716894
Sum squared resid	723.9177	Schwarz criterion	4.854797
Log likelihood	-281.731	F-statistic	5.737886
Durbin-Watson stat	1.685045	Prob(F-statistic)	9.09E-05

Note: ** Significant at 1%, * Significant at 10%.

13.2

Dependent Variable: PERFORMANCE
Method: Least Squares
Sample: 1 122
Included observations: 122

Variable	Coefficient	Std. Error	t-Statistic	Prob.	
Q11 Securing new suppliers	0.326329783	0.1038293	3.142945045	0.00211154	**
Q13 Improving business process	0.728405909	0.215642089	3.377846654	0.000987878	**
C Constant	3.766063424	0.547101977	6.88365896	2.93E-10	

R-squared	0.181940364	Mean dependent var	6.286885246
Adjusted R-squared	0.168191463	S.D. dependent var	2.731752406
S.E. of regression	2.491454848	Akaike info criterion	4.687893475
Sum squared resid	738.6743241	Schwarz criterion	4.756844812
Log likelihood	-282.961502	F-statistic	13.23308375
Durbin-Watson stat	1.647605657	Prob(F-statistic)	6.47E-06

Note: ** Significant at 1%, * Significant at 10%.

4.3. More Findings from Factory Visits and In-depth Interviews

Due to inadequate sample size and the limited resources to collect more questionnaires, we deemed it useful to look for more evidence through factory visits and in-depth interviews with entrepreneurs. We chose the machinery industry, which is a large industry in Thailand especially that which deals with machines and equipment for the automotive market, and the pharmaceutical industry, in which R&D and linkages play an important role for their innovation and upgrading.

4.3.1. NR Group of Companies

The NR Industry Co., Ltd. and Group of Companies were established in 1977 at Samutprakarn province (1 hour east of Bangkok) as a small workshop company with 100%-owned Thai capital. It produces various types of tailor-made machines and services including R&D and design, 5-Axises CNC, metal sheet and painting, and maintenance service, mostly to support the pharmaceutical and packaging industries.

The NR group has a strong internal R&D department integrated with affiliated R&D companies. It is linked with the Thailand Ministry of Sciences and Technology, public universities such as the Engineering Faculty of Kasetsart University and some vocational colleges, and international agencies. Internal R&D and international best practices are the most important partners for their innovation and upgrading of production. Since the NR group believes the importance of a knowledge-based economy though knowledge creation, diffusion and utilization, it has placed huge investments on R&D activities. More than 20% of its annual expenses each year are spent especially on reverse engineering methodology and retrofitting technique to create new innovations at least once every decade. The group has a motto of “one supplier, one equipment” for traceability purpose. Its owner or CEO has played a very important role in initiating new innovations by forging wide and strong domestic networks, especially with public R&D funders such as the Ministry of Sciences and Technology (NSTDA, M-TECH, BIOTECH, NIA), universities and machinery clusters such as the Thai Machinery Association. The owner and managerial staff are also regularly attending international workshops, exhibitions or trade fairs to seek for relevant new technologies.

This case study shows the importance of having a leader who has an initiative in leading internal R&D activities as well as in linking with external networks or linkages for innovation and upgrading, all of which contribute to enhancement of the firm’s industrial performance.

4.3.2. Thai Central Mechanics Co., Ltd.

The Thai Central Mechanics Company (TCM) was established in 1989 at Samutprakarn province and has 100% owned Thai capital. It produces various made-to-order machines and services such as turnkey solution, automation system, material handling, electrical system, CNC and retrofit, mostly to support the automotive industry.

TCM’s internal R&D teams that are linked with customers are the company’s most important parties for innovation and upgrading. When customers (which are mainly Japanese automotive firms) launch new models, products or parts, the company discusses and produces made-to-order products under technical assistance from customers and university professors. TCM has a close relationship or linkage with the academe especially the King Mongkut's University of Technology North Bangkok, the Thai-German Institute (TGI) and recently, the National Innovation Agency (NIA). It is also a member of the Thai Machinery Association. TCM has received only a minimal support from government or public grants. It usually utilizes the financial support of private commercial banks in developing new innovations. The management of this company has highly concentrated much on human resource development, especially in-house training, and provision of incentives to engineers and technicians. The company has been cooperating with universities annually in implementing an international student exchange program to capitalize on the information and technique flows from this activity.

Since two years ago, thanks to the deep experience, far vision, nationalism and astute management of its owner/CEO, the company was able to prepare in advance for the impending regional economic downturn. It has invested most of its resources on environmental engineering and bio-technology, which was also made possible through some financial support from the government in the form of interest subsidy.

As this case study has shown, the expertise and experience of a company's leader in coordinating the internal R&D activities and in linking with customers and universities for technical assistance have played a crucial role in realizing innovations to improve the firm's performance.

5. CONCLUSION

The survey results and country studies reveal that the Thai industry is made up mostly of SMEs that have a limited budget with hardly any public financial support for R&D activities for innovation or upgrading. They stand in contrast to large, foreign or joint venture firms that have active R&D activities. For firms with R&D activities, they have relied much on their own R&D and internal resources. Nevertheless, Thai firms who have been linking with customers/suppliers/competitors, universities or public organizations, exchanging engineers with customers/suppliers or accessing public assistance or R&D grants, have gained benefits from these linkages. Furthermore, significant associations among domestic and foreign firms and university-industry linkages were seen particularly in industries such as textiles and apparels, food and beverages, plastics and plastic products. These have led to product/process innovations, agglomeration and upgrading. As witnessed in recent years, firms were able to pioneer in the development of new products/services. The results have also provided evidence that innovation advances a firm's performance. Product innovation or launching new products could lead to better performance by boosting total sales and profit. Meanwhile, process innovation or improvement of existing machines has an effect of increasing productivity but it has hardly any substantial effect on diminishing production cost at least on the short term.

For the Thai industry, the significant sources of innovation and upgrading include cluster/agglomeration, industrial linkages, university-industry linkages and own R&D resources. These resources have, to some extent, led to some improvement in firm performance and the country's industrial development.

Policy Implications and Recommendations

1) Promoting linkages and agglomeration

- Uphold linkages and networks among Thai firms, joint ventures and foreign firms through clustering, business matching, workshops and virtual networks via ICT and web portal, as foundation for information exchange, knowledge generation and technology catching-up.
- Encourage engineer and researcher exchange program (dispatch and accept) among customers/suppliers/competitors.
- Persuade firms to locate in industrial estates or special zones to generate industrial agglomeration.
- Endorse and broaden research/scholastic consortium to enhance linkages among public- university– private researchers.

2) Building up internal resources and R&D function

- Enhance R&D financial support scheme to industry.
- Diminish direct/indirect cost of R&D for the private sector (e.g., tax exemption for preferred industrial R&D activities, refundable import duty/tariff for R&D equipment especially those that are used for joint projects between university and industry)
- Support the broadening of expertise and foreign linkages among researchers

3) Enhancing environment for knowledge-based industry/society

- Initiate East Asian cooperation on intellectual property law to give confidence to the creation of new innovations and to ensure that firms are given sufficient incentives to innovate new products and processes for industry and the services sectors.
- Enhance infrastructure (e.g. science parks, software parks, research funding, incubation center, IT infrastructure, media, etc.) for knowledge diffusion, utilization and commercialization, and continue to promote private sector involvement in developing the knowledge economy.

REFERENCES

Ann Markusen (1996). *"Sticky Places in Slippery Space: A Type of Industrial Districts"*. Economic Geography, Vol.72, No.3. pp. 293-313, www.jstor.org. (accessed February 28, 2009)

Arkhom Termpittayapaisith (2007). "Thailand and Its Knowledge Economy", The National Economic and Social Development Board (NESDB), Thailand, www.nesdb.go.th (accessed February 12, 2009)

Asian Development Bank (2008). "Thailand's Key Indicators", www.adb.org. (accessed February 20, 2009)

Department of Industrial Promotion (2004). *"Industrial Cluster Boots Thai SMEs Potential"*, www.dip.go.th (accessed January 15, 2009)

Department of Intellectual Property (2008). *"Granted Patents of Thailand"*, Ministry of Commerce, Thailand, www.ipthailand.org (accessed February 10, 2009)

Faculty of Economics, Chulalongkorn University (2007). *"Key Performance Indicators Development for Evaluating the 2nd SMEs National Plan"* Thailand.

Masatsugu Tsuji, Shoichi Miyahara, Tomohiro Machikita, and Yasushi Ueki (2009). *"Development of Regional Production and Logistics Networks In East Asia"*, tentative summary of estimation, Institute of Development Economies (IDE)

Takao Tsuneshi (2005). *"The Regional Development Policy of Thailand and Its Economic Cooperation with Neighboring Countries"* Discussion paper No.32, Institute of Developing Economies.

The Board of Investment of Thailand (2007). "The Investment Received Support from BOI, 2007" Thailand, www.boi.go.th (accessed January 14, 2009)

The Industrial Estate Authority of Thailand (2008). "Foreign Investors in Industrial Estate of Thailand", www.ieat.go.th (accessed January 14, 2009)

The Industrial Estate Authority of Thailand (2008). "Industrial Estate in Thailand", www.ieat.go.th (accessed January 14, 2009)

The National Sciences and Technology Development Agency (NSTDA) (2006). "Knowledge-based Industry – supported tables", Thailand, www.nstda.go.th

(accessed January 20, 2009)

The Office of Industrial Economic (2007). *“Development of Technology and Manpower for Knowledge-based Industry”* Thailand, www.oie.go.th (accessed January 20, 2009)

The Office of Industrial Economic (2008). *“Industrial Economic Status Report, October 2008”* Thailand, www.oie.go.th (accessed January 20, 2009)

APPENDIX

- **List of variables**

Descriptive	Variables
Linkages	Q16.2 Q16.3 Q16.4 Q16.5 Q16.6 Q16.7
Innovation	Q9 Q10 Q11 Q12 Q13
Performance	Q6

Q6. Current business performance of your establishment in comparison with that of 2007

Q9. Introduced new products or services to the market in recent three years
Q10. Adopted a new production method in the recent three years
Q11. Secured new supplier of raw materials, parts, supplies or services in the recent three years
Q12. Secured a new customer in the recent three years
Q13. Made efforts to improve business processes or organizations in the recent three years

Q16.2 Technology transfer from local firms/cooperation with local firms (100% Thai capital)
Q16.3 Technology transfer from multinational companies (MNCs) or cooperation with MNCs
Q16.4 Technical assistances by local support organizations (government and local business organization) such as dispatch of experts, seminar, lecture or training counselor/expert dispatched/hired by them
Q16.5 Linkages with universities, R&D institutes and academic societies
Q16.6 Human resources
Q16.7 Other sources of information and technologies

4

Development of Regional Production and Logistic Networks in East Asia-Vietnam

Upgrading of Firms in Vietnam through Linkages with Customers and Suppliers

Truong Chi Binh

Abstract

Hanoi has the most innovative research and education system with a high-quality human resource. However, the R&D capacity does not meet the demand of manufacturing firms. This research focuses on the business linkages among manufacturing firms in Hanoi, particularly between domestic and foreign direct investment (FDI) firms; the development of R&D and upgrading activities of firms and the different motivations for innovation of FDI and domestic firms; and the connection of business linkage with R&D and upgrading. This paper shall identify the motivations, resources and information sources from which firms base their decisions to implement regular innovation and upgrading. From these results, the research will propose a design for linking Vietnam's innovation system to the demand of industrial sectors or firms. Although the respondent firms in this study are of medium size, their assets are rather large and their technological capacity is not so outdated unlike the firms in the previous survey. However, firms have not realized the benefits of innovation and upgrading.

They seemed to have no motivation for linkage thus the poor business linkage. Linkage between firms and research institutions has not been formed. The activities of these government agencies have not met the firm's demand. The government has not proposed incentive policies for R&D and upgrading activities of firms. In addition, the market providing R&D activities in Vietnam has not been developed yet.

1. INTRODUCTION OF RESEARCH AREA

1.1. Advantages of Hanoi over other Cities/Provinces

According to the Department of Planning and Investment, Hanoi has eight advantages over other localities:

- Capital, cultural and trade center of the nation
- Political stability and safe business environment
- High-quality human resources
- Huge market potential
- Improved infrastructure
- Social service cost and real estate cost lower than in other locations
- Many industrial parks
- Convenient administrative procedures

1.2. Industrial Development

At present, Hanoi has one high-tech park, 18 industrial parks, 45 small and medium clusters and 171 other industrial areas. Major fields invested in industrial parks are electricity-electronics, information technology (IT), mechanics, textile and garment, and food processing. These industrial parks and clusters have contributed significantly to the city's industrial development. The industrial production value of Hanoi has increased from year to year. The table below indicates the industrial production value index of Hanoi in January 2009.

Table 1. Industrial Areas in Hanoi

Ord.	Type	No.	Area
1	High Tech Park	01	1.586 ha
2	Industrial Park	18	6.846 ha
3	Small and medium industrial cluster	45	2.400 ha
4	Industrial area	171	1265 ha

Table 2. Industrial Production Value Index of Hanoi

	January 2009 compared to December 2008	January 2009 compared to January 2008
Hanoi	42,8	93,6
State owned	69,1	96,9
Non-State owned	75,2	102,5
FDI	24,3	83,5

Source: General Statistics Office.

In addition to industrial growth, Hanoi possesses a synchronized and developed infrastructure. Industrial parks, export-processing zones and the Noi Bay airport are situated 40 km away from the city center. The two biggest ports in North, Hai Phong and Cai Lan, are 120 km away from Hanoi. Hanoi also serves as an excellent transport connection in the North given its improved railway and highway.

1.3. Human Resources

After its expansion, Hanoi stands as the second biggest city in Vietnam with a population of 6.233 million people. More than 3 million people are of working age. A major proportion of the labor force in Hanoi comes from the surrounding provinces in the North.

Low labor cost is one of the factors attracting foreign firms to invest in Hanoi. Most of the employees working in foreign firms are highly skilled and able to absorb new technologies. More than 62% of the scientific and management staff have either a PhD or a master's degree.

1.4. Science &Technology (S&T) System

The Vietnamese S&T system is dominated by public research institutes. Only a few State-owned enterprises (SOEs) have their own laboratories because of the legacies of the erstwhile planned economy. In the past, the government took the responsibilities for technical change and industrial modernization. About 85% of the total R&D finance was from the state budget (UNIDO, 2000) and the share of government budget has decreased to around 70% of the total R&D investment in Vietnam. Government R&D investment decreased dramatically in the 1990s since the *Doi moi* reform and recovered from between 50 and 60 million USD in 1997 to 270 million USD in 2005.The small government R&D fund was divided among the various research projects in every research institute and university.

Table 3. Number of Registered R&D Organization (2005)

State owned	694 (34.5%)
Ministerial	484 (24%)
Academia	147 (7.3%)
SOE Company	63 (3.1%)
Private and Public. collective owned	626 (31.1%)
Total	2014 (100%)

Source: VISTEC-Vietnam S&T Evaluation Center (2007).

The government research institutes consist of the Vietnamese Academy of Science and Technology (VAST), the Vietnam Academy of Social Sciences (VASS), ministry-line research institutes and local government research centers. Vietnam's goal for these institutes is to enhance their contribution to economic development and to promote the commercialization of their research outcomes. Towards this end, Decree 115 was passed, requiring government research institutes to be self-financed and to be S&T-based enterprises. As of 2004, Vietnam has a total of 40,000 researchers, 14,000 of them with PhD and 16,000 of them MSc degree holders.

As one of the two biggest education centers in the country, Hanoi has more than 50 universities and several colleges. However, R&D activities at universities have been poorly promoted. The education system also requires further development to support the setting up of an S&T system by way of producing qualified researchers and engineers.

Shortcomings of innovation system and recommendations

National priority programs

In 2006, the identified technology priorities consisted of information and communication technology (ICT), biotechnology, new and advanced materials, automation and machinery, energy, food and foodstuff and aero plane. However, the national priority program is ineffective because of the limited involvement of R&D institutes, private and public enterprises and foreign high-tech firms. Moreover, the weak linkage among ministerial laboratories, national institutes, local laboratories and universities results in the poor performance of the national priority program.

Figure 1. Weak Linkage among R&D Bodies

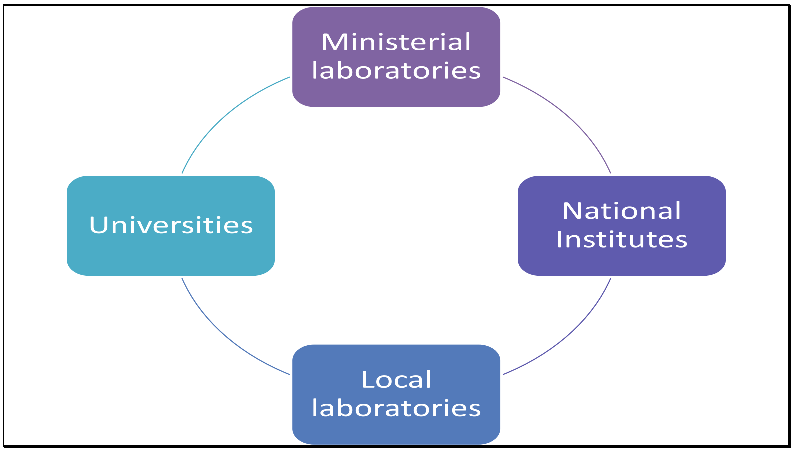
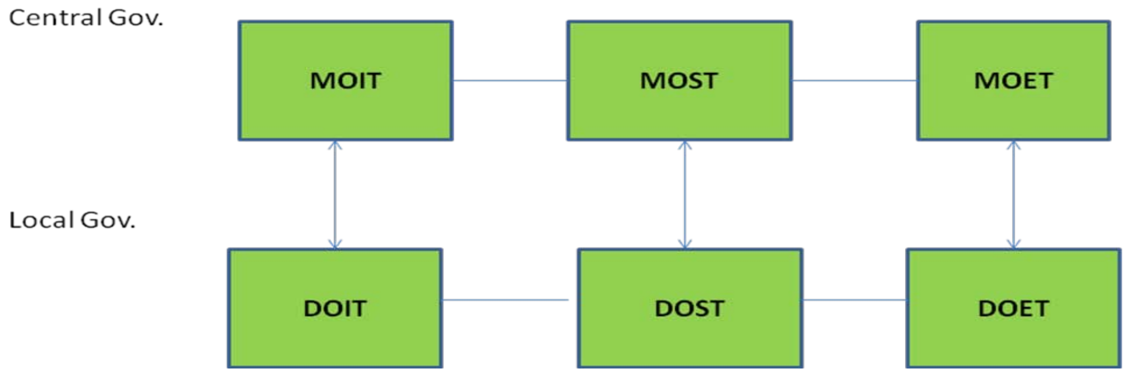


Figure 2. Local and Central Government

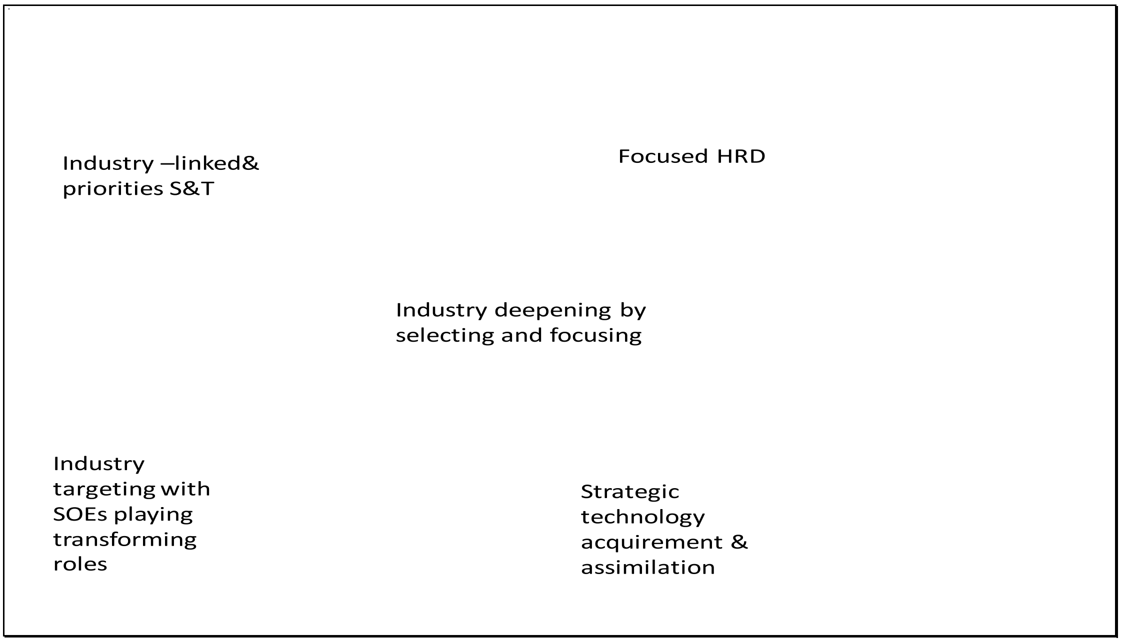


In general, the poor linkage of these entities is a problem in Vietnam. There is weak vertical and horizontal coordination between local government and central government in strategy building and priority setting.

Overall, the S&T systems have shortcomings that need to be fixed. For instance, the FDIs are not strategically and efficiently utilized for acquiring new technologies towards domestic capacity building and the SOEs also need to take a leadership role in promoting strategic industries. Besides, the government does not play a guiding role in S&T for industrialization due to lack of strategies, coordination or sufficient funding. In addition, the educational system does not provide appropriately trained workers for the industry and qualified researchers and engineers for the S&T system.

Designing a comprehensive policy framework for industry targeting, prioritized S&T, focused human resource development (HRD) and strategic technology transfer is recommended for Vietnam in general and Hanoi in particular. The key point in strategy setting is to select and focus. The success of building and maintaining a strategy will depend more on how determined the government is about its strategy and not so much on the technological details.

Figure 3. Policy Strategy



1.5. Supporting Industry (SI) Development

After more than 20 years since Vietnam initiated the *Doi moi*, the Vietnamese industry has gained remarkable achievements, integrating with the regional and global economies and contributing significantly to rapid economic growth. However, value added in industrial production (VA/GO) tends to go down. From a VA/GO of 42.5% in 1995, it decreased to 38.45% in 2000, 29.63% in 2005 and further down to 26.3% in 2007. The lowest percentage (13.81%) came from the electronics and IT technology industry. This low value added in industrial products results from the poor performance of SI.

The Ministry of Industry approved Decision 34/2007/QD-BCN on “Project on supporting industry development by 2010, vision to 2020”. Accordingly, the SI will focus on textile and garment, leather footwear, electronics and information technology, automobile assembly and manufacturing and mechanics. For this development, the project recommends to formulate industrial clusters producing parts, components and materials. In addition, SME development contributes significantly to material and products manufacturing and supply. The project encourages FDI firms to implement technology transfer and participate in training human resources for SI development.

The Vietnamese government is deeply aware of and highly values the role of SI development in the economy. The terminology “SI” came from some Japanese experts a few years ago and has now become an urgent issue in the national industry. Much attention has been paid on SI development as evidenced by the significant support of the government through the Ministry of Industry and Trade. SI development was also an important point agreed upon by Vietnam and Japan as stated in their economic partnership agreement signed in December 2008. The Ministry of Industry and Trade developed the Japan-Vietnam cooperative program on SI development in Vietnam, with Japan as a key partner for this development.

Hanoi has the advantage of developing SI in mechanics due to the large downstream market size including FDI and domestic firms. Hanoi also has the biggest advantage in mechanics given its experienced and skilled workers and engineers in the state-owned mechanics enterprises. The motorcycle industry itself used to get a favorable policy from the government, especially in terms of the regulation of local content. Thanks to these advantages, the Vietnamese motorcycle industry in general and Hanoi in particular have the most developed SI through which domestic firms could supply basic components and parts to FDI firms. Compared to the SI of electronics or automobile, that of the motorcycle industry requires lower investment capital and technology, which is an advantage of the motorcycle industry. According to 2006 statistics, there were 79 firms involved in the manufacture and assembly of motorcycle parts and accessories plus some 100 household-type ventures engaged in the manufacture of simple motorcycle parts. Aided by Vietnam's favorable investment climate, many FDI firms have invested in the country such as Honda, Yamaha and VMEP, to name a few. Overall, the local content of motorcycle has reached 91%. However, the competitiveness of SI domestic firms is still low due to lack of linkage, division and specialization among supporting operations. Moreover, the linkage among suppliers and between FDI and domestic firms is limited and domestic firms seem to be passive in this relationship.

Vietnam's economic environment has been unsuccessful in facilitating the economic sectors to make specialized investment in long-term SI manufacturing. Sharing of market information and manufacturing linkage among different firms are limited. The associations have not taken a lead role.

The following are some of the things that need to be done to promote SI development in Hanoi and Vietnam:

- Develop database on SI

Most of the existing databases (by the Vietnam Chamber of Commerce and

Industry, associations, Department of Investment and Planning, business directories) just state the enterprise’s name, business form, products, and sales with no information at all about manufacturing capacity, human resources, manufacturing and marketing. This prevents FDI firms from considering to tap supporting firms in Vietnam. The results of a survey conducted by the Institute for Industrial Policies and Strategies (IPSI) show that most of the firms from both the supply and assembly sides are willing to provide and update information regularly for the SI databases.

- Building SI Zones

These SI zones specialize in SI development and have favorable policies to encourage FDI suppliers to invest. Since suppliers normally have small-to-medium scale operation within a smaller manufacturing area than those of the assemblers, it is necessary to set up specific criteria for suppliers to attract investors. The building of SI zones is needed for Hanoi as SI in metal parts manufacturing is considered an advantage of Hanoi. This may be considered in the plans for Hanoi’s expansion. In the survey of JETRO in 2005, more than 70% of Vietnam-based Japanese firms said they plan of increasing the local content of their components and parts. Only a few enterprises had the intention to import parts from China. Although ASEAN was a big competitor of Vietnam (with more than 60% of Japanese firm interested in the ASEAN), up to 73% of Japanese firms were interested to expand the supply chain in Vietnam.

- Product diversification

Since the typical feature of SI is semi-product, the target customer of SI manufacturer is limited to some assemblers. This relationship will gradually evolve into a mutual dependence. Motorcycle parts manufacturers in Hanoi could expand their manufacturing activities by investing in modern technology to attain higher productivity, accuracy and quality so they could to supply not only to motorcycle assemblers but also to the automobile and electronics industry, especially to the manufacturers of electric, plastics and metal parts.

2. THE SURVEY IN HANOI

2.1. Background and Objective

Following the 2008 mail survey on factors of industrial agglomeration in Hanoi, which was funded and supported by BRC/IDE, the Research Group (RG) of IPSI/MOIT Vietnam continued to implement the mail survey on Hanoi-based firms. The mail survey focused on forward and backward business linkages among manufacturing firms in Hanoi, particularly between domestic and FDI firms, the development of R&D and upgrading activities of firms and the different motivations for innovation of FDI and domestic firms. The connection of business linkage with R&D and upgrading is also an objective of this research. Apart from this, the research will identify the motivations, resources and information sources from which firms (FDI and domestic) base their decisions to implement regular innovation and upgrading. From these results, the research will propose a design for linking Vietnam's innovation system to the demand of industrial sectors or firms.

In Vietnam, Hanoi has the most innovative research and education system with a high-quality human resource. However, results from past surveys show the very weak linkage between manufacturing demand and R&D capacity results in the demand of manufacturing firms not being met. There have been some R&D activities in Hanoi but these were done mostly by SOEs. These R&D activities are implemented only to fulfill the requirements of S&T organizations but not to meet the real demand. There are few R&D and upgrading activities in private and FDI firms but these have not been considered yet as important by public research institutes.

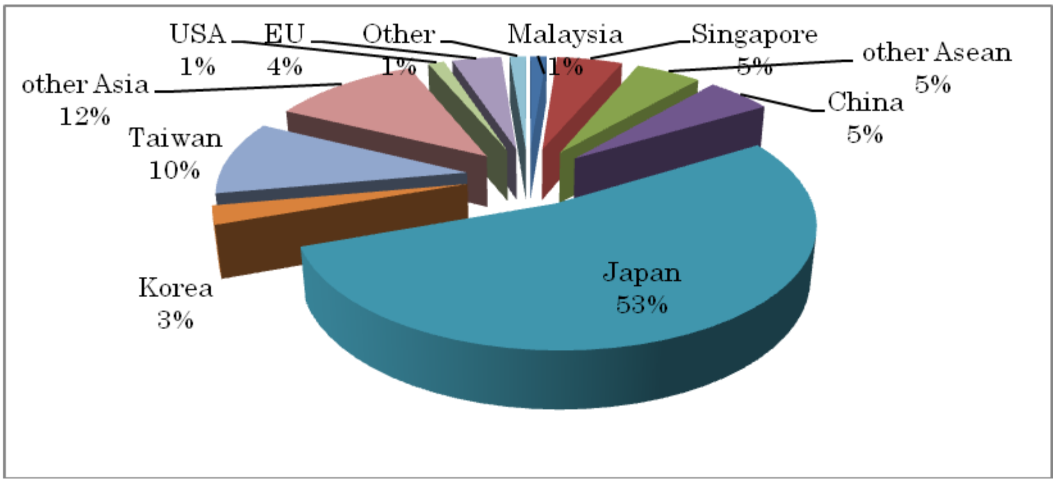
2.2. The Questionnaire Survey

Since the content of the questionnaire is quite complicated, RG conducted pilot interviews from 30 November to 10 December. The main survey was implemented from 12 December to 5 January. The target groups were manufacturing firms including FDI and SME and those in the industrial parks. With the assistance of the managing board of industrial parks in Hanoi, we sent out questionnaires to 600 manufacturing firms by mail and email. Face-to-face and phone interviews were also conducted. A total of 138 questionnaires (or 23% of the total) were received. There were, however, many missing data because of too many subquestions. Thus, RG had to contact again the respondents concerned to complete their questionnaires.

2.2.1. The feature of firms

Domestic firms accounted for 41% of the respondents; FDI and JV firms (only 3%) made up the rest. Among FDI firms, there were 53% from Japan, 10% from Taiwan, 5% from China, 5% from Singapore and 4% from the European Union (figure 4).

Figure 4. Enterprise's Nationality



The manufacturing firms interviewed were larger compared to those in the 2008 survey. About 63% of the firms have employees from 50 to 300. Firms possessing assets from 1 to 9.9 million USD accounted for nearly 50% in which majority of them have more than 10 million USD (32%) (Table 4). About 85% of the FDI and joint venture (JV) firms have under 300 employees but possess large assets. In particular, 34 of the 77 FDI firms have capital from 1 to 9.9 million USD and a similar number of JV firms possess more than 10 million USD. Among 43 Japanese firms, medium-sized firms made up the majority. Firms with 50-99 employees totaled 16 and those with 100-299 employees totaled 18. However, there were 19 firms having assets from 1 to 9.9

million USD and 19 others possessing capital of more than 10 million USD.

Table 4. Firm Size

Employment	Amount	%	Capital	Amount	%
1-19	9	7%	< 10.000	1	1%
20-49	21	15%	10.000-24.999	2	2%
50-99	**47**	**34%**	25.000-49.999	2	2%
100-199	**21**	**15%**	**50.000-74.999**	**7**	**5%**
200-299	**19**	**14%**	75.000-99.999	1	1%
300-399	5	4%	100.000-499.999	5	4%
400-499	3	2%	500.000-999.999	9	7%
500-999	3	2%	**1-4.9Mil**	**35**	**27%**
1000-1499	2	1%	**5-9.9Mil**	**26**	**20%**
1500-1999	1	1%	**> 10Mil**	**41**	**32%**
> 2000	**7**	**5%**			
Total	138	100%	Total	129	100%

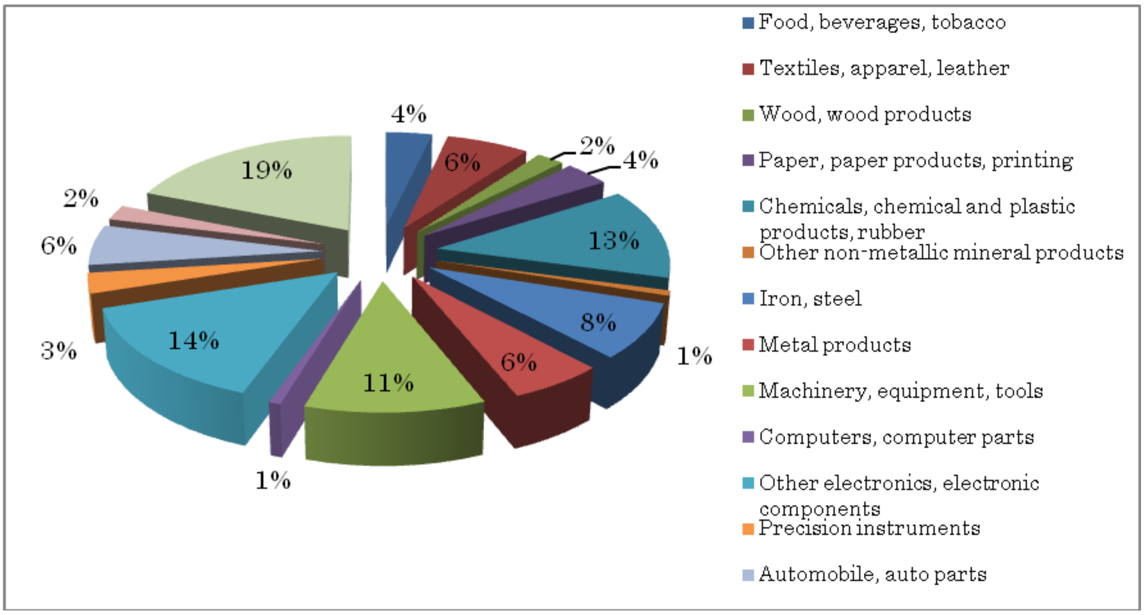
Table 4.1. Firm Size by Employment and Capital Structure

Fulltime employees	Capital structure			Total
	100% Local owned	100% foreign owned	Joint venture	
1-19	6	4	0	10
20-49	11	10	0	21
50-99	16	30	1	47
100-199	5	16	0	21
200-299	4	15	0	19
300-399	3	1	1	5
400-499	3	0	0	3
500-999	2	0	1	3
1000-1499	1	0	0	1
1500-1999	1	0	0	1
above 2000	4	3	0	7
Total	56	79	3	138

Table 4.2. Firm Size by Total Assets and Capital Structure

Total assets (USD)	Capital structure			Total
	100% domestic	100% FDI	Joint venture	
below 10.000	1	0	0	1
10.000-24.999	1	1	0	2
25.000-49.999	2	0	0	2
50.000-74.999	7	0	0	7
75.000-99.999	1	1	0	2
100.000-499.999	3	2	0	5
500.000-999.999	4	5	0	9
1-4.9 Mil	20	13	1	34
5-9.9 Mil	4	21	1	26
above 1 Mil	6	34	1	41
Total	49	77	3	129

Figure 5. Main Business Activities



There were some clusters by industries (figure 5). Although SI in Vietnam has not developed yet, the presence of these industry clusters indicate the manufacturing of parts and components to meet the demand of the assembling industry.

- Group 1 or the firms related to the manufacture of metal and mechanics parts includes 42 firms: iron, steel (11); metal products (8); machinery, equipment, tools (15); and automobile, auto parts (8). As earlier emphasized, Hanoi has an advantage of developing a supporting industry in mechanics such as motorcycle assembly and more likely automobile assembly in the future.
- Group 2 consists of more than 20 firms engaged in the manufacture of electronics and electronic components;
- Group 3 has 18 firms involved in chemicals, chemical and plastic products and rubber, in which plastic and rubber are dominant

The target market of these firms is the domestic region with an equal proportion (50%) for Hanoi and for Ho Chi Minh City (Table 5). Japan is also a big market with 44%, followed by China and Europe. However, the main material source of firms is China (for 745 respondent firms). Ho Chi Minh City ranks as second largest supplier accounting for 34% while Hanoi just accounts for 23%. Japan is the third largest supplier at 33%, followed by Taiwan (30%) and Singapore (22%). Europe accounts for only 4% of the supply source.

Table 5. Target Markets and Origins of Raw Materials of Respondents

Country/Region	Target market	%	Main raw material	%
Vietnam (Hanoi region)	67	48.9	29	23.2
Vietnam (Ho Chi Minh region)	60	43.80	16	12.8
Vietnam (Central area/ other region)	70	51.09	43	34.4
China	35	25.55	92	73.6
Japan	60	43.80	41	32.8
United State	21	15.33	2	1.6
Europe	35	25.55	5	4
Taiwan	11	8.03	37	29.6
Singapore	5	3.64	27	21.6

Firms in Hanoi concentrate on manufacturing final products (71%), followed by raw material processing (49%) and parts and components manufacture (only 21%). Up to 98% of firms implement marketing activities in Hanoi which indicates the interest of firm to cater to the domestic market. Seventeen of 56 domestic firms and 16 of 79 FDI firms (Japanese firms account for 50%) replied affirmatively to part and component manufacturing (Table 5.1 and 5.1.1). Most of the firms manufacture final products (table 5.2).

Table 5.1. Components and Parts Producing Firms

Components and parts producing firms	Q7.1_2		Total
	yes	no	
100% local owned	17	39	56
100% foreign owned	16	63	79
Joint venture	0	3	3
Total	33	105	138

Table 5.1.1. Components and Parts Producing Firms by Nationality

Components and parts producing firms	Q7.1_2		Total
	yes	no	
Malaysia	0	1	1
Singapore	0	4	4
other Asean	2	2	4
China	0	5	5
Japan	8	35	43
Korea	1	2	3
Taiwan	2	6	8
Other Asia	3	6	9
US	0	1	1
Europe	0	3	3
Others	0	1	1
Total	16	66	82

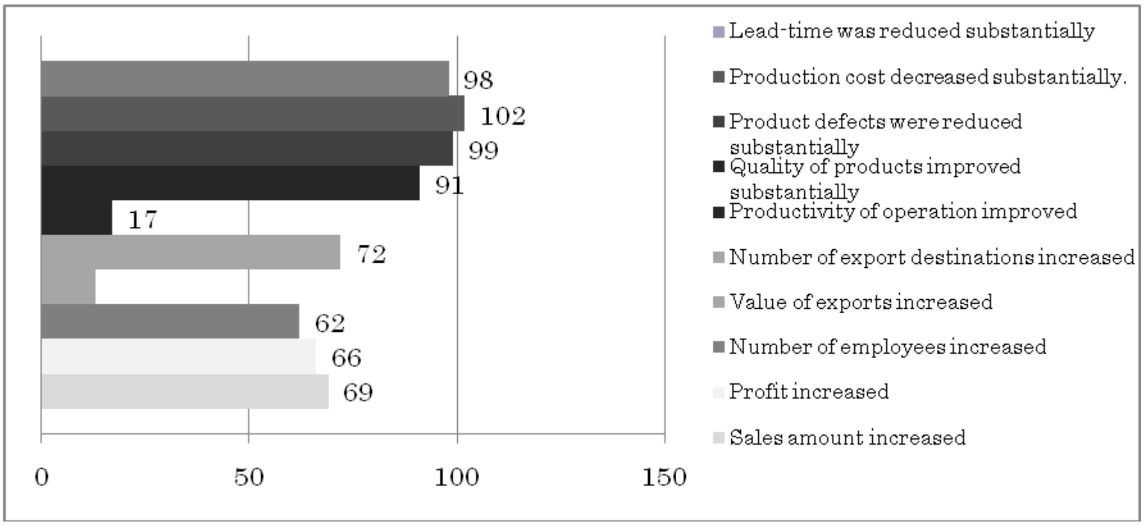
Table 5.2. Final Product Producing Firms

Final product producing firms	Q7.1_3		Total
	yes	no	
100% local owned	42	14	56
100% foreign owned	63	16	79
Joint venture	1	2	3
Total	106	32	138

2.2.2. Firm operations

Compared to the survey results in 2007, firms pay attention to reducing production cost, lead-time and product defects as well as increasing product quality. Although the number of export destinations increased, the value of exports did not increase significantly. Productivity of operation has also not improved much (figure 6).

Figure 6. Current Business Performance in Comparison with that of 2007



R&D capacity was assumed by only 16 of 122 firms (13%) including six firms who own R&D departments. There were 11 out of 16 firms that answered they have been conducting these activities since 2005. Firms did not provide answers to the more detailed questions. Five out of nine firms have percentage of R&D expenditure to total sales lower than 1% (table 6).

Table 6. Human Resources and Expenditure for R&D Activities

Employment		**R&D expenditure**	
0	1	No expenditure	1
1-5	6	0.00-0.5%	3
6-10	1	0.51-1.0%	1
16-20	3	1.01-1.5%	2
21-25	2	1.51-2.0%	1
		2.01-2.5%	1
Total	**13**	**Total**	**9**

Among 16 firms conducting R&D activities, there were only two FDI firms; the rest were local firms.

On new product and service, 40 out of 138 firms (29%) said they used new technology (Q9.2-figure 7). Regarding the technology method, 55 out of 138 firms bought or improved their machines and facilities while only 34 firms introduced new know-how on production methods (figure 8).

Table 6.1. Firms with R&D Activities in Hanoi

	R&D implemented in Hanoi presently		Total
	yes	no	
100% local owned	14	42	56
100% foreign owned	2	77	79
Joint venture	0	3	3
Total	16	122	138

Figure 7. Innovative Activities for Businesses Upgrading in the Recent Three Years

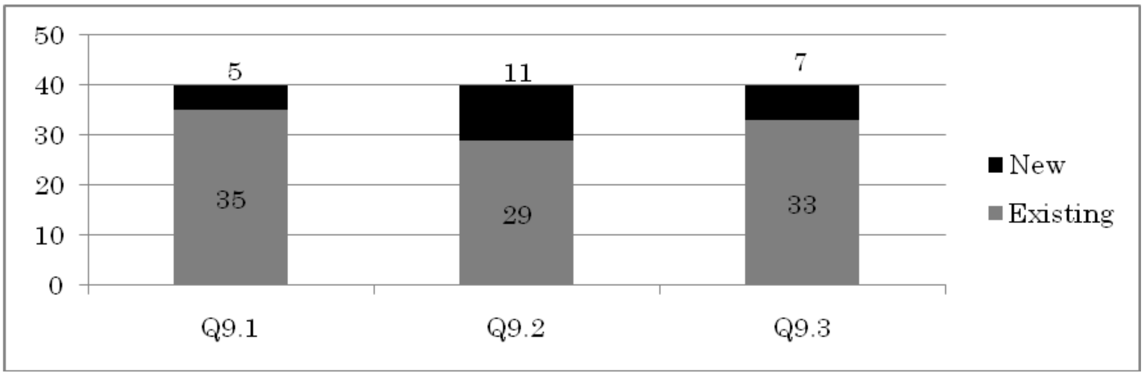
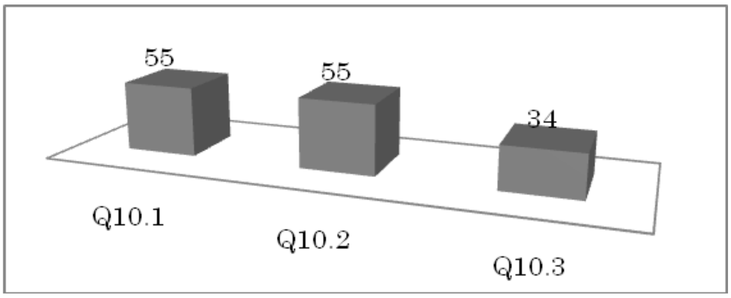


Figure 8. New Production Method in the Recent 3 years



The change of supply is more obvious (figure 9). The selection of securing a new local supplier (100% local capital) in Hanoi is dominant (11.1). Moreover, suppliers from Ho Chi Minh City and East Asian countries have been secured by firms in the last three years.

New customers in Hanoi and Ho Chi Minh City have been rapidly increasing (figure 10). In particular, firms are interested in raising the number of multinational companies (MNCs) in Hanoi (12.3) as well as in East Asia. However, MNCs outside of Hanoi have not been paid much attention to (12.4). To improve business process, firms mostly adopted international standard or introduced internal activities (70%); only 33% of firms introduced ICT.

Regarding logistics, the Haiphong port and Noi Bai airport were widely used by the respondent firms (114 out of 116 firms for the Haiphong port and 108 out of 109 firms for the Noi Bai airport). This is expected considering that these two are in close proximity to the firms.

Figure 9. Supplies in the Recent 3 years

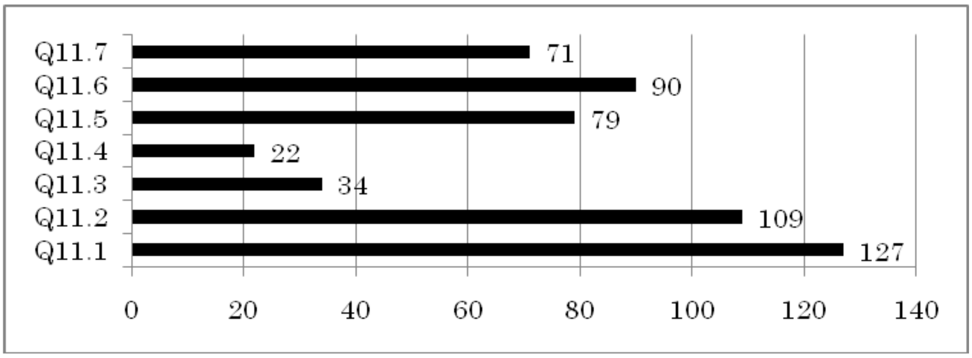
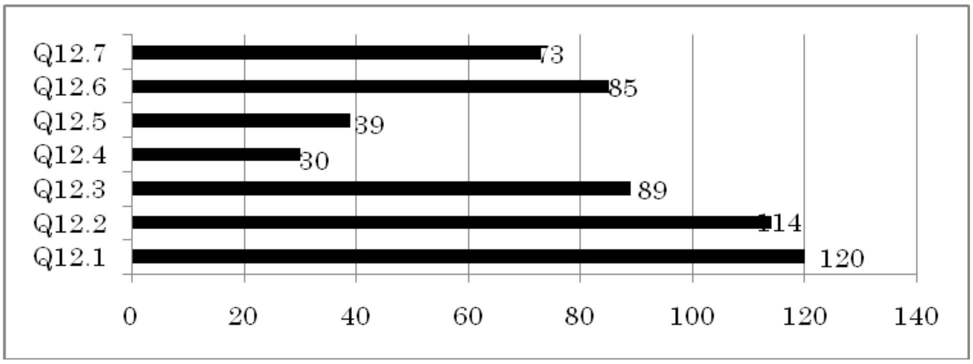


Figure 10. New Customer in the Recent 3 Years



2.2.3. Business linkage among firms

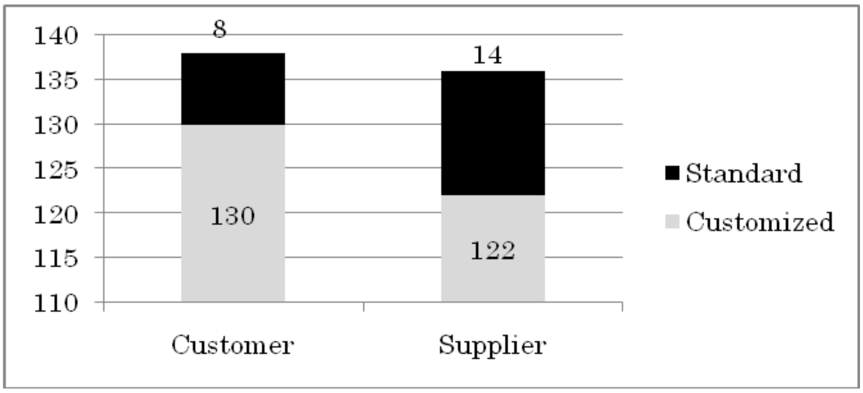
The business activities of customers and suppliers are quite similar to those of the firms as reflected by 100 out of 138 customers and 91 out of 136 suppliers that answered affirmatively. For 94% of respondents, the main products were mostly customized. Another 10% of respondents revealed the main product of suppliers is standard (figure 11). In general, the standard system especially for parts and components has not worked properly thus most of supporting production contracts rely on customer's specific requirements and supplier's experience.

Almost all firms have no capital tie-up with both customers and suppliers. Only 12 out of 134 firms have tie-up with suppliers and 15 out of 138 firms with customers. These firms are mainly domestic ones.

Table 7. Business Activities of Customers and Suppliers are Same as Operation

Customer	100	72.46%
Supplier	91	65.94%
Total	138	100%

Figure 11. Main Products are Customized/Standard



Among 82 respondents, 57% of them (Japanese, Korea, Taiwan and other ASEAN firms are dominant) revealed their relationship with supplier normally lasts from 1 to 6 years. Nearly 40% of firms have established a relationship below one year and the same percentage of Japanese investors in Vietnam confirmed this (table 8.1). For local firms (8.2), they have sustainable relationship with customers; 13 out of 56 local firms have sustained relationship with customer for more than seven years. Moreover, more than

50% of local firms have built this relationship in the past three years. This was the time when the concept of supporting industry has started to become popular in Vietnam.

Table 8.1. Duration of Relationship with Customers by Nationality

Nationality	Duration of relationship with supplier (Q14.11_s)					Total
	Below 1 year	1-3 years	4-6 years	7-9 years	above10 years	
Malaysia	0	0	0	0	1	1
Singapore	2	1	1	0	0	4
Other ASEAN	1	1	2	0	0	4
China	2	3	0	0	0	5
Japan	17	9	15	1	1	43
Korea	0	2	1	0	0	3
Taiwan	2	4	2	0	0	8
Other Asian	5	2	2	0	0	9
US	1	0	0	0	0	1
Europe	0	1	1	0	1	3
Others	1	0	0	0	0	1
Total	31	23	24	1	3	82

Table 8.2. Duration of Relationship with Customers by Capital Structure

firm capital structure	Duration of relationship with customers Q14.11_c					Total
	Below 1 year	1-3 years	4-6 years	7-9 years	above10 years	
100% local owned	6	31	6	3	10	56
100% foreign owned	25	18	31	2	3	79
Joint venture	1	1	1	0	0	3
Total	32	50	38	5	13	138

In terms of relationship with customer and supplier, firms have varied answers. Overall, SMEs are a popular form. Large firms are more common among customer firms than among supplier firms.

FDI and joint venture supplier firms rarely use the "just-in-time" system (table 9). Only three customer firms implemented this while 27 out of 131 supplier firms have no plan to implement it. Basically, on-time delivery is the most serious obstacle of Vietnamese firms when dealing with FDI firms and MNCs.

Figure 12. Customer and Supplier Size

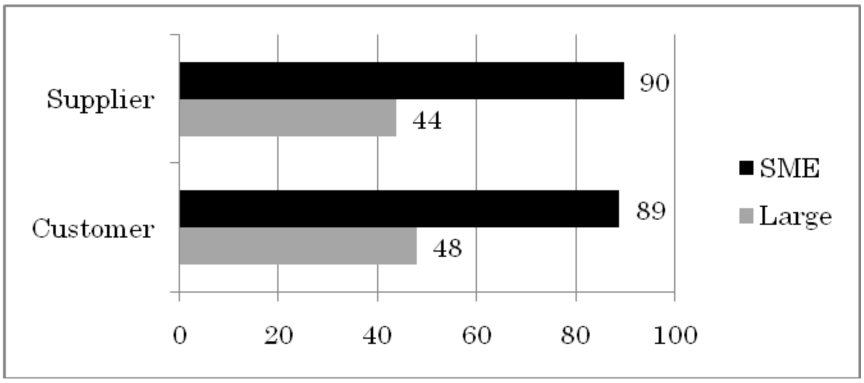


Table 9. Suppliers Adopt "Just-in-time"

Firm capital structure	Suppliers adopt "just-in-time" Q14.8_s				Total
	implemented	planning	No plan	No need	
100% local owned	5	17	19	9	50
100% foreign owned	3	26	35	14	78
Joint venture	0	1	1	1	3
Total	8	44	55	24	131

Firms also support each other in term of human resources (table 9). Of 79 FDI firms, 70 received engineers from their customers whereas only more than a half of local firms (32 out of 56) did. Table 10.1 shows the receipt of engineers from customers classified according to firm size: firms belonging to groups of 50 to 299 employees received the most number of engineers. These firms likely produce supplies.

Table 10.1 Engineer Reversing

Firm capital structure	Receiving engineers from customers Q14.12_c		Total
	yes	no	
100% local owned	32	24	56
100% foreign owned	70	9	79
Joint venture	1	2	3
Total	103	35	138

Table 10.2. Engineer Reversing by Size

firm size	Receiving engineers from customers Q14.12_c		Total
	yes	no	
1-19	5	5	10
20-49	11	10	21
50-99	38	9	47
100-199	20	1	21
200-299	16	3	19
300-399	3	2	5
400-499	1	2	3
500-999	2	1	3
1000-1499	0	1	1
1500-1999	1	0	1
above 2000	6	1	7
Total	103	35	138

Regarding the evaluation of the effects of customers and suppliers to innovation and upgrading, customers generally have the greater impact (figure 13). For 42 of 56 local firms, customer impacts are supposed to be more important (75%) while it is very important for 51 of the 79 (65%) FDI firms. However, FDI firms evaluate the role of suppliers in their innovation higher than local firms do (table 11) as 50 out of 64 FDI firms consider it “very important”. Local firms evaluate the importance at level 2 higher than FDI firms do; therefore, the impact of suppliers on FDI firms seems to be greater than on local firms.

Figure 13. Overall Evaluation on Impacts of Customers and Suppliers to Firm's Innovation and upgrading Activities

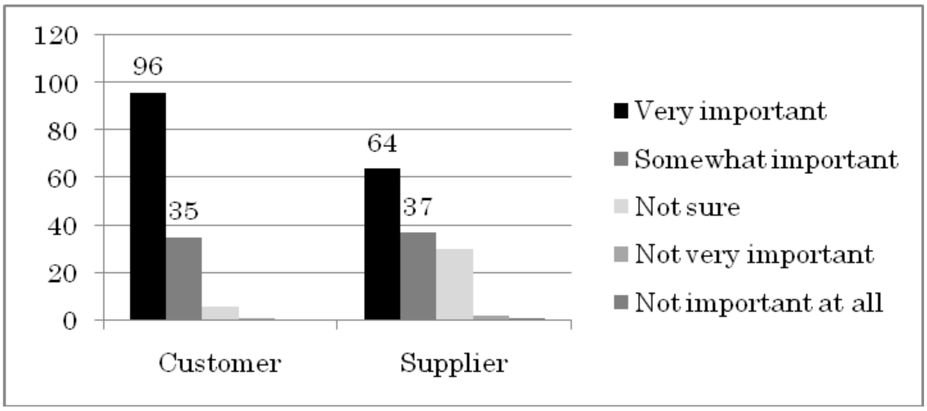


Table 11. Evaluation on Impacts of Customers and Suppliers to Firm's Innovation and Upgrading Activities

Capital structure	Customer Q14.14_c		Supplier Q14.14_s	
	Very important	Somewhat important	Very important	Somewhat important
100% local owned	42	9	13	33
100% foreign owned	51	26	50	3
Joint venture	2	1	1	1
Total	95	36	64	37

2.2.4. Resources for innovation and upgrading

Figure 14 indicates firms do not highly evaluate the importance of having their "own R&D department" (16.1.1) as internal forces for innovation. However, since firms are aware of the role of R&D activities, they rate quite highly the second important level. At present, the "sales department or sales agent (16.1.2), production or manufacturing department (16.1.3)" are supposed to be the main forces for innovation activities. About one-third of the firms find "technological agreement with the headquarters or affiliated firm" as an important force. It is noticeable that all 138 respondents implemented these agreements (table 12).

Figure 14. Source of Internal Information and R&D

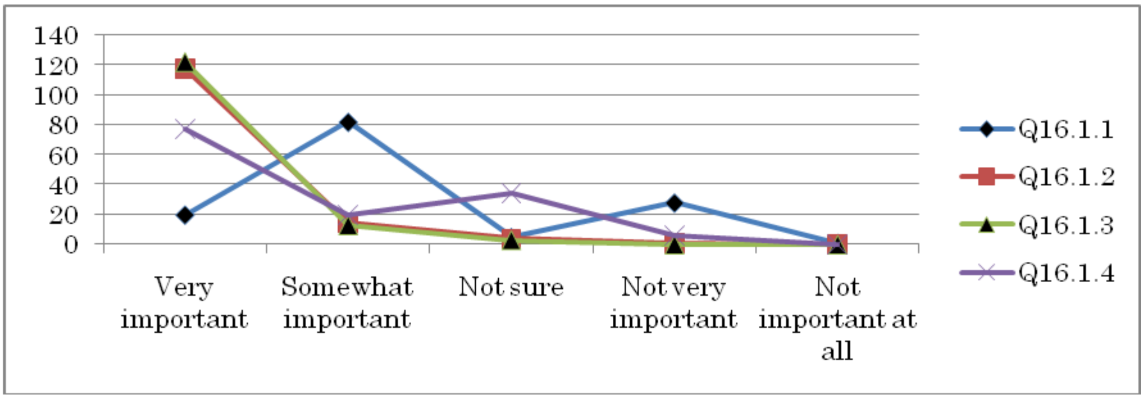


Table 12. Technological Agreement

		Technological agreement Q16.1_4p	Total
		yes, practicing	
	100% local owned	56	56
	100% foreign owned	79	79
	Joint venture	3	3
Total		138	138

Cooperation with local firms is not considered as an upgrading source (figure 15). Accordingly, only "joint venture established by your establishment with other local firms (16.2.1)" is supposed to be "somewhat important". "Local supplier or customer, local competitor local firm in the different business and "Local consultant" are not considered sources of innovation and upgrading. On the other hand, 54 out of 82 FDI firms, especially Japanese ones, affirm they built linkage with Vietnamese firms (table

13). Only 33 out of 56 Vietnamese firms (59%) assume the linkage with local customers. None of respondents firm has linkage or cooperation with local competitors. To sum it up, the linkage ratio is still low.

Figure 15. Technology Transfer from Local Firms/Cooperation with Local Firms

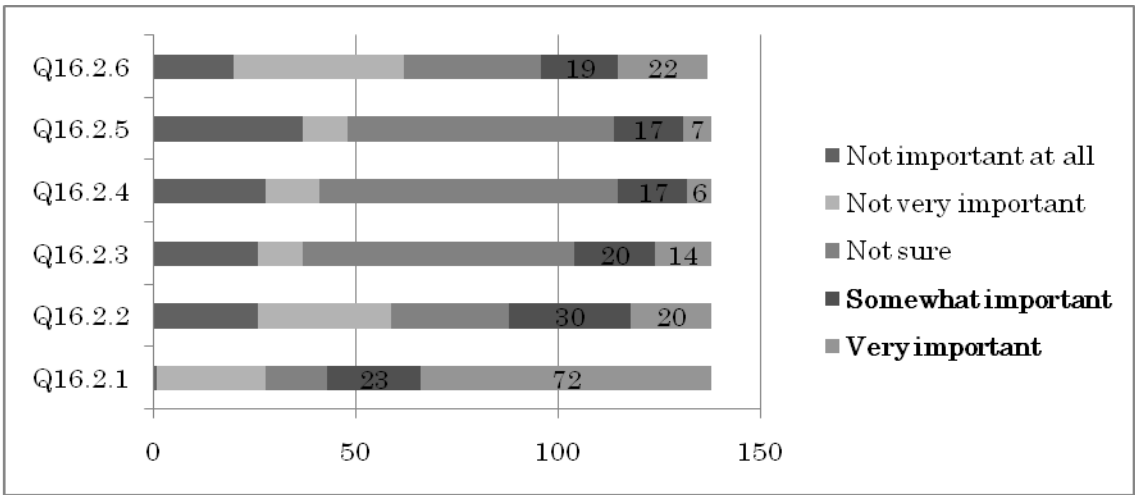


Table 13. Technology Transfer/Cooperation with Local Firms

	Technology Transfer/Cooperation with Local Firms Q16.2_2p		Total
	yes, practicing	no	
Malaysia	0	1	1
Singapore	3	1	4
Other ASEAN	3	1	4
China	1	4	5
Japan	33	10	43
Korea	2	1	3
Taiwan	6	2	8
Other Asia	5	4	9
US	0	1	1
Europe	1	2	3
Other	0	1	1
100% domestic	**33**	**23**	**56**

"Technology transfer from multinational companies (MNCs) or cooperation with

MNCs” is also not considered as a source of innovation (figure 16) whereas “joint venture established by your firm with other foreign-owned firms (16.3.1)” is evaluated very important” by 50% of the firms. As can be seen from table 14, despite the low evaluation on innovative sources from MNCs, local firms (56 in all) cooperated closely with foreign customer firms. Thirty-one firms also indicated cooperating closely with foreign competitor firms.

Figure 16. Technology Transfer from Multinational Companies (MNCs) or Cooperation with MNCs

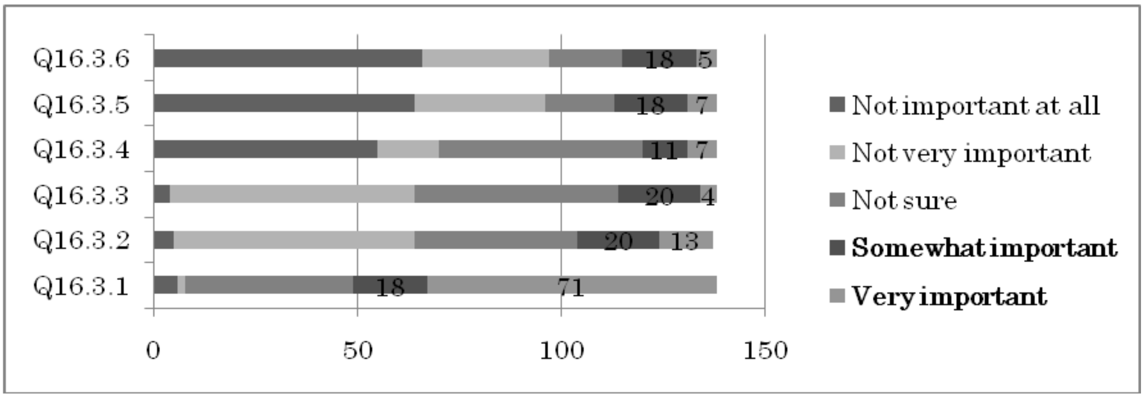


Table 14. Technology Transfer/Cooperation from/with Foreign-own Companies

	yes, practicing	
	Foreign-owned supplier/customer Q16.3_2p	Foreign-owned competitor Q16.3_3p
100% local owned	**56**	**31**
100% foreign owned	79	46
Joint venture	3	2
Total	138	79

“Technical assistances by local support organizations (16.4)” is evaluated “not very important" (figure 17). Only "technical assistance financed/provided by local business organization (16.4.2)" was practiced by 22 out of 137 firms including 9 local and 13 FDI firms (table 15).

Figure 17. Technical Assistances by Local Support Organizations

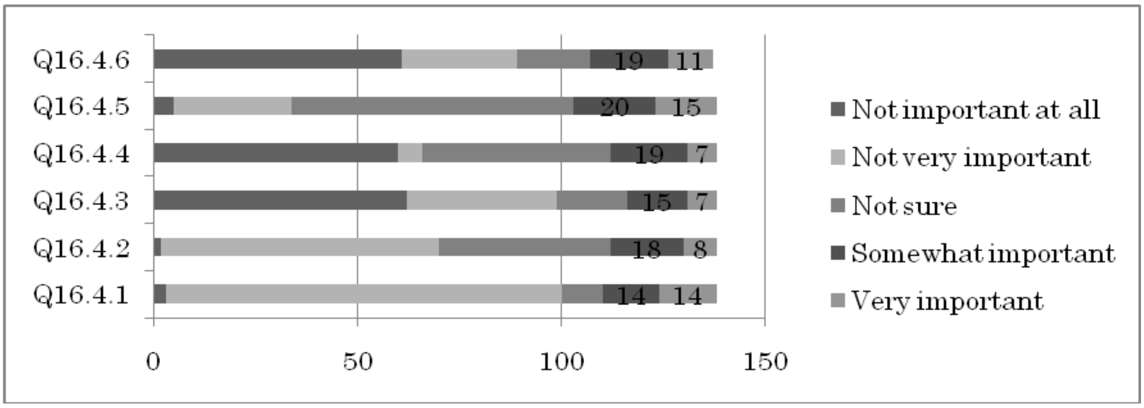
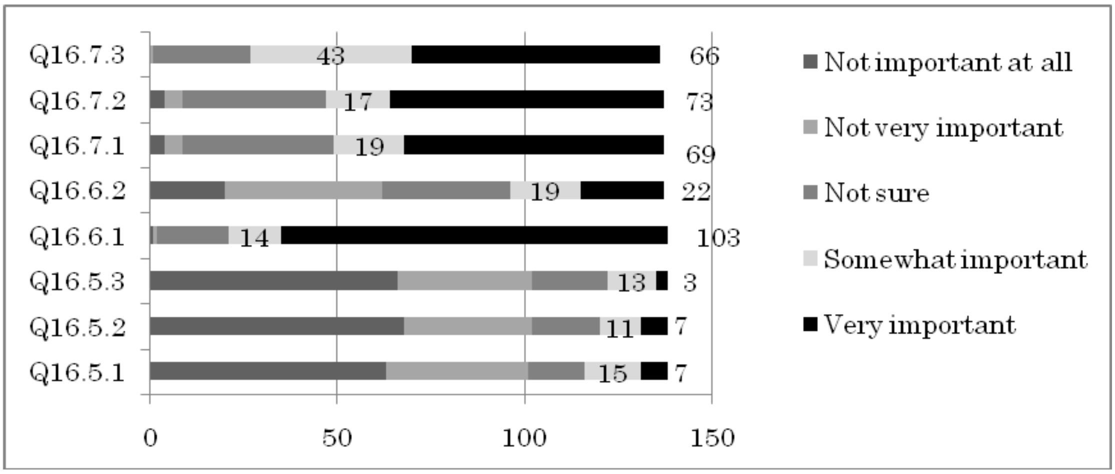


Table 15. Technical Assistance Financed/Provided by Local Business Organization

	Technical assistance financed/provided by local business organization Q16.4_2p		Total
	yes, practicing	no	
100% local owned	9	47	56
100% foreign owned	12	66	78
Joint venture	1	2	3
Total	22	115	137

From Figure 18, it can be seen that although there are large research institutes and universities in Hanoi, firms evaluated this "not very important at all" (16.5). Even "technical cooperation with (or assistance from) foreign university or R&D institute and academic society (16.5.2) and academic journal (16.5.3)" is also seen "not very important at all" to their innovation and upgrading.

Figure 18. Linkages with Universities, R&D Institutes and Academic Societies; Human Resources; and Other Sources of Information and Technologies



Human resources play a very significant role for upgrading. There is a serious lack of mid-class personnel in Vietnam as indicated by 117 out of 138 (85%) respondents that considered "recruitment of mid-class personnel" to be important. Almost all firms (124 out of 138) practiced this recruitment (table 16). As a result, mid-class personnel actually contribute to firm's innovation and upgrading activities. As to local human resources, firms hardly used personnel retired from MNCs and large firms (16.6.2). Firms also evaluate it as not important for innovation and upgrading.

Table 16. Recruitment of Mid-class Personnel

	Recruitment of mid-class personnel Q16.6_1p		Total
	yes, practicing	no	
100% local owned	53	3	56
100% foreign owned	68	11	79
Joint venture	3	0	3
Total	124	14	138

"Other sources of information and technologies" is considered important for innovation (figure 18). "Reverse engineering (16.7.3)" is considered important and very important by 103 out of 138 firms. Additionally, "Technical information obtainable from patents" and "introduction of 'foreign-made' equipment and software" are highly evaluated as sources of innovation. Accordingly, all firms practiced "introduction of 'foreign-made' equipment and software' while 54 out of 138 firms practiced "Reverse engineering".

2.2.5. Important Partner for Innovation and Upgrading

Figure 19 indicates the two most important partners for innovation and upgrading assumed by firms. "Own department, headquarters, affiliates" was evaluated by 58 firms as the most important and by 37 firms as the second most important. "Local firm (customer or supplier)" is the second most important partner. "Other local firms" are mentioned as not very important partner. MNCs or JVs (customer or supplier) are the third most important partner of firms. In addition, "Government, public agencies and local business organizations" are also stated as partner for innovation and upgrading despite the low ratio. Research institutions are not considered as partners of firms in innovation and upgrading.

The most important partners are located far from firms with more than 50% of firms situated "above 200 km" (figure 20). Firms have set up the relationship with these partners for over three years (figure 21).

Figure 19. Important Partners for Innovation and Upgrading

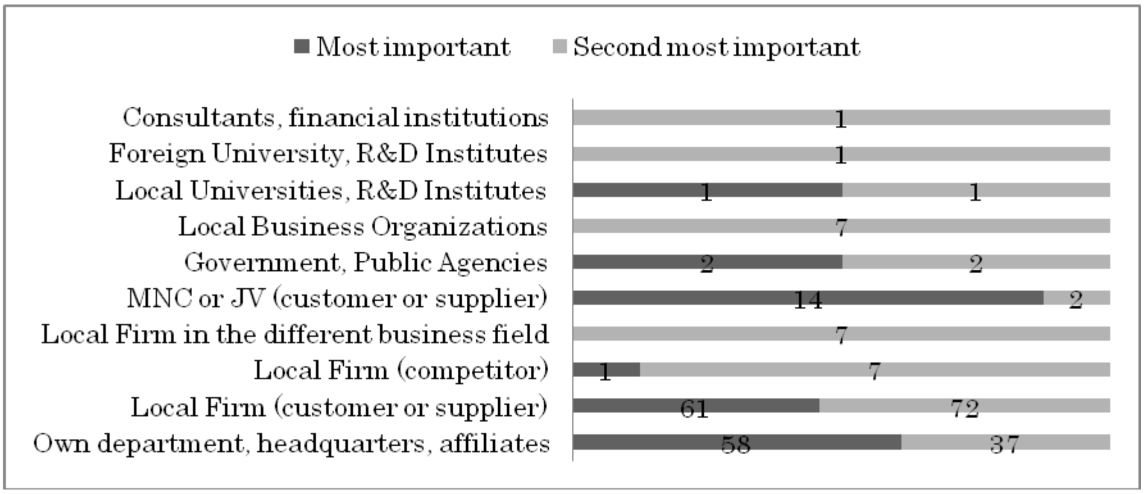


Figure 20. Distance to the Two Most Important Partners

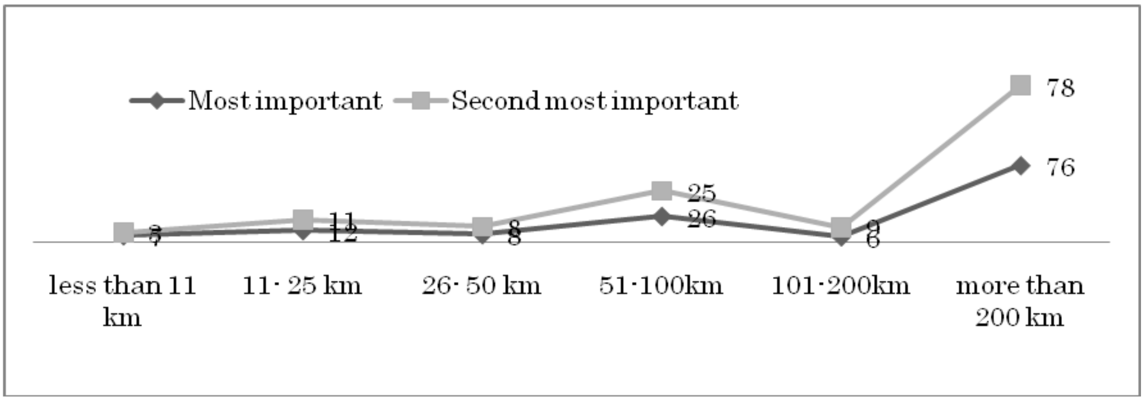
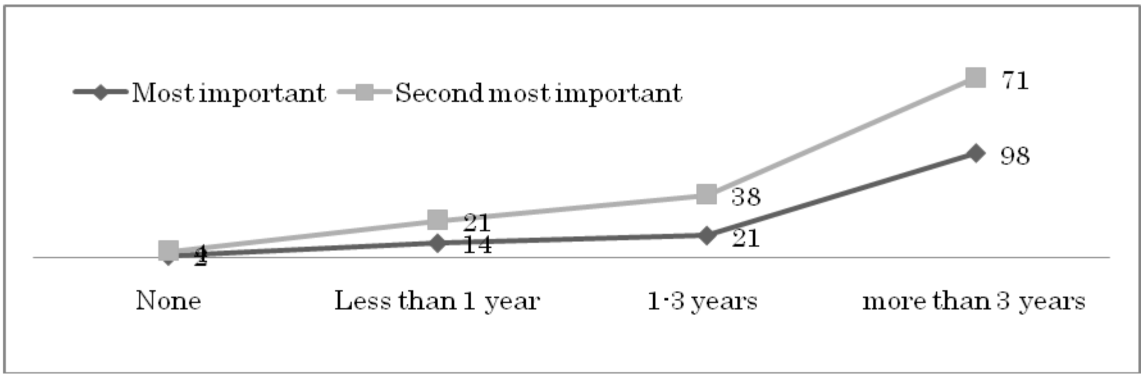


Figure 21. Duration of the Relationship with the Two Most Important Partners



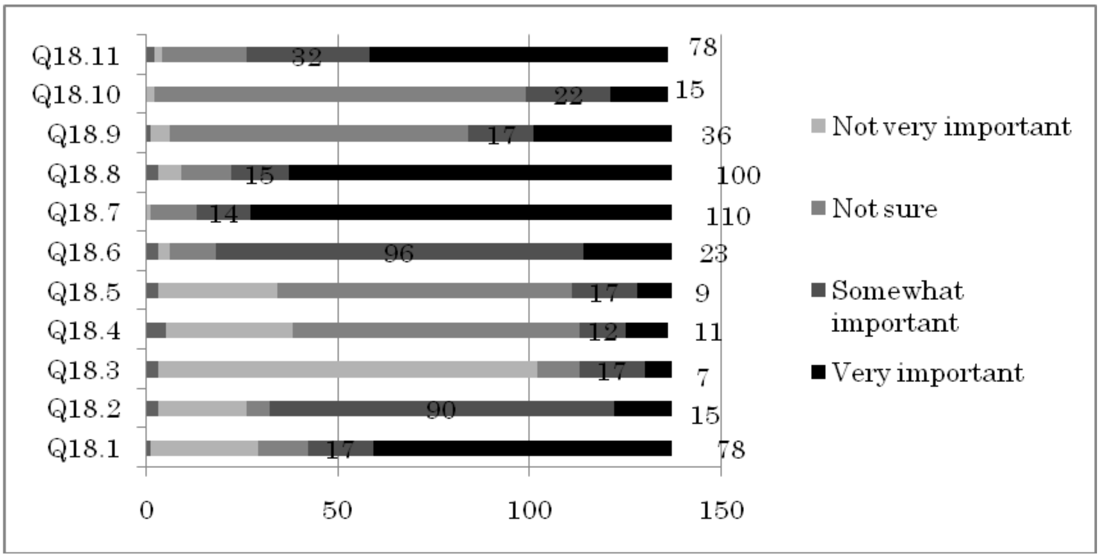
The most serious obstacles for innovation and upgrading related to tax are "high tariffs on equipment and materials necessary for innovation (18.7) and "no tax break or accelerated depreciation system (18.8)" (figure 22).

The second most serious obstacles related to R&D capacity and human resources are 'No R&D supporting industry such as consulting, financing (18.1) and "labor mobility is too rigid for workers to bring with them technologies acquired from previous employer or from previous training" (18.11).

The third most serious obstacle indicated by firms is "protection of intellectual property right (IPR) is not sufficient (18.6)". While laws on these issues existed in Vietnam, violations greatly impact on firm's initiatives to pursue innovation and upgrading.

Issues regarding capacity of research institution (18.3, 18.4, services for R&D development (18.2, 18.5, 18.9, 18.10) do not prevent firms from innovation and upgrading. It is understandable as this capacity of Hanoi is highly evaluated in Vietnam as well as in the region.

Figure 22. Obstacles for Innovation and Upgrading



These obstacles are confirmed by firms in Question 3 with the most serious obstacles for innovation and upgrading (table 17).

Table 17. Obstacles for Innovation and Upgrading

Obstacles for Innovation and Upgrading	Most serious	2nd serious	3rd serious
1. No R&D supporting industry such as consulting, financing.	9	3	5
2. Price of R&D support services is high.	8	7	1
3. No university or public institute in the neighborhood.	0	0	3
4. Technological capabilities of universities or public institutes located in the neighborhood are too weak to collaborate.	0	4	2
5. No business organization or chamber of commerce which can provide training courses, seminar or testing facilities in the neighborhood.	2	2	6
6. Protection of intellectual property right (IPR) is not sufficient.	3	12	13
7. High tariffs on equipments and materials necessary for innovation.	83	29	8
8. No tax break or accelerated depreciation system.	2	62	28
9. My establishment is not familiar with public support programs and procedures to apply for support measures.	1	7	18
10. Public support programs are not designed appropriately for innovation	3	1	3
11. Labor Mobility is too rigid for workers to bring with them technologies acquired from previous employer or from previous training.	26	10	50

2.3. Conclusion

The survey focuses on firms whose capacity and size are supposed to be good in industrial parks. Although firms in the survey are of medium size, their assets are rather large and their technological capacity is not so outdated unlike firms in the previous survey. The limitation of target firms and the use of too detailed subquestions have led to obvious results.

(i) Firm linkage

Some industrial clusters that supply to production firms in Hanoi can be found in the field of mechanics, electronic and plastic.

(ii) Innovation and upgrading of production firms in Hanoi

Overall, firms are not fully aware of the importance of innovation and upgrading for their development. R&D activities have not developed in Hanoi-based firms. While many firms think highly of innovation, they see it as something that cannot be achieved.

Upgrading activities are more popular and specific compared to those in the 2008 survey. Many firms conduct upgrading spontaneously (as need for development arises) without any proper strategy and plan for these activities. At present, upgrading activities of firms are mainly based on the demand of customers and suppliers mostly in Hanoi in which MNC/FDI firms play as key partners.

Firms implement innovation and upgrading by using mainly their internal capacity. External forces are local firms (customers and suppliers), MNC and FDI firms. Other sources of information are rarely used or used in an inefficient way. Although R&D sources in Hanoi are quite strong (according to Part 1 of the reports and evaluation from interviewed firms), firms have not realized the benefits they could get when integrating into the national/local innovation system. This results from the fact that government agencies and supporting organizations have not delivered the necessary activities to enterprises. This also proves that R&D products from the Vietnamese innovation system have not been used to respond to the needs of firms or have not been fully utilized to bring the intended benefits to them, which only leads to waste of national resources. Information and technology for innovation of firms basically comes from outside the country or through the demand of customer MNC/FDI.

Human resources play an important role in innovation and upgrading activities but do not draw much attention of firms. For most firms, the most serious obstacle for innovation and upgrading seems to be the high rigidity of labor mobility for workers constraining them to bring the technologies they acquired from previous employer or from previous training.

(iii) Main empirical findings

From the mail survey, we come to following findings:

- Firms have not realized the benefits of innovation and upgrading. There is lack of full awareness of the necessity for innovation and upgrading in business operations. In addition, firms have not realized the motivation for linkage causing the poor business linkage.
- Linkage between and among firms and research institutions has not been formed. The activities of these government agencies have not met the firm’s demand.
- The government has not proposed incentive policies for R&D and upgrading activities of firms. In addition, the market providing R&D services in Vietnam has not been developed yet.
- The impact of production linkage on upgrading is small and almost all sources of information/technology are external.

2.4. Recommendations

2.4.1. National recommendation

- Raise awareness
  - Raise awareness of linkage and innovation in production using a systemic way such as by supporting and implementing training programs for local firms.
  - Make enterprises recognize the benefits of innovation for firm’s development
  - Improve knowledge about standard quality of product/production (JIT, 5S…) and
  - IPR
- Build business linkage
  - Support the linkage among local firms, between local and MNC/FDI firms, MNC and domestic firms through sectoral programs for supporting industry (parts and components of mechanics, plastic and electronics).
  - Connect firms with research institutions by promoting the research results of institutes and universities to firms.
- Develop state policies on innovative activities
  - Come up with state policies related to innovative activities such as tax and relevant cost reduction.
  - Develop market providing R&D activities.
- Provide finance for innovation

- Spend budget for S&T to deploy research works in companies; import and transfer technology to production firms, etc.
- Raise public funds for innovative firms.
- Promote venture capital funds.

- <u>Build human resources for innovation</u>
  - Develop human resources for firm's innovation such as employment for management, engineers, skilled workers, etc.
  - Enhance educational and vocational training system.
  - Take advantage of "silver consultant program."[i]

- <u>Develop supporting industry</u>
  - Support the development of supporting industry by building a system of part and semi-product quality standard.
  - Construct centers for evaluating and testing the quality of supporting products.
  - Attract MNC/FDI production firms to Vietnam as well as develop their linkage with local firms.
  - Assist in building linkages among local firms to enhance their production capacity (cluster formulation).
  - Develop projects on supporting industries; connect firms in the same industry from different nations to share experiences in production; form production linkage; link to MNCs as well as to innovation and upgrading.

- Call for the participation and assistance of large Japanese assembling groups and suppliers to invest in late-coming countries in the region where labor and transportation are advantages.
- Construct a regional database on the processes and systems of firms that produce parts and semi-products in fundamental supporting industries such as mechanics, plastic or electronics.

2.4.2. Objective and actions

- Objective

+Utilize the regional production network for market-based innovations of firms

+ Exchange human resources (HR) within countries

+Create information resources for the R&D activities of firms

+ Improve the effectiveness of regional research organizations

- Actions needed to achieve these objectives

+ Utilize the regional production network for market-based innovations of firms

- Develop supporting industries such as automotive, electronics, garments and food processing.
- Encourage Japanese assembling groups and suppliers to invest in ASEAN.
- Build regional standard systems on products/semi-products.
- Maintain regional databases on production networks.

+ Exchange HR within countries

- Exchange HR among similar culture and language.
- Find HR with lower cost but with higher skills level than China.
- Provide “regional labor license” for high-skilled workers.
- Promote free movement of high-skilled workers in core industries within the region.
- Link to the “silver consultant program” in Japan.

+Create information resources for the R&D activities of firms

- Conduct research on technological demand of (sectoral) firms in the region.
- Build programs on transferring appropriate technologies from preceding countries to latecomers in the region.
- Declare a regional IPR policy.

+ Improve the effectiveness of regional research organizations

- Conduct an evaluation of the capacity of research organizations in the region.
- Create inter-cooperation of research organizations in each country to meet the R&D demands of firms.

NOTES

[i] Japan's Silver Human Resource Center (SHRC) program provides retiree as part-time, paid employment for developing countries.

5

Linked versus Non-linked Firms in Innovation: The Effect of Economies of Network in East Asia

Tomohiro Machikita, Shoichi Miyahara, Masatsugu Tsuji, and Yasushi Ueki

Abstract

This paper proposes a new mechanism linking innovation and network in developing economies to detect explicit production and information linkages and investigates the empirical implications of these linkages using survey data gathered from manufacturing firms in the Indonesia, Thailand, Philippines, and Vietnam. In a model consisting of heterogeneous firms with R&D activity and linkages, the more productive firms achieve greater variety of innovations than less productive firms and successfully introduce new goods to market. Only the most productive firms introduce new goods produced using new technologies to new markets. Linkages with local firms, foreign firms, and public organizations play a role in reducing the search costs of finding new suppliers and customers. We found that firms with more information linkages tend to innovate more, have a higher probability of introducing new goods, introducing new goods to new markets using new technologies, and finding new partners located in remote areas. We also found that firms that dispatched engineers to customers achieved more innovations than firms that did not. These findings support the hypothesis that production linkages and face-to-face communication encourage product and process innovation.

1. INTRODUCTION

This paper proposes a new mechanism linking innovations (product and process innovation and creation of new markets) and networks in developing economies to identify explicit linkages between production and information. It also investigates the empirical implications of this new mechanism using survey data gathered from manufacturing firms in four megacities in East Asia. Our sampling countries and cities are Indonesia (JABODETABEK area, i.e., Jakarta, Bogor, Depok, Tangerang and Bekasi), the Philippines (CALABARZON area, i.e., Cavite, Laguna, Batangas, Rizal, and Quezon), Thailand (Greater Bangkok area), and Vietnam (Hanoi area). We collected firm-level evidence on innovations, linkages between production and information, and the respondent-firms' own characteristics using mail surveys and field interviews.

Why the particular focus on East Asia? The production network in East Asia contrasts with the innovation system in the European Union (EU) and the United States (U.S.) where universities and research institutes form the core of research and development (R&D) networks. Evidence from East Asia indicates a new role of production networks in the upgrading of industry. The approach we will take to find the answers is simple descriptive statistics and regressions.

In a model consisting of heterogeneous firms with R&D activity and linkages, the more productive firms introduce more innovations than less productive firms and are more successful in introducing new goods to market, with only the most productive firms able to introduce new goods and technologies in new markets. Linkages with local and foreign firms and public organizations help reduce the cost of finding new suppliers and customers. Firms with more information linkages tend to innovate more and are more likely to introduce new goods and technologies in new markets as well as find new partners in remote areas. These findings support the hypothesis that production and information linkages stimulate product and process innovation.

This paper also discusses the impact of small and hypothetical subsidies on the extent of upgrading knowledge-exploiting and knowledge-creation (or knowledge-exploring) activities for firms in production networks. Likewise, it discusses the policy implications of these findings and some theoretical background to evaluate the extent of production-related knowledge on industry upgrading.

There is a dearth of empirical researches that precisely capture the knowledge-transmission mechanism through inter-firm communication. There is also a lack of quantitative evidence that rigorously identifies the effects on product innovation of production-related knowledge based on process innovation or creation of new markets. Since we need to quantify the contribution of production networks on innovation, this paper collects detailed information about production linkages, product and process innovation, and creation of new markets. This field survey-based information provides findings that are lacking in previous studies.

Most of the previous studies on the effects of geographic proximity on innovation used the local average of R&D expenditures or the number of R&D engineers as explanatory variable. These studies assumed that all firms in a local area benefit equally from the local average of R&D activities in their empirical specification. Even if this assumption were plausible on average, it is natural that the role of knowledge flows on production linkages and volume of interactions would vary among linkages. That is why we have to go beyond geographic proximity, collect information about linkages directly, and carefully investigate the effects of each type of production linkage on innovation.

To examine the role of local production linkages on product innovations, we need to identify the extent of companies' investment in R&D, the exact channels used to upgrade existing products, the geographic extent of new-market creation, and the emergence of local alliances to introduce a new product. We will build a simple model to explain the large variation of product innovation across firms with and without R&D activities or multiple production linkages. This simple theoretical framework will be based on the reduced-form regression model and will provide some interpretations of the empirical estimates of the effect of two factors, i.e., the variety of production linkages and engineer-level communications, on innovations. Estimating the empirical elasticity of production linkages or microlevel communications on innovation would enable us to detect the exact channels of process and product innovations and creation of new markets.

How do agglomeration economies affect firm-level productivity and any changes in this productivity? How does agglomeration affect productivity and growth in developing economies? How do geographic variations in competitiveness stimulate technological spillovers and enhance firm and industry performance? In the era of globalization, which entails reduction of trade costs across nations, the importance of geographic concentration of economic activities within a country has been growing. The main reason for this is the combination of globalization and technologies that promote increasing returns to scale (IRS). Globalization pushes industries that use IRS technologies to relocate to a small number of countries where many consumers, input suppliers, and other supporting industries are already in place. Manufacturing firms, particularly those in IRS-technology industries, are concentrated not only in a limited number of countries but also in limited geographical areas within a country. Globalization and economic integration make markets denser and more competitive. Reduction in costs of cross-border trade forces manufacturing firms in developing countries to upgrade and innovate their products and processes.

This paper will investigate the role of production networks on industry upgrading by documenting the spatial architecture of upstream and downstream firms in developing economies and examining the network effects of innovations. Local network externalities are a mechanism for understanding the relationship between production networks and innovation. Lucas (1988) identified local knowledge spillovers as important sources of economic growth. Glaeser, Kallal, Scheinkman, and Shleifer (1992) showed city-level evidence of the role of knowledge spillovers. Conley and Udry (2009) studied the role of communication networks in determining the importance of learning from others.

This paper also focuses on production networks to quantify the extent to which information flows with customers or suppliers motivate a firm to innovate. The lack of empirical studies and the potential heterogeneity in production- network availability provide several empirical questions about the effects of innovation networks. The specific question we are trying to answer is how production networks affect firms' incentive to innovate when interfirm linkages become dense. Do firms tend to innovate more if their innovation linkages are concentrated in single source or if their innovation sources are heterogeneous? How do firms innovate if communication with their suppliers increases? Should firms respond to information flows from their consumers? This paper empirically explores these questions.

To summarize our introduction, we present the following two statistical findings that this paper will attempt to explain. These findings are basically consistent with the network-based theory of agglomeration and innovation.

(1) There is positive effect or correlation between the variety of linkages and the variety of innovations for firms with no R&D activities while there is no significant effect for firms with R&D activities.

(2) Firms with face-to-face communications at the engineer level and firms with frequent interactions with production partners are successful in implementing innovations, particularly organizational reform toward external markets and process innovations like

creation of new markets and securing new sources of input.

The next section contains a simple model from which we will derive testable hypothesis and an empirical strategy. Data will be described in Section 3 while the measurement of the innovation network and its spatial architecture will be discussed in Section 4. Empirical results are examined in Section 5. The interpretation of the main results and the concluding remarks are in Sections 6 and 7, respectively.

2. RELATED LITERATURE

2.1. Why Firms Agglomerate

We combine two different literatures to investigate the effects of production networks on innovation and upgrading. First, we review agglomeration economies to define the effects of production networks on a firm's performance. Second, we survey firms' product and process innovation responses to tougher market competition.

There are three kinds of forces in agglomeration economies: (1) technological externalities; (2) pecuniary externalities; and (3) competition-based selection process. The first two forces often produce knowledge and information spillovers across firms, sharing of the same intermediate goods and labor pooling (the Marshallian "thick market" effect), and IRS on the local input-output level.

Rosenthal and Strange (2004) provide a fully comprehensive review of the causes and consequences of agglomeration economies. In a recent attempt to quantify agglomeration economies, Ellison, Glaeser, and Kerr (2009) find the significant contribution of input-output linkages to coagglomeration patterns instead of natural advantage which played a dominant role in previous studies, such as that done by Ellison and Glaeser in 1999. Through these linkages, producers in denser areas are able to obtain positive impacts from agglomeration economies.

Greenstone, Hornbeck, and Moretti (2008) present clear evidence of agglomeration spillovers in a local area, focusing on the local cost linkages between customers and suppliers to test the agglomeration-induced productivity effect. They used the "Million Dollar Plant" (i.e., a large, new manufacturing plant like Mercedes Benz or Toyota) in winning and losing counties as evidence. The corporate real estate journal Site Selection includes an article titled "The

Million Dollar Plant" that describes how a large plant decided where to locate. This article presents not only the county where the "Million Dollar Plant" chose to locate (the "winning county") but also one or two "runner-up" counties (the "losing counties").

In the absence of an actual plant opening, they use the total factor productivity (TFP) of incumbent plants in losing counties as a counterfactual for the TFP of incumbent plants in winning counties. They examine agglomeration spillovers by estimating the impact of the opening of "The Million Dollar Plant" on the TFP of incumbent plants in the same county. The empirical result is consistent with theories of agglomeration and shows that the opening of the new plant induces incumbent plants in winning counties to experience a significant and sharp relative increase in TFP compared to incumbent plants in losing counties five years after plant opening.

The last force involves the competition-driven selection process of agglomeration. Denser markets here often mean markets with greater substitutability. It is relatively easier for inefficient producers in denser areas to lose their market share and exit the market than producers in less dense areas. Consequently, the average productivity of firms in denser markets is always higher. To consider this effect, Syverson (2004) provides a simple and novel starting point. The specific mechanism Syverson raised is the spatial substitutability in single product market, i.e., relatively inefficient producers find it more difficult to operate profitably when it is easier for consumers to change suppliers within a local area.

Combes, Duranton, Gobillon, Puga, and Roux (in progress) present an empirical framework to distinguish the agglomeration spillover effects of productivity from the selection effects of (average) productivity improvement. This model suggests that the stronger or tougher selection effect in denser markets left-truncates the productivity distribution while stronger or positive agglomeration effect right-shifts the productivity distribution.

2.2. How Firms Innovate in Low-wage Countries

Tougher market competition arising from globalization and economic integration spurs firms to be innovative to escape price competition. The main aim of this research is to identify the procompetitive effects of trade liberalization on the incentive to innovate.

Bloom, Draca, and Van Reenen (2008) find positive impacts of increases in Chinese imports on European firms' investment in the use of information technology (IT) and their innovation (based on patent counts). However, using datasets from emerging economies, Gorodnichenko, Svejnar, and Terrell (2008) find a negative association between firms' subjective perception on the toughness of competition and innovation. Teshima (2008) distinguishes process innovation from product innovation when market competition becomes tougher. He utilizes new information about process and product innovation from Mexican plant-level datasets to estimate the effects of tariff changes on changes in expenditures for process and product R&D. He finds that increased competition arising from the reduction of tariffs causes an increase in total R&D expenditures for plants and process R&D rather than product R&D. This result suggests that trade liberalization stimulates firms to be cost-efficient, not necessarily to produce new varieties of products.

Additionally, Brambilla (2006) compares the performance of foreign and domestic firms in terms of the introduction of new varieties using firm-level data for the Chinese manufacturing sector during the country's export boom period of 1998-2000. The empirical result implies that firms with more than 50 percent foreign ownership create more than twice as many new varieties of products as private domestic firms. Foreign firms are superior to domestic firms in terms of fixed cost of development and variable cost of operation. This productivity difference between foreign and domestic firms also explains the difference in the number of new product varieties released.

2.3. What is the Benefit of Linkages?

To determine the relationship between economies of agglomeration and innovations, we investigate the role of linkages between firms and their economies of network. If applicable to our context, economies of network can be broken down into the following three categories: (1) production network; (2) transportation network and other network of utilities; and (3) innovation network. We will also consider why industries are agglomerated in a specific space, mostly a hub/node of such networks.

In addition to the traditional arguments for economies of agglomeration (input-output linkages, labor market pooling, and idea spillovers), a town's reputation in the global supply chains and the world market also plays big role in developing economies (Banerjee and Duflo, 2005). Firms in the auto parts industry, for example, may be able to find a better partner in the Eastern Seaboard area, which contains the largest agglomeration of auto industry firms in East Asia, than in other areas in Thailand or other East Asian countries. Firms in the Eastern Seaboard area are familiar with the Just-In-Time (hereafter JIT) delivery system and have a reputation for providing high-quality auto parts. Such collective reputation among producers in developing economies invites new entrants into the agglomeration.

A town's reputation is formed by the nexus of linkages or production processes between firms. If many producers have a good reputation for quality and timeliness, local and global buyers will flock to the area for high-quality goods. Other firms may ask for new and more complex products. This is the key point of industry upgrading for local firms in developing economies. Everybody benefits from producers that have linkages to local and foreign markets. Collective reputation matters especially for young producers and those located in non-established clusters. This paper will try to find the innovation impact of linkages in concentrated areas in order to pinpoint the positive and negative externalities of collective reputation in developing economies.

2.4. The Role of MNEs

We should not forget about the presence of multinational enterprises (hereafter, MNEs) in developing economies, especially in East Asia. Since Japanese MNEs have led the formation of production networks in the region, the relationship between production networks and innovation intensity and its type should be varied according to the degree of firms' capital tie-up with MNEs.

In Indonesia and Thailand, Ramstetter and Sjoholm (2006) try to answer the following empirical questions: (1) why multinationals pay higher wages than their counterparts in their host countries and whether the entry of multinationals raise wages for domestic workers; (2) why multinationals have higher productivity and whether multinationals affect the productivity of domestic enterprises; (3) whether multinationals have a greater tendency to export than local firms. This paper investigates the role of MNEs in associating cluster-based production networks with innovation.

The empirical questions we raise are based on Ramstetter and Sjoholm's work (2006). First, do MNEs or joint-venture firms enjoy communications with customers or suppliers located in neighboring or remote areas and do such communications with MNEs or joint-venture firms increase the innovations done by local firms with connections to foreign capital firms? Second, do MNEs or joint-venture firms tend to introduce new goods or create new markets and do product and process innovations made by MNEs or joint-venture firms intensify innovations done by domestic firms?

3. DATA

We used the dataset from the Establishment Survey on Innovation and Production Network for selected manufacturing firms in four countries in East Asia. We created this dataset in December 2008 in Indonesia, the Philippines, Thailand, and Vietnam. The sample population is restricted to selected manufacturing hubs in each country (JABODETABEK area for Indonesia, CALABARZON area for the Philippines, Greater Bangkok area for Thailand, and Hanoi area for Vietnam). A total of 600 firms agreed to participate in the survey: (1) 149 firms in Indonesia; (2) 203 firms in the Philippines; (3) 112 firms in Thailand; and (4) 137 firms in Vietnam.

Table 1 shows the number of observations by industry and country. The pooled dataset from the four countries also suggests that the following industries have either more than or approximately 5 percent share of our survey: apparel (105 firms), food processing (80 firms), chemical products (59 firms), electronics (54 firms), metal (37 firms), auto (32 firms), wood products (31 firms), machinery (30 firms), and paper products (27 firms).

Table 1. Number of Observations by Industry and Country

		Pooled sample			Indonesia			Philippines			Thailand			Vietnam		
		Freq.	Percent	Cum.	Freq.	Percent	Cum.	Freq.	Percent	Cum.	Freq.	Percent	Cum.	Freq.	Percent	Cum.
1	Food	80	13.31	13.31	25	16.78	16.78	35	17.24	17.24	15	13.39	13.39	5	3.65	3.65
2	Apparel	105	17.47	30.78	36	24.16	40.94	43	21.18	38.42	17	15.18	28.57	9	6.57	10.22
3	Wood	31	5.16	35.94	16	10.74	51.68	7	3.45	41.87	4	3.57	32.14	4	2.92	13.14
4	Paper	27	4.49	40.43	13	8.72	60.4	5	2.46	44.33	4	3.57	35.71	5	3.65	16.79
5	Coal	3	0.5	40.93	1	0.67	61.07		N.A.		2	1.79	37.5		N.A.	
6	Chemical	59	9.82	50.75	5	3.36	64.43	21	10.34	54.68	15	13.39	50.89	18	13.14	29.93
7	Nonmetal	9	1.5	52.25		N.A.		8	3.94	58.62		N.A.		1	0.73	30.66
8	Iron	24	3.99	56.24	7	4.7	69.13	5	2.46	61.08	1	0.89	51.79	11	8.03	38.69
9	Nonferrous	1	0.17	56.41		N.A.		1	0.49	61.58		N.A.			N.A.	
10	Metal	37	6.16	62.56	2	1.34	70.47	16	7.88	69.46	11	9.82	61.61	8	5.84	44.53
11	Machinery	30	4.99	67.55	2	1.34	71.81	8	3.94	73.4	5	4.46	66.07	15	10.95	55.47
12	Computers	6	1	68.55		N.A.		1	0.49	73.89	4	3.57	69.64	1	0.73	56.2
13	Electronics	54	8.99	77.54	2	1.34	73.15	30	14.78	88.67	2	1.79	71.43	20	14.6	70.8
14	Precision	6	1	78.54		N.A.		1	0.49	89.16	1	0.89	72.32	4	2.92	73.72
15	Auto	32	5.32	83.86	4	2.68	75.84	12	5.91	95.07	8	7.14	79.46	8	5.84	79.56
16	Transport	8	1.33	85.19	2	1.34	77.18	1	0.49	95.57	3	2.68	82.14	2	1.46	81.02
17	Other	89	14.81	100	34	22.82	100	9	4.43	100	20	17.86	100	26	18.98	100
	Total	601	100		149	100		203	100		112	100		137	100	

Table 2 presents the summary statistics of the main variables. The average age of a firm is 14 years, with a standard deviation of 12 years. Firm size is also much dispersed. Average size is 293 employees, with a standard deviation of 456. Since our sampling strategy covers whole manufacturing in each country, some firms have more than 2,000 employees while some firms are very small, with less than 20 employees.

Of the total number surveyed, approximately 60 percent are local firms; 13 percent, joint-venture firms; and 25 percent, MNEs.

A firm's function is classified into any one of five categories here. Forty-six percent of the firms process raw materials. Twenty-eight percent produce components and parts while 71 percent produce final goods. A total of 24 percent procure raw materials while and 43 percent do marketing activities.

Table 2. Summary Statistics

	Obs	Mean	Std. Dev.	Min	Max
Age	589	14.2020	12.3921	0	80
Full-time Employees	602	293.8787	456.4826	10	2000
Local Firms	605	0.6165	0.4866	0	1
Joint Venture Firms	605	0.1322	0.3390	0	1
Multinational Enterprise	605	0.2512	0.4341	0	1
Production (raw material processing)	605	0.4628	0.4990	0	1
Production (components and parts)	605	0.2810	0.4499	0	1
Production (final products)	605	0.7124	0.4530	0	1
Procurement of raw materials, parts, or supplies	605	0.2496	0.4331	0	1
Marketing, sales promotion	605	0.4331	0.4959	0	1
R&D activities (1 if Yes, 0 otherwise)	605	0.2215	0.4156	0	1
Food	605	0.1322	0.3390	0	1
Apparel	605	0.1736	0.3790	0	1
Wood	605	0.0512	0.2207	0	1
Paper	605	0.0446	0.2067	0	1
Coal	605	0.0050	0.0703	0	1
Chemical	605	0.0975	0.2969	0	1
Nonmetal	605	0.0149	0.1212	0	1
Iron	605	0.0397	0.1953	0	1
Nonferrous	605	0.0017	0.0407	0	1
Metal	605	0.0612	0.2398	0	1
Machinery	605	0.0496	0.2173	0	1
Computers	605	0.0099	0.0992	0	1
Electronics	605	0.0893	0.2853	0	1
Precision	605	0.0099	0.0992	0	1
Auto	605	0.0529	0.2240	0	1
Transport	605	0.0132	0.1143	0	1
Other	605	0.1471	0.3545	0	1

We also collected information about the firms' subjective evaluation of their current internal and external environment and their assessment of their present situation compared with the previous year's (2007). Seventy-seven percent of the firms said that the quality of products improved. Nearly 70 percent said that production defects were reduced. However, many firms in East Asia have to hurdle a number of challenges: (1) increase the value of exports; (2) increase the value of exports to developed countries; and (3) increase the number of export destinations. Less than 20 percent of sample firms felt they could achieve these export-market successes.

Table 2. Summary Statistics (Continued)

	Obs	Mean	Std. Dev.	Min	Max
Sales amount increases (1 if Yes, 0 otherwise)	605	0.5603	0.4968	0	1
Profit increased (1 if Yes, 0 otherwise)	605	0.4992	0.5004	0	1
Number of employees increased (1 if Yes, 0 otherwise)	605	0.3719	0.4837	0	1
Value of exports increased (1 if Yes, 0 otherwise)	605	0.2430	0.4292	0	1
Value of exports to developed countries increased (1 if Yes, 0 otherwise)	605	0.1884	0.3914	0	1
Number of export destination increased (1 if Yes, 0 otherwise)	605	0.1752	0.3805	0	1
Productivity of operation improved (1 if Yes, 0 otherwise)	605	0.6314	0.4828	0	1
Quality of products improved (1 if Yes, 0 otherwise)	605	0.7752	0.4178	0	1
Product defects were reduced (1 if Yes, 0 otherwise)	605	0.6992	0.4590	0	1
Production cost decreased (1 if Yes, 0 otherwise)	605	0.4545	0.4983	0	1
Lead-time was reduced (1 if Yes, 0 otherwise)	605	0.5785	0.4942	0	1

Table 2 also presents our main interests: innovations and linkages. We classified innovations into the following three categories: (1) product innovation (introduction of new goods); (2) process innovations, including adoption of new technology and organizational changes to improve product quality and cost efficiency; and (3) securing new customers to sell to, and new suppliers to produce existing products for, efficiently.

While approximately 45 percent of the sample firms, on average, are able to do product innovations in general, it appears that more firms find it difficult to achieve certain kinds of product innovations. Only 9 percent said they were able to introduce new goods to new markets, while only 11 percent of were able to introduce new goods using new technology. This situation may be due to the higher fixed costs of creating new markets and using new technology in addition to the typical costs associated with product innovations.

In contrast, more than 50 percent of the firms were able to introduce process innovations, such as (1) buying new machines; (2) improving existing machines; (3) introducing new know-how on production processes; (4) earning certification from the International Standards Organization (ISO); and (5) introducing internal activities to respond to changes in the markets.

Table 2. Summary Statistics (Continued)

	Obs	Mean	Std. Dev.	Min	Max
Number of Types of Innovations	605	8.9702	4.9134	0	21
Number of Types of Product Innovations	605	0.6711	0.8704	0	3
Number of Types of Process Innovations in Production Method	605	1.7521	1.2199	0	3
Number of Types of Securing New Supplier	605	2.5488	2.0611	0	7
Number of Types of Securing New Customer	605	2.7421	2.1282	0	7
Number of Types of Organizational Changes	605	1.4694	1.1979	0	3
Introduction of New Good	605	0.4579	0.4986	0	1
Introduction of New Good to New Market	605	0.0959	0.2947	0	1
Introduction of New Good with New Technology	605	0.1174	0.3221	0	1
Bought New Machines	605	0.5289	0.4996	0	1
Improved Existing Machines	605	0.6727	0.4696	0	1
Introduced New Know-how on Production Methods	605	0.5504	0.4979	0	1
Adopted an international standard (ISO or others)?	605	0.5306	0.4995	0	1
Introduced ICT and reorganized business processes?	605	0.3421	0.4748	0	1
Introduced other internal activities to respond to changes in the market?	605	0.5967	0.4910	0	1

Firms reported different experiences in the task of securing new customers and suppliers depending on the locations and characteristics of the customers and suppliers. The probability of securing a new local supplier or customer in a metropolitan area in which the respondent is also located is higher (63 percent for securing a new supplier and 65 percent for securing a new customer) than the probability of securing a new supplier or customer outside the metropolitan area (56 percent for securing a new supplier and 58 percent for securing a new customer). Securing a new supplier or customer in other ASEAN countries is more difficult for the four countries involved in the study (32 percent for securing a new supplier and 27 percent for securing a new customer). Sample firms also found it difficult to buy inputs from, or sell products to, MNEs. Only 17 percent of the firms successfully secured new multinational suppliers within a metropolitan area while only 16 percent were able to do so outside the metropolitan area. Between the two tasks, however, firms found it easier to sell products to MNEs than to buy inputs from them. Nearly 30 percent of the firms successfully secured new multinational customers within an agglomeration area, while 21 percent did so outside.

Table 2. Summary Statistics (Continued)

	Obs	Mean	Std. Dev.	Min	Max
Secured a new local supplier (100% local capital) in survey city	605	0.6364	0.4814	0	1
Secured a new local supplier (100% local capital) in the country outside survey city	605	0.5669	0.4959	0	1
Secured a new Multinational Company (MNC) (100% foreign capital) or joint venture (JV) supplier in survey city	605	0.1736	0.3790	0	1
Secured a new MNC or JV supplier in the country outside survey city	605	0.1620	0.3687	0	1
Secured a new supplier in other ASEAN countries	605	0.3273	0.4696	0	1
Secured a new supplier in other countries in East Asia (China, Japan, Korea, Taiwan)	605	0.3802	0.4858	0	1
Secured a new supplier in other foreign countries	605	0.3025	0.4597	0	1
Secured a new local customer (100% local capital) in survey city	605	0.6529	0.4764	0	1
Secured a new local customer (100% local capital) in the country	605	0.5802	0.4939	0	1
Secured a new MNC or JV customer in survey city	605	0.3074	0.4618	0	1
Secured a new MNC or JV customer in the country	605	0.2182	0.4134	0	1
Secured a new customer in other ASEAN countries	605	0.2711	0.4449	0	1
Secured a new customer in other countries in East Asia (China, Japan, Korea, Taiwan)	605	0.3471	0.4764	0	1
Secured a new customer in other foreign countries	605	0.3653	0.4819	0	1

The distribution of linkages is also presented in Table 2. The most striking evidence of technical transfer is that production-related linkages are more cultivated than intellectual linkages. For example, collaboration with joint ventures established by a sample firm with other local firms and collaboration with a local supplier or customer were done by 32 percent and 41 percent of the firms, respectively.

On the other hand, 27 percent of the firms accepted technical assistance financed or provided by a government or public agency while 23 percent engaged in technical-cooperation projects with a local university. Technology transfer between firms is prevalent, and University-Industry Linkages (hereafter, UIL) does not play a key role in technology transfer in East Asia.

Table 2. Summary Statistics (Continued)

	Obs	Mean	Std. Dev.	Min	Max
Number of Linkages	605	8.0645	8.7827	0	26
Number of Production Linkages	605	5.8926	5.8841	0	17
Number of Intellectual Linkages	605	2.1719	3.4574	0	9
Number of Internal Sources	605	1.9174	1.6019	0	4
Joint venture established by your firm with other local firms	605	0.3256	0.4690	0	1
Local supplier or customer (100% local capital)	605	0.4116	0.4925	0	1
Local competitor (Firms in the same business which is neither supplier nor customer)	605	0.2364	0.4252	0	1
Local firm in the different business which is neither supplier nor customer	605	0.2264	0.4189	0	1
Licensing technologies from other local firms	605	0.4479	0.4977	0	1
Local consultant hired by your firm	605	0.2331	0.4231	0	1
Joint venture established by your firm with other foreign-owned firms	605	0.3835	0.4866	0	1
Foreign-owned (or multinational) supplier or customer	605	0.4496	0.4979	0	1
Foreign-owned competitor (Firms in the same business which is neither supplier nor customer)	605	0.3207	0.4671	0	1
Foreign-owned firm in the different business which is neither supplier nor customer	605	0.2942	0.4561	0	1
Licensing technologies from other MNCs	605	0.2364	0.4252	0	1
International consultant hired by your firm	605	0.1934	0.3953	0	1
Recruitment of mid-class personnel	605	0.5587	0.4970	0	1
Recruitment of personnel retired from MNCs and large firms	605	0.2430	0.4292	0	1
Technical information obtainable from patents	605	0.3620	0.4810	0	1
Introduction of “foreign-made” equipment and software	605	0.5091	0.5003	0	1
Reverse engineering	605	0.4612	0.4989	0	1
Technical assistance financed/provided by government/public agency	605	0.2777	0.4482	0	1
Technical assistance financed/provided by local business organization	605	0.3025	0.4597	0	1
Research consortium organized with the support of government	605	0.2347	0.4242	0	1
Research consortium organized with the support of local business organization	605	0.2248	0.4178	0	1
Business consortium organized with the support of government	605	0.2364	0.4252	0	1
Business consortium organized with the support of local business organization	605	0.2331	0.4231	0	1
Technical cooperation with (or assistance from) local university or R&D institute	605	0.2331	0.4231	0	1
Technical cooperation with (or assistance from) foreign university or R&D institute	605	0.2165	0.4122	0	1
Academic society and academic journal	605	0.2132	0.4099	0	1
Own R&D department	605	0.3388	0.4737	0	1
Own Sales department or sales agent	605	0.4479	0.4977	0	1
Own production or manufacturing department	605	0.6182	0.4862	0	1
Technological agreement with the headquarters or affiliated firm	605	0.5124	0.5003	0	1

Table 2. Summary Statistics (Continued)

	Obs	Mean	Std. Dev.	Min	Max
Main Customer makes Customized Good (1 if Yes, 0 otherwise)	605	0.6380	0.4810	0	1
Geographic Proximity to Customer (km)	584	400.0685	438.0871	5	1000
JIT with Customer (1 if Yes, 0 otherwise)	605	0.4512	0.4980	0	1
Capital Tie-up with Customer (1 if Yes, 0 otherwise)	605	0.1074	0.3099	0	1
Duration of the Relationship with Customer (year)	590	6.4119	3.4889	0.5	10
Accept Engineers from Customer (1 if Yes, 0 otherwise)	605	0.3388	0.4737	0	1
Dispatch Engineers to Customer (1 if Yes, 0 otherwise)	605	0.2149	0.4111	0	1
Customer is Important Partner for Innovation	605	0.6678	0.4714	0	1
Main Supplier makes Customized Good (1 if Yes, 0 otherwise)	605	0.5537	0.4975	0	1
Geographic Proximity to Supplier (km)	545	343.4183	413.1761	5	1000
JIT with Supplier (1 if Yes, 0 otherwise)	605	0.3620	0.4810	0	1
Capital Tie-up with Supplier (1 if Yes, 0 otherwise)	605	0.1124	0.3161	0	1
Duration of the Relationship with Supplier (year)	570	6.2333	3.5869	0.5	10
Accept Engineers from Supplier (1 if Yes, 0 otherwise)	605	0.2727	0.4457	0	1
Dispatch Engineers to Supplier (1 if Yes, 0 otherwise)	605	0.1702	0.3762	0	1
Supplier is Important Partner for Innovation	605	0.1174	0.3221	0	1

Many firms also rely on internal sources for information on upgrading and innovation. Thirty-four percent of the surveyed firms depend on their own R&D departments as a source of information and R&D initiatives while 38 percent utilize their own sales departments and sales agents as information sources. Fifty-one percent use technological agreements with headquarters or affiliated firms; 62 percent look to their own production and manufacturing departments when undertaking upgrades.

Industries in the sample are primarily involved in manufacturing and exporting and are currently operating in East Asia. To keep pace with domestic demand and stay on top of international competition, the firms adopt new technology, acquire new organizational form to adapt to market changes, create new markets, find new inputs to improve product quality and cost efficiency, and introduce new products. They utilize the external environment and local/international markets to upgrade themselves. Therefore, it is reasonable to say that they are more likely to adapt new technology and undertake organizational changes in response to the external environment and the demands made by their respective local and international markets. Tables 3 and 4 show the variety of innovations and linkages across countries and industries, respectively.

There is a large cross-sectional dispersion of innovations not only across countries but also across industries within a country. The variety of innovations for each firm is the sum of product innovations, process innovations including organizational changes, and securing new customers and suppliers at firm-level. The variety of linkages here is the sum of sources of information and new technology for each firm. The sample average (median) of variety of innovations for the pooled dataset is 8.96 (9) and the standard deviation is 4.91. Firms in Thailand and Vietnam are above the sample average (median) of innovations: 12.07 (12) and 10.83 (12), respectively. Standard deviations of innovations across firms within each country are 4.58 for Thailand and 3.6 for Vietnam.

The variety of linkages is also quite different across countries. The sample average (median) of linkages is 8.04 (6) for the pooled dataset. The standard deviation of linkages is quite high at 8.77. Firms in the Philippines only have 1.9 linkages on average while firms in Thailand have an average of 19 linkages. Indonesian firms have 7.63 linkages; Vietnamese firms, 8.62. The dispersion in linkages may be explained by the difference in the composition of industries across countries and the difference in the nature of production networks across industries. However main industries are concentrated in food processing and apparel (textile and garment) in each country, there is a large dispersion of linkages across countries for food processing and apparel.

Table 3. Number of Innovations by Industry and Country

		Pooled sample					Indonesia					Philippines					Thailand					Vietnam				
		Mean	Median	S.D.	Min	Max	Mean	Median	S.D.	Min	Max	Mean	Median	S.D.	Min	Max	Mean	Median	S.D.	Min	Max	Mean	Median	S.D.	Min	Max
1	Food	8.07	8	4.91	0	21	5.48	4	4.16	0	15	8.11	8	5.03	0	21	11.2	11	4.2	5	20	11.4	12	1.52	9	13
2	Apparel	6.29	6	4.68	0	21	5.5	4.5	3.45	0	15	4.4	4	3.95	0	17	11.35	11	4.24	4	21	8.89	8	5.51	0	18
3	Wood	6.87	7	3.58	0	13	6.81	6	3.62	0	13	6.14	5	5.24	0	13	7.25	7	1.26	6	9	8	8	1.83	6	10
4	Paper	9.7	9	4.46	2	21	7.92	8	3.8	2	16	11.2	12	2.59	8	14	13.25	13.5	6.85	5	21	10	12	4.3	5	15
5	Coal	12.67	13	0.58	12	13	13	13	.	13	13			N.A			12.5	12.5	0.71	12	13			N.A		
6	Chemical	10.37	11	4.14	2	21	9	8	4.47	4	15	9.1	8	3.99	2	19	11.87	11	4.85	4	21	11	12.5	3.27	4	14
7	Nonmetal	8.44	8	5.64	1	19			N.A			8.63	8.5	6	1	19			N.A			7	7	.	7	7
8	Iron	8.42	8.5	4.7	0	17	6.29	6	5.5	0	17	7.6	10	5.77	0	13	7	7	.	7	7	10.27	9	3.44	5	17
9	Nonferrous	6	6	.	6	6						6	6	.	6	6			N.A					N.A		
10	Metal	12	12	4.99	0	20	5	5	2.83	3	7	9.94	10	4.95	0	20	16.82	17	2.79	11	20	11.25	11.5	1.58	9	14
11	Machinery	10.8	12.5	4.37	1	17	14	14	1.41	13	15	8.63	7	6.48	1	17	10.4	11	1.95	8	13	11.67	13	3.52	4	16
12	Computers	12.33	14	6.89	3	20			N.A			14	14	.	14	14	10	9.5	7.16	3	18	20	20	.	20	20
13	Electronics	10.63	10	3.57	1	19	7	7	0	7	7	10.2	9.5	4.33	1	19	11	11	2.83	9	13	11.6	12	1.96	7	14
14	Precision	10.67	12	3.39	6	14			N.A			7	7	.	7	7	11	11	.	11	11	11.5	13	3.7	6	14
15	Auto	10.25	10.5	5.71	0	21	9.5	10.5	3.11	5	12	7.5	6	5.79	0	19	16.13	15.5	3.83	11	21	8.88	8	4.26	4	16
16	Transport	10.38	10	3.46	6	17	10.5	10.5	2.12	9	12	11	11	.	11	11	12.67	12	4.04	9	17	6.5	6.5	0.71	6	7
17	Other	8.78	8	5.02	1	21	5.85	5	4.49	1	21	6.67	5	4.33	2	15	11.1	12	4.29	4	20	11.54	12	4.08	1	20
	Total	8.96	9	4.91	0	21	6.44	6	4.14	0	21	7.84	8	5.01	0	21	12.07	12	4.58	3	21	10.83	12	3.6	0	20

Table 4. Number of Linkages by Industry and Country

		Pooled sample					Indonesia					Philippines					Thailand					Vietnam				
		Mean	Median	S.D.	Min	Max	Mean	Median	S.D.	Min	Max	Mean	Median	S.D.	Min	Max	Mean	Median	S.D.	Min	Max	Mean	Median	S.D.	Min	Max
1	Food	6.86	4	8.41	0	26	8.32	7	6.9	0	20	2.69	0	5.81	0	26	13.4	12	11.86	0	26	9.2	9	0.84	8	10
2	Apparel	6.67	3	8.56	0	26	5.86	5.5	5.22	0	20	0.58	0	1.56	0	8	22.18	26	6.9	6	26	9.67	10	1.5	8	12
3	Wood	6.74	4	8.87	0	26	5.38	2.5	7.87	0	26	0.86	0	2.27	0	6	21	26	10	6	26	8.25	9	1.5	6	9
4	Paper	8.22	6	8.4	0	26	7.08	5	6.17	0	20	0	0	0	0	0	23.5	26	5	16	26	7.2	7	1.3	6	9
5	Coal	6.67	4	4.62	4	12	4	4	.	4	4			N.A			8	8	5.66	4	12			N.A		
6	Chemical	10.05	8	10.1	0	26	14.6	12	11.13	1	26	4	0	8.15	0	26	19.2	26	11.53	0	26	8.22	8	1.52	6	12
7	Nonmetal	3.44	0	5.34	0	15			N.A			2.75	0	5.26	0	15			N.A			9	9	.	9	9
8	Iron	7.96	8	7.96	0	26	13.29	10	12.37	0	26	1.4	0	3.13	0	7	0	0	.	0	0	8.27	8	1.56	6	11
9	Nonferrous	0	0	.	0	0	N.A					0	0	.	0	0			N.A					N.A		
10	Metal	9.7	7	9.98	0	26	7.5	7.5	0.71	7	8	1.13	0	2.83	0	11	23.91	24	1.22	22	26	7.88	8	1.46	6	10
11	Machinery	8.17	9	7.1	0	26	17.5	17.5	10.61	10	25	0.88	0	2.47	0	7	12.4	11	11.84	0	26	9.4	10	1.55	7	11
12	Computers	9	5.5	10.77	0	26			N.A			0	0	.	0	0	11	9	12.68	0	26	10	10	.	10	10
13	Electronics	6.65	7	7.08	0	26	13.5	13.5	3.54	11	16	4.03	0	7.87	0	26	16	16	14.14	6	26	8.95	9	1.96	6	14
14	Precision	10.33	8.5	8.64	0	26			N.A			0	0	.	0	0	26	26	.	26	26	9	8.5	2.16	7	12
15	Auto	7.75	6	9.66	0	26	9.25	5.5	11.47	0	26	0	0	0	0	0	17.88	26	11.39	0	26	8.5	8.5	2.14	6	12
16	Transport	12.13	7.5	10.29	0	26	15	15	15.56	4	26	0	0	.	0	0	17.33	20	10.26	6	26	7.5	7.5	0.71	7	8
17	Other	10.01	8	9.07	0	26	6.65	5.5	6.82	0	26	0	0	0	0	0	22.3	26	8.16	0	26	8.42	8.5	1.65	5	12
	Total	8.04	6	8.77	0	26	7.63	6	7.49	0	26	1.89	0	5.11	0	26	19	26	9.97	0	26	8.62	9	1.68	5	14

4. CHARACTERISTICS OF LINKED VERSUS NON-LINKED FIRM'S INNOVATIONS

Innovative activities reflect several dimensions of industry upgrading. There is no single measure to evaluate the success or failure of a firm's policy of industry upgrading. We drew up four different groups of measures: new goods, adoption of new technologies and organizational structure, new source of procurement, and creation of new markets. We map out the firm's linkage to innovations and present univariate comparisons of the outcome of the innovations with the status of the linkages.

4.1. New Varieties

Our first measure is the number and percentage of firms introducing new goods. We define "linked" and "non-linked" firms by the level of median linkages and found that there is no significant difference between linked and non-linked firms in terms of introducing new goods. Linked firms have different sources of information compared with non-linked firms when they develop and introduce new goods. If the cost of introducing new goods decreased as a function of the variety of linkages, linked firms would have an advantage in the area of product innovations. Panel A of Table 5 suggests that there is no significant evidence that a linked firm's success in introducing new goods can be compared with a non-linked firm's results based on mean and median differences. There is also no significant evidence that a linked firm's outcome in introducing new goods in a new market and new goods based on new technologies can be compared with non-linked firm's.

4.2. Adoption of New Technologies and Organizational Structure

Aside from product innovations, the most striking evidence of industry upgrading is the implementation of plant-level process innovations. It was assumed that linked firms tend to invest in process innovations if production-related linkages reduced the cost of buying new machines, maintaining existing ones, and changing a firm's organizational form or structure. But contrary to the above-mentioned assumption, Panel B of Table 5 suggests that the percentage of improved existing machines is actually lower for linked firms than non-linked firms. It was found that there are no significant differences between linked and non-linked firms in terms of buying new machines and introducing new know-how on production methods, although non-linked firms seem to implement more process innovations.

These results suggest that it is easy for stand-alone firms to reorganize machine-based production processes. As expected, linked firms are able to implement more organizational changes than non-linked firms, and their success can be traced to getting ISO certification, using information and communication technologies (ICT), and introducing internal activities aimed at responding to changes in the market.

4.3. New Sources of Input

Finding new sources of inputs, raw materials, and parts could help upgrade production processes and product quality and reduce production costs. Ultimately, it could also result in new product varieties because it would help firms find new, possibly more cost-efficient, and higher-quality types of inputs. This measure can be considered as a market-based innovation.

Panel B of Table 5 suggests that the probability of finding new suppliers is higher for linked firms than non-linked firms. Firms with many linkages could use these existing linkages to procure new inputs. A firm's direct linkages provide information not only about its partners but also its partner's linkages (this includes both the partner's partners and its competitors). If a firm's direct linkages increase, its indirect linkages will also increase.

The probability of securing new local suppliers within a firm's immediate location and in nearby areas are also higher for linked firms than non-linked firms. Linked firms enjoy both local and global linkages and are more likely to secure new multinational suppliers within and outside of a concentrated area.

Linked and non-linked firms differ in their importing activities as well. Linked firms have more advantages in terms of securing new international suppliers than non-linked firms when they decide to import new parts and materials. If the importation of new parts and materials from a particular country is too costly, a firm's linkages can help it to partially overcome this challenge by making it easier for the firm to seek a new supplier in other countries.

4.4. Creation of New Markets

Finally, creation of new markets also reflects a firm's upgrading behavior. Our first question here is whether or not existing linkages could help a firm create a new market for existing and new goods. Our second and similar question is whether or not existing linkages could help create a new international market. Panel D of Table 5 presents the difference between linked and non-linked firms in creating new markets.

Linked firms tend to secure new domestic customers more than non-linked firms. In particular, linked firms are able to secure new local customers within the area where they and the new customers are both located. Linked firms also tend to find new multinational customers in areas near where they (the linked firms) operate.

There is large difference between the ability of linked and non-linked firms to export to markets in East Asia (but outside the ASEAN), the EU, and U.S. and their ability to export to ASEAN countries alone. This suggests that their linkages actually help linked firms meet the challenge and difficulties of exporting to distant markets.

Table 5. Innovation Outcomes by Linkages and Mean Differences

	All	Linkages: Under Median	Linkages: Over Median	t-Statistics
Number of Types of Innovations	8.970	7.142	10.878	-10.101
	A. Product Innovations			
Number of Product Innovations	0.671	0.628	0.716	-1.249
Introduction of New Good	0.458	0.440	0.476	-0.893
Introduction of New Good to New Market	0.096	0.084	0.108	-1.000
Introduction of New Good with New Technology	0.117	0.104	0.132	-1.077

Table 5. Innovation Outcomes by Linkages and Mean Differences (Continued)

	All	Linkages: Under Median	Linkages: Over Median	t-Statistics
	B. Process Innovations			
Number of Types of Process Innovations in Production Method	1.752	1.832	1.669	1.643
Bought New Machines	0.529	0.557	0.500	1.395
Improved Existing Machines	0.673	0.706	0.639	1.757
Introduced New Know-how on Production Methods	0.550	0.570	0.530	0.967
Number of Types of Organizational Changes	1.469	1.159	1.794	-6.758
Adopted an international standard (ISO or others)?	0.531	0.430	0.635	-5.145
Introduced ICT and reorganized business processes by it?	0.342	0.246	0.443	-5.200
Introduced other internal activities to respond to changes in the market?	0.597	0.482	0.716	-6.030

Table 5. Innovation Outcomes by Linkages and Mean Differences (Continued)

	All	Linkages: Under Median	Linkages: Over Median	t-Statistics
	C. Securing New Suppliers			
Number of Types of Securing New Supplier	2.549	1.893	3.233	-8.446
Secured a new local supplier (100% local capital) in survey city	0.636	0.515	0.764	-6.577
Secured a new local supplier (100% local capital) in the country outside survey city	0.567	0.472	0.666	-4.876
Secured a new Multinational Company (MNC) (100% foreign capital) or joint venture (JV) supplier in survey city	0.174	0.110	0.240	-4.271
Secured a new MNC or JV supplier in the country outside survey city	0.162	0.117	0.209	-3.122
Secured a new supplier in other ASEAN countries	0.327	0.207	0.453	-6.657
Secured a new supplier in other countries in East Asia (China, Japan, Korea, Taiwan)	0.380	0.259	0.507	-6.482
Secured a new supplier in other foreign countries	0.302	0.214	0.395	-4.953

Table 5. Innovation Outcomes by Linkages and Mean Differences (Continued)

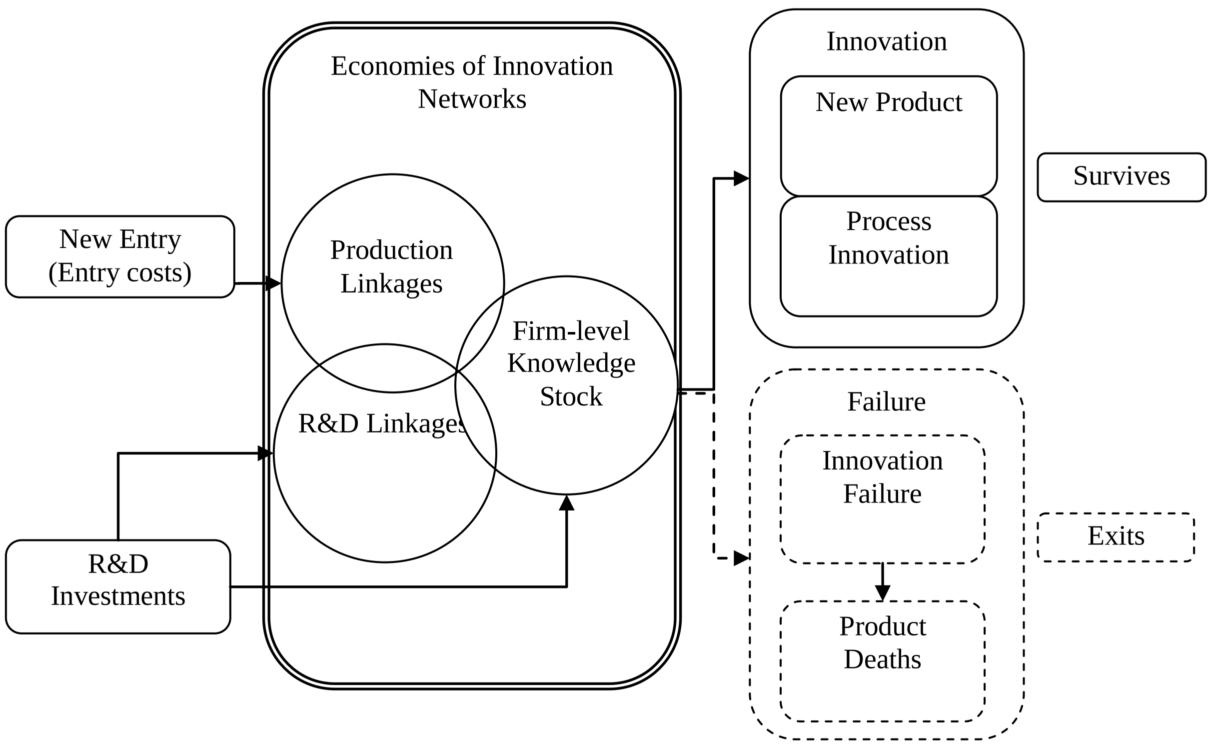
	All	Linkages: Under Median	Linkages: Over Median	t-Statistics
	D. Securing New Customers			
Number of Types of Securing New Customer	2.742	1.819	3.706	-12.157
Secured a new local customer (100% local capital) in survey city	0.653	0.518	0.794	-7.440
Secured a new local customer (100% local capital) in the country	0.580	0.443	0.723	-7.251
Secured a new MNC or JV customer in survey city	0.307	0.126	0.497	-10.758
Secured a new MNC or JV customer in the country	0.218	0.126	0.314	-5.737
Secured a new customer in other ASEAN countries	0.271	0.175	0.372	-5.575
Secured a new customer in other countries in East Asia (China, Japan, Korea, Taiwan)	0.347	0.191	0.510	-8.736
Secured a new customer in other foreign countries	0.365	0.239	0.497	-6.802

5. DETERMINANTS OF INNOVATION FAILURE AND SUCCESS

5.1. The Variety of Innovations

In this section, we present the effects of linkages on innovations. Figure 1 suggests our theoretical framework. The univariate comparison reports in the last section do not control for factors that explain the success or failure of innovations. In this section, too, we present the results of the multivariate test that controls for the country differences and other firm characteristics, such as capital structure, age, number of employees, function, and R&D activities. We report the determinants of the variety of innovations. Table 6 presents the baseline results of the impacts of linkages on innovations. The dependent variable is the variety of innovations, i.e., the sum of product innovations, process innovations including organizational changes, and securing new customers and suppliers. The variety of innovations is approximated by normal distribution. Ordinary regression model was used to explain the variety of innovations.

Figure 1. A Framework of Product and Process Innovation



Note: Given local innovation system and firm's exogenous productivity, each firm chooses to the number of information linkages and frequency of commuting to partner to maximize present value of firm.

The independent variables include the following explanatory variable: number of linkages is calculated by the sum of firm's production linkages and intellectual linkages. Rigorously speaking, we count the number of *types* of linkages. If the firm has a linkage to a local or foreign customer or supplier, we count that as *one* type of local or foreign production linkage. In addition, if the firm has a linkage to local or foreign university, we also count that as another type of local or foreign intellectual linkage. This means that such a firm has two types of linkages. "Multinational Enterprises" is a dummy variable equal to one for a firm that is wholly funded by foreign capital. Multinationals can access global technology frontiers and belong to international markets. This is not only a proxy of financial advantages for innovations but also a proxy of technology advantages compared with local firms.

Age and employment size are also attributes of innovations. Aged firms have a history of established production linkages and accumulated innovations. There is also a difference in the types of innovations and innovation investments that large and small/medium firms make. Cross-country differences can be attributed to the fundamental differences in the causes and consequences of innovations in response to market conditions.

The results are reported in Table 6. The coefficient for the variety of linkages is .189 with standard error of .027; it is statistically significant at the 1 percent level. Firms with more types of linkages implement significantly more innovations than firms with fewer types of linkages, even after one controls for capital structure, age, size, and country differences. We separately estimate the innovation impacts of the variety of linkages by R&D activities because there is a strong correlation between R&D activities and the variety of linkages. The coefficient for the variety of linkages is .161 with standard error of .041 for firms with R&D activities and .161 with standard error of .031 for firms without R&D activities. Both of them are statistically significant at the 1 percent level. The effects of being an MNE and the size of the firm are significant. The variety of innovations achieved cannot be attributed to differences in the age of the sample firms. Cross-country differences in the variety of innovations are apparent: firms in Indonesia and the Philippines innovate less than those in Thailand. This sample also reflects the difference between less developed countries in East Asia like Indonesia and the Philippines and more developed countries like Thailand. There is no significant difference between Vietnam and Thailand.

Table 6. Number of Linkages and Number of Innovations by R&D

OLS	(1)	(2)	(3)
Dependent variables: Number of Innovations	All	With R&D	Without R&D
Number of Linkages	**0.189****	**0.161****	**0.161****
	[0.027]	**[0.041]**	**[0.031]**
Multinational Enterprises	1.635**	-0.129	2.431**
	[0.464]	[1.267]	[0.518]
Age	0.030+	0.039	0.005
	[0.017]	[0.027]	[0.021]
Full-time Employees	0.003**	0.003**	0.002**
	[0.000]	[0.001]	[0.000]
Indonesia	-3.925**	-3.502**	-3.688**
	[0.570]	[1.077]	[0.718]
Philippines	-1.725**	-0.837	-2.346**
	[0.663]	[0.979]	[0.821]
Vietnam	0.08	0.355	-0.292
	[0.628]	[1.204]	[0.793]
Constant	7.363**	9.111**	7.527**
	[0.647]	[0.961]	[0.811]
Observations	587	128	459
R-squared	0.35992	0.30877	0.35505

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 7 presents the impacts of different types of linkages on innovations: (1) the number of production linkages with customers, suppliers, and other linkages made through the labor market and the equipment supply chain; (2) the number of intellectual linkages with universities, research institutes, business organizations, and public support agencies; (3) the number of the sample firms' internal resources. The Production linkages, intellectual linkages, and internal resources are also positive and have a significant impact on the variety of innovations at the 1 percent level. More than production and intellectual linkages, however, the innovations could be attributed to internal resources.

Table 7. Number of Linkages and Number of Innovations by R&D

OLS	(1)	(2)	(3)	(4)
Dependent variables: Number of Innovations	All	All	All	All
Number of Linkages	**0.189****			
	[0.027]			
Number of Production Linkages		**0.283****		
		[0.039]		
Number of Intellectual Linkages			**0.428****	
			[0.074]	
Number of Internal Resources				**0.989****
				[0.134]
Multinational Enterprises	1.635**	1.619**	1.697**	1.908**
	[0.464]	[0.462]	[0.471]	[0.451]
Age	0.030+	0.029+	0.032+	0.026
	[0.017]	[0.017]	[0.017]	[0.017]
Full-time Employees	0.003**	0.003**	0.003**	0.002**
	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-3.925**	-4.104**	-4.181**	-4.113**
	[0.570]	[0.538]	[0.608]	[0.583]
Philippines	-1.725**	-1.933**	-2.214**	-2.431**
	[0.663]	[0.630]	[0.688]	[0.630]
Vietnam	0.08	-0.862	1.007	-0.951
	[0.628]	[0.595]	[0.742]	[0.608]
Constant	7.363**	7.601**	7.870**	7.605**
	[0.647]	[0.605]	[0.686]	[0.642]
Observations	587	587	587	587
R-squared	0.35992	0.36141	0.3431	0.36584

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

It is natural that the innovation impacts of linkages are different among the types of function. Table 8 reports the effects of linkages on the variety of innovations by the firms' functions. First, the coefficient for the variety of linkages is .293 with a standard error of .063 for firms with procurement functions. Second, the coefficient for the variety of linkages is .249 with a standard error of .038 for firms with a marketing department. Third, the coefficient for the variety of linkages is .239 with a standard error of .037 for firms that produce raw materials. Finally, the coefficients for the variety of linkages are also positive and significant for firms that do final assembly and parts production, although the volume is less than that for the functions of producing raw materials, parts procurement, and marketing.

Table 8. Number of Linkages and Number of Innovations by Functions

OLS	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables: Number of Innovations Last 3 years	All	Raw materials	Parts	Final Assembling	Procurement	Marketing
Number of Linkages	**0.189****	**0.239****	**0.162****	**0.191****	**0.293****	**0.249****
	[0.027]	**[0.037]**	**[0.045]**	**[0.037]**	**[0.063]**	**[0.038]**
Multinational Enterprises	1.635**	2.406**	1.810*	1.428**	-0.332	2.691**
	[0.464]	[0.645]	[0.834]	[0.535]	[0.976]	[0.549]
Age	0.030+	0.046+	0.016	0.048*	-0.026	0.037*
	[0.017]	[0.024]	[0.034]	[0.019]	[0.049]	[0.018]
Full-time Employees	0.003**	0.002**	0.002**	0.002**	0.005**	0.003**
	[0.000]	[0.001]	[0.001]	[0.000]	[0.001]	[0.001]
Indonesia	-3.925**	-3.874**	-5.053**	-3.797**	-4.518**	-2.814*
	[0.570]	[1.112]	[1.110]	[0.772]	[1.667]	[1.261]
Philippines	-1.725**	-1.531	-2.117	-1.488	0.606	1.411
	[0.663]	[1.187]	[1.343]	[0.912]	[1.770]	[1.361]
Vietnam	0.080	-0.222	-1.164	0.793	-0.535	0.092
	[0.628]	[1.175]	[1.235]	[0.827]	[1.846]	[1.298]
Constant	7.363**	6.737**	8.907**	7.059**	6.382**	6.041**
	[0.647]	[1.157]	[1.270]	[0.898]	[1.760]	[1.401]
Observations	587	272	167	419	146	253
R-squared	0.360	0.407	0.402	0.346	0.318	0.500

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

5.2. New Varieties

To what extent are firms able to introduce new products with and without linkages? To what extent are firms able to create new markets when they introduce new products? To what extent do firms utilize new technologies when they introduce new products? We test these questions here. Table 9 reports the effects of linkages on the number of types of introducing new product varieties. In our sample, each firm has following three options: (1) introduce new goods or not, (2) introduce new goods to new markets or not, and (3) introduce new goods based on new technologies or not. If a firm achieves all types of introducing new varieties, it acquires three points. We used the Ordered Logit model to explain the determinants of the number of types of introducing new varieties. As reported in Table 9, the number of types of introducing new varieties is positive and significantly related to the variety of linkages. Two decomposed linkages (production and intellectual linkages) and internal resources are also positively related to the number of types of introducing new varieties. The coefficient for the number of MNEs is negative and significant.

Table 9. Number of Linkages and Number of Product Innovations

Ordered Logit	(1)	(2)	(3)	(4)
Dependent variables: Number of Innovations in Introducing New Product (0, 1, 2, 3)	All	All	All	All
Number of Linkages	**0.031** [0.012]**			
Number of Production Linkages		**0.042* [0.017]**		
Number of Intellectual Linkages			**0.088* [0.035]**	
Number of Internal Resources				**0.298** [0.065]**
Multinational Enterprises	-0.589* [0.238]	-0.587* [0.238]	-0.585* [0.239]	-0.512* [0.238]
Age	0.007 [0.007]	0.007 [0.007]	0.008 [0.008]	0.007 [0.007]
Full-time Employees	0.001** [0.000]	0.001** [0.000]	0.001** [0.000]	0.001** [0.000]
Indonesia	-0.388 [0.294]	-0.453 [0.282]	-0.35 [0.304]	-0.172 [0.281]
Philippines	0.303 [0.314]	0.218 [0.300]	0.335 [0.323]	0.523+ [0.281]
Vietnam	-0.636* [0.321]	-0.807** [0.298]	-0.368 [0.376]	-0.686* [0.294]
Observations	587	587	587	587

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 10 presents the coefficients for linkages by R&D activities. The coefficient for all types of linkages is not significantly different from zero when firms have R&D activities. On the other hand, the coefficient for all types of linkages is .038 with standard errors of .020 when firms do not have R&D activities, indicating that a firm with many production linkages would be able to achieve more of the number of types of introducing new varieties than a firm that does not have many linkages.

Table 10. Number of Linkages and Number of Product Innovations by R&D

Orderd Logit	(1)	(2)	(3)
Dependent variables: Number of Innovations in Introducing New Product (0, 1, 2, 3)	All	With R&D	Without R&D
Number of Linkages	**0.031****	0.007	**0.038+**
	[0.012]	[0.019]	**[0.020]**
Multinational Enterprises	-0.589*	0.115	-0.45
	[0.238]	[0.523]	[0.311]
Age	0.007	-0.005	0.006
	[0.007]	[0.011]	[0.010]
Full-time Employees	0.001**	0	0.001**
	[0.000]	[0.000]	[0.000]
Indonesia	-0.388	-0.786	0.038
	[0.294]	[0.622]	[0.447]
Philippines	0.303	-0.12	0.541
	[0.314]	[0.461]	[0.529]
Vietnam	-0.636*	0.521	-0.63
	[0.321]	[0.455]	[0.485]
Observations	587	128	459

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 11 presents the coefficients for production linkages by R&D activities. The coefficient for production linkages is positive but this does not have significant impact when firms have R&D activities. This is true in the case of intellectual linkages and internal resources. Table 12 and 13 reports the coefficients for intellectual linkages and internal resources as .115 with standard error of .055 and .212 with standard error of .103, respectively, when firms do not have R&D activities. As shown in Table 14, there are also functional differences in the number of types of introducing new varieties. The coefficients for the variety of linkages are positive and significant when firms do marketing, production of raw materials, procurement, and final assembly.

Table 11. Number of Production Linkages and Number of Product Innovations by R&D

Orderd Logit Dependent variables: Number of Innovations in Introducing New Product (0, 1, 2, 3)	(1) All	(2) With R&D	(3) Without R&D
Number of Production Linkages	**0.042***	0.009	0.047
	[0.017]	[0.029]	[0.028]
Multinational Enterprises	-0.587*	0.117	-0.446
	[0.238]	[0.522]	[0.310]
Age	0.007	-0.005	0.006
	[0.007]	[0.011]	[0.010]
Full-time Employees	0.001**	0	0.001**
	[0.000]	[0.000]	[0.000]
Indonesia	-0.453	-0.799	-0.091
	[0.282]	[0.617]	[0.411]
Philippines	0.218	-0.134	0.362
	[0.300]	[0.455]	[0.484]
Vietnam	-0.807**	0.485	-0.873*
	[0.298]	[0.439]	[0.427]
Observations	587	128	459

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 12. Number of Intellectual Linkages and Number of Product Innovations by R&D

Orderd Logit Dependent variables: Number of Innovations in Introducing New Product (0, 1, 2, 3)	(1) All	(2) With R&D	(3) Without R&D
Number of Intellectual Linkages	**0.088***	0.02	**0.115***
	[0.035]	[0.057]	**[0.055]**
Multinational Enterprises	-0.585*	0.117	-0.455
	[0.239]	[0.520]	[0.313]
Age	0.008	-0.005	0.006
	[0.008]	[0.012]	[0.010]
Full-time Employees	0.001**	0	0.001**
	[0.000]	[0.000]	[0.000]
Indonesia	-0.35	-0.766	0.116
	[0.304]	[0.636]	[0.453]
Philippines	0.335	-0.11	0.637
	[0.323]	[0.475]	[0.529]
Vietnam	-0.368	0.584	-0.239
	[0.376]	[0.530]	[0.587]
Observations	587	128	459

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 13. Number of Internal Sources and Number of Product Innovations by R&D

Orderd Logit Dependent variables: Number of Innovations in Introducing New Product (0, 1, 2, 3)	(1) All	(2) With R&D	(3) Without R&D
Number of Internal Sources	**0.298****	0.233	**0.212***
	[0.065]	[0.153]	**[0.103]**
Multinational Enterprises	-0.512*	-0.042	-0.422
	[0.238]	[0.516]	[0.310]
Age	0.007	-0.002	0.007
	[0.007]	[0.013]	[0.010]
Full-time Employees	0.001**	0	0.001**
	[0.000]	[0.000]	[0.000]
Indonesia	-0.172	-0.735	0.014
	[0.281]	[0.597]	[0.399]
Philippines	0.523+	0.064	0.466
	[0.281]	[0.418]	[0.453]
Vietnam	-0.686*	0.386	-0.790+
	[0.294]	[0.454]	[0.426]
Observations	587	128	459

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 14. Number of Linkages and Number of Product Innovations by Functions

Ordered Logit	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables: Number of Innovations in Introducing New Product (0, 1, 2, 3)	All	Raw materials	Parts	Final Assembling	Procurement	Marketing
Number of Linkages	**0.031****	**0.058***	0.015	**0.037****	**0.041+**	**0.069****
	[0.012]	**[0.024]**	[0.024]	**[0.014]**	**[0.023]**	**[0.024]**
Multinational Enterprises	-0.589*	-0.614	-0.841+	-0.797**	-0.314	-1.648**
	[0.238]	[0.412]	[0.434]	[0.292]	[0.467]	[0.428]
Age	0.007	0.013	0.004	0.013	-0.014	0.024*
	[0.007]	[0.011]	[0.021]	[0.009]	[0.018]	[0.012]
Full-time Employees	0.001**	0.001+	0.001**	0.001**	0.001*	0.001*
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-0.388	0.697	-1.052+	-0.622+	-0.606	-0.019
	[0.294]	[0.578]	[0.601]	[0.342]	[0.765]	[0.808]
Philippines	0.303	1.614*	0.530	0.107	-0.887	1.109
	[0.314]	[0.723]	[0.666]	[0.354]	[0.624]	[0.900]
Vietnam	-0.636*	-0.162	-0.438	-0.568	-1.362+	-0.071
	[0.321]	[0.687]	[0.645]	[0.358]	[0.750]	[0.824]
Observations	587	272	167	419	146	253

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

5.3. Adoption of New Technologies and Organizational Structure

Process innovations also play a key role in upgrading business activities. Innovations in business processes can be carried out in two ways. The first involves the adoption of new technologies to improve efficiency or quality. The second involves changing the organizational structure to respond to the external environment.

First, we report the result of adoption of new technologies. There are three types of process innovations related to the adoption of new technologies inside the firm: (1) purchase of new machines or facilities with new functions; (2) improvement of existing machines, equipment, or facilities; (3) introduction of new know-how on production methods. We call these "process innovations towards the firm" or innovations made for the firm's internal processes. Table 15 presents the impacts of process innovation on the variety of linkages. Only "internal resources" has a positive and significant effect. The coefficient for the number of internal resources is .110 with a standard error of .060. As reported in Table 16, the coefficient for the number of internal resources is .064 with a standard error of .024 when firms do marketing activities.

Table 15. Number of Linkages and Number of Process Innovations

Ordered Logit Dependent variables: Adopted a New Production Method (0, 1, 2, 3)	(1) All	(2) All	(3) All	(4) All
Number of Linkages	0			
	[0.011]			
Number of Production Linkages		0.017		
		[0.017]		
Number of Intellectual Linkages			0.027	
			[0.029]	
Number of Internal Resources				**0.110+**
				[0.060]
Multinational Enterprises	-0.766**	-0.767**	-0.764**	-0.738**
	[0.228]	[0.228]	[0.229]	[0.231]
Age	0.013+	0.013+	0.013+	0.012+
	[0.007]	[0.007]	[0.007]	[0.007]
Full-time Employees	0.002**	0.002**	0.002**	0.002**
	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-0.632*	-0.643*	-0.648*	-0.536*
	[0.262]	[0.261]	[0.257]	[0.269]
Philippines	-0.042	-0.056	-0.071	0.041
	[0.295]	[0.296]	[0.283]	[0.278]
Vietnam	-1.330**	-1.388**	-1.269**	-1.338**
	[0.318]	[0.306]	[0.346]	[0.309]
Observations	587	587	587	587

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 16. Number of Linkages and Number of Process Innovations by Functions

Ordered Logit	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables: Adopted a New Production Method (0, 1, 2, 3)	All	Raw materials	Parts	Final Assembling	Procurement	Marketing
Number of Linkages	0.012	0.030	0.027	0.006	0.042	**0.064****
	[0.011]	[0.019]	[0.024]	[0.015]	[0.026]	**[0.024]**
Multinational Enterprises	-0.766**	-1.190**	-0.200	-0.838**	0.102	-1.981**
	[0.228]	[0.349]	[0.443]	[0.261]	[0.415]	[0.369]
Age	0.013+	0.019*	0.020	0.014+	-0.013	0.024*
	[0.007]	[0.009]	[0.017]	[0.007]	[0.018]	[0.010]
Full-time Employees	0.002**	0.001**	0.001**	0.001**	0.002**	0.001**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]
Indonesia	-0.632*	-0.763	-1.047+	-0.579+	-0.656	-0.631
	[0.262]	[0.577]	[0.582]	[0.339]	[0.607]	[0.988]
Philippines	-0.042	-0.085	-0.151	0.000	0.673	0.560
	[0.295]	[0.639]	[0.667]	[0.378]	[0.732]	[1.061]
Vietnam	-1.330**	-1.266*	-1.479*	-1.187**	-1.657*	-0.963
	[0.318]	[0.599]	[0.668]	[0.385]	[0.783]	[1.012]
Observations	587	272	167	419	146	253

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Second, we report the result of changing the organizational structure to enable a firm to respond to its external environment. There are three types of process innovations related to this: (1) Certification by International Organization for Standardization (ISO); (2) Introduction of ICT to reorganize the business process; (3) Introduction of other internal activities to respond to changes in the market. We call these "process innovations toward the outside market." Table 17 reports the effect of the variety of linkages on process innovations toward the outside market. The coefficient for the variety of linkages is .054 with a standard error of .013 for all types of linkages. The number of production linkages, intellectual linkages, and internal resources is also positive and has a significant impact on process innovations. Table 18 presents the effects of the variety of linkages on process innovations toward the outside market by functions. All the coefficients are positive and significant. The coefficients of the variety of linkages for firms involved in producing raw materials, doing marketing, parts, and procurement are relatively larger than for firms doing final assembly.

Table 17. Number of Linkages and Number of Process Innovations

Ordered Logit	(1)	(2)	(3)	(4)
Dependent variables: Number of Business Process Improvement (Min:0, Max:3)	All	All	All	All
Number of Linkages	**0.054****			
	[0.013]			
Number of Production Linkages		**0.084****		
		[0.020]		
Number of Intellectual Linkages			**0.113****	
			[0.036]	
Number of Internal Resources				**0.333****
				[0.062]
Multinational Enterprises	1.272**	1.266**	1.286**	1.390**
	[0.219]	[0.220]	[0.219]	[0.225]
Age	0.002	0.002	0.003	0.001
	[0.007]	[0.007]	[0.007]	[0.007]
Full-time Employees	0.001**	0.001**	0.001**	0.001**
	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-2.041**	-2.087**	-2.118**	-2.003**
	[0.308]	[0.299]	[0.315]	[0.301]
Philippines	-0.907**	-0.939**	-1.092**	-1.001**
	[0.328]	[0.317]	[0.330]	[0.286]
Vietnam	-0.991**	-1.255**	-0.766*	-1.232**
	[0.319]	[0.308]	[0.361]	[0.299]
Observations	587	587	587	587

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 18. Number of Linkages and Number of Product Innovations by Functions

Ordered Logit	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables: Number of Business Process Improvement (Min:0, Max:3)	All	Raw materials	Parts	Final Assembling	Procurement	Marketing
Number of Linkages	**0.054****	**0.099****	**0.079***	**0.052****	**0.072+**	**0.088****
	[0.013]	**[0.023]**	**[0.031]**	**[0.017]**	**[0.037]**	**[0.021]**
Multinational Enterprises	1.272**	1.735**	1.303**	1.200**	1.022*	1.974**
	[0.219]	[0.324]	[0.377]	[0.266]	[0.415]	[0.358]
Age	0.002	-0.004	-0.005	0.012	0.010	0.001
	[0.007]	[0.010]	[0.018]	[0.008]	[0.015]	[0.010]
Full-time Employees	0.001**	0.001**	0.001**	0.001**	0.002**	0.001**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-2.041**	-0.906	-2.395**	-1.944**	-2.011*	-3.021*
	[0.308]	[0.631]	[0.649]	[0.404]	[0.920]	[1.193]
Philippines	-0.907**	0.187	-0.460	-0.894*	-0.151	-1.197
	[0.328]	[0.730]	[0.655]	[0.418]	[0.927]	[1.224]
Vietnam	-0.991**	-0.491	-1.757**	-0.644	-0.536	-2.202+
	[0.319]	[0.655]	[0.627]	[0.415]	[0.827]	[1.215]
Observations	587	272	167	419	146	253

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

5.4. New Sources of Input

It is important to secure new sources of input—both locally and overseas—in order to improve quality and stimulate process innovations. The dependent variable is higher for firms that are successful in doing this than for firms that fail to secure multiple types of local and foreign trade partners.

Table 19 reports the impacts of the variety of linkages on securing new sources of input. The coefficient for the variety of linkages is .061 with a standard error of .011. This indicates that firms with more linkages tend to secure more new suppliers than firms with few linkages.

Table 19. Number of Linkages and Number of Process Innovations

Ordered Logit	(1)	(2)	(3)	(4)
Dependent variables: Number of Securing New Suppliers of Raw Materials and Parts (Min:0, Max:7)	All	All	All	All
Number of Linkages	**0.061****			
	[0.011]			
Number of Production Linkages		**0.091****		
		[0.016]		
Number of Intellectual Linkages			**0.139****	
			[0.029]	
Number of Internal Resources				**0.347****
				[0.060]
Multinational Enterprises	1.041**	1.032**	1.061**	1.152**
	[0.219]	[0.218]	[0.220]	[0.219]
Age	0.008	0.007	0.009	0.005
	[0.008]	[0.008]	[0.008]	[0.008]
Full-time Employees	0.001**	0.001**	0.001**	0.000*
	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-0.905**	-0.961**	-0.964**	-0.880**
	[0.246]	[0.242]	[0.246]	[0.259]
Philippines	-0.191	-0.253	-0.319	-0.29
	[0.263]	[0.259]	[0.266]	[0.280]
Vietnam	0.985**	0.687*	1.296**	0.733**
	[0.273]	[0.269]	[0.300]	[0.280]
Observations	587	587	587	587

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

The most striking evidence in cross-country comparison is Vietnamese firms that have been able to secure more suppliers than Thai firms. This is partially reflected by the difference in the industry composition between the two countries. Table 20 compares the results of the impact of the variety of linkages on the number of secured new suppliers by functions. All of coefficients are positive and significant. The coefficients of the variety of linkages for firms that produce raw materials and do marketing functions are relatively larger than for firms that produce parts and do final assembly.

5.5. Creation of New Markets

The creation of new local and international markets is very important in helping upgrade business processes and, to a certain extent, spurring process innovations. The dependent variable is higher for firms that are able to secure new local and international customers than for firms fail to do so. Table 21 reports the impacts of the variety of linkages on securing new customers. The coefficient for the variety of linkages is .076 with a standard error of .012, indicating that firms with many linkages are more successful in securing new markets than firms with few linkages. Table 22 compares the results of the impact of the variety of linkages on the number of secured new suppliers by functions. All of coefficients are positive and significant. The coefficients of the variety of linkages for firms with procurement and marketing functions are relatively larger than for firms that make raw materials and parts and do final assembly.

Table 20. Number of Linkages and Number of Securing New Suppliers by Functions

Ordered Logit	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables: Number of Securing New Suppliers of Raw Materials and Parts (Min:0, Max:7)	All	Raw materials	Parts	Final Assembling	Procurement	Marketing
Number of Linkages	**0.061****	**0.077****	**0.041***	**0.063****	**0.110****	**0.075****
	[0.011]	**[0.018]**	**[0.019]**	**[0.016]**	**[0.024]**	**[0.024]**
Multinational Enterprises	1.041**	1.336**	1.272**	1.069**	0.037	2.017**
	[0.219]	[0.298]	[0.418]	[0.273]	[0.382]	[0.356]
Age	0.008	0.018+	0.008	0.014	-0.017	0.008
	[0.008]	[0.010]	[0.019]	[0.010]	[0.018]	[0.015]
Full-time Employees	0.001**	0.000	0.000	0.000	0.002**	0.001
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]
Indonesia	-0.905**	-1.007+	-0.771	-0.748*	-1.582*	-0.536
	[0.246]	[0.599]	[0.539]	[0.339]	[0.649]	[0.848]
Philippines	-0.191	-0.190	-0.050	-0.063	0.034	0.997
	[0.263]	[0.617]	[0.586]	[0.368]	[0.673]	[0.864]
Vietnam	0.985**	0.784	0.843	1.339**	0.215	1.483+
	[0.273]	[0.631]	[0.592]	[0.383]	[0.719]	[0.850]
Observations	587	272	167	419	146	253

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 21. Number of Linkages and Number of Securing New Customer

Ordered Logit	(1)	(2)	(3)	(4)
Dependent variables: Number of Securing New Customers (Min:0, Max:7)	All	All	All	All
Number of Linkages	**0.076****			
	[0.012]			
Number of Production Linkages		**0.116****		
		[0.018]		
Number of Intellectual Linkages			**0.163****	
			[0.032]	
Number of Internal Resources				**0.307****
				[0.062]
Multinational Enterprises	0.486*	0.467*	0.518*	0.562**
	[0.221]	[0.220]	[0.222]	[0.213]
Age	0.011	0.011	0.012+	0.01
	[0.007]	[0.007]	[0.007]	[0.007]
Full-time Employees	0.000**	0.000*	0.001**	0.000+
	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-1.502**	-1.574**	-1.597**	-1.665**
	[0.257]	[0.247]	[0.268]	[0.277]
Philippines	-1.328**	-1.406**	-1.516**	-1.745**
	[0.283]	[0.274]	[0.296]	[0.296]
Vietnam	0.445+	0.068	0.783**	0.007
	[0.261]	[0.258]	[0.301]	[0.271]
Observations	587	587	587	587

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 22. Number of Linkages and Number of Securing New Customer by Functions

Ordered Logit	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables: Number of Securing New Customers (Min:0, Max:7)	All	Raw materials	Parts	Final Assembling	Procurement	Marketing
Number of Linkages	**0.076****	**0.077****	**0.049***	**0.077****	**0.106****	**0.117****
	[0.012]	**[0.021]**	**[0.024]**	**[0.016]**	**[0.030]**	**[0.027]**
Multinational Enterprises	0.486*	0.747*	0.293	0.561*	-0.709+	1.737**
	[0.221]	[0.337]	[0.397]	[0.262]	[0.405]	[0.306]
Age	0.011	0.015	0.004	0.017*	-0.008	0.016+
	[0.007]	[0.009]	[0.017]	[0.008]	[0.020]	[0.009]
Full-time Employees	0.000**	0.000	0.000	0.000	0.001*	0.001**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-1.502**	-2.369**	-2.558**	-1.480**	-1.039	-1.257
	[0.257]	[0.699]	[0.529]	[0.337]	[0.765]	[1.012]
Philippines	-1.328**	-2.236**	-2.190**	-1.203**	0.345	0.410
	[0.283]	[0.725]	[0.657]	[0.372]	[0.831]	[1.026]
Vietnam	0.445+	-0.419	-0.157	0.605+	0.747	0.459
	[0.261]	[0.675]	[0.540]	[0.357]	[0.828]	[0.987]
Observations	587	272	167	419	146	253

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

6. THE EFFECT OF SPATIAL ARCHITECTURE OF PRODUCTION NETWORKS

6.1. Production Networks in Space

This section focuses on five issues related to production linkages between the main customer and supplier in a spatial economy: (1) capital tie-up; (2) products type; (3) JIT system; (4) exchange of engineers; (5) the relationship between production networks and innovation networks.

We have two competing theories of spatial architecture of production network to explain colocation between two firms. First, if fixed search costs of production partners (or setup and coordination costs of alliances) decrease with capital structure between firms, it is efficient for firms with capital tie-up to form production linkages with their affiliates. Second, if communication costs per meeting and information exchanges increase with geographic distance between firms, these two firms will form production linkages that will tend to colocate in one area. Capital tie-up with affiliates is a good proxy for the existence of production linkages. If both of the first and second conjectures are appropriate in East Asia, firms with capital tie-up tend to locate nearer each other than firms without capital tie-up. That is, the geographic extent of input-output linkage is locally limited for firms with capital tie-up than firms without capital tie-up due to the needs of the JIT system or frequent information exchanges for quality upgrading. This is a transport costs-based theory of colocation. This explanation is also derived from standard spatial economy. Less productive (less differentiated goods production) firms forge local or nearby alliances while more productive firms do it globally. For given variable communication costs of alliances, the geographic extent of input-output linkages should be ruled out by productivity. If communication costs increase, the probability of network formation with remote firms could decrease.

Second, there is the enforceability-based theory of agglomeration. This theory emphasizes the monitoring effect of production networks from buyer to seller. If buyers do not have a long-term or tight relationship with the producers, such buyers would have to frequently monitor and check product quality repeatedly. The cost of communication is an increasing function of geographic distance between buyers and sellers. If this conjecture is right, for example, firms with capital tie-up need not be colocated because these buyer and sellers would already know each other. The geographic extent of input-output linkage is locally limited for firms without capital tie-up compared to firms with capital tie-up due to monitoring needs. This section answers the following questions of production networks in space: (1) Are there any differences in the input-output linkages across firms and countries in East Asia; (2) How strong are the linkages between customers and suppliers; (3) Are production linkages also important partners for innovations?

Table 23 presents data on geographic proximity of a firm to its main customer and supplier in relation to capital tie-up. Almost all of the sample firms do not have capital tie-up to their main customer and supplier. On average, firms with a capital tie-up to the main customer and supplier are located more remotely from one another (514 km from customer, 374 km from supplier) than firms that have no any capital tie-up to their main customer or supplier (394 km from main customer, 353 km from supplier). This result validates the theory of colocation that some kind of monitoring occurs to enable firms to create a production network.

Table 23. Geographic Proximity to Customer/Supplier by Capital Tie-up with Customer/Supplier

With Customer	With Supplier	Variable (km)	Obs	Mean	S.D.	Min	Max
No	No	Geographic Proximity to Consumer	498	394.2	435.2	5	1000
		Geographic Proximity to Supplier	462	353.0	415.1	5	1000
Yes	No	Geographic Proximity to Consumer	23	301.2	392.3	5	1000
		Geographic Proximity to Supplier	19	236.9	351.8	5	1000
No	Yes	Geographic Proximity to Consumer	23	428.0	471.8	5	1000
		Geographic Proximity to Supplier	23	182.5	316.7	5	1000
Yes	Yes	Geographic Proximity to Consumer	40	514.2	471.9	5	1000
		Geographic Proximity to Supplier	41	374.8	449.7	5	1000

This result also holds for the types of goods that buyers and sellers produce. Table 24 compares the geographic proximity of sample firms to their main customer and supplier by the status of customized-goods production. If the transport cost-based theory of colocation is accurate, firms could buy standard goods from nearby suppliers and sell their own products to nearby customers. On the other hand, if customized goods are insensitive to transport costs, a firm can buy from a remote producer and sell to a remote customer. Data show that on average, firms who buy standard goods from a supplier and sell their own product to a customer who makes standard goods are located near their main customer and supplier (353 km from main customer, 206 km from supplier). Firms who buy customized goods from a supplier and sell their own products to a customer who makes customized goods are located farther away from their main customer and supplier (467 km from customer, 432 km from supplier).

Table 24. Geographic Proximity to Customer/Supplier by Customized Goods Transaction with Customer/Supplier

With Customer	With Supplier	Variable (km)	Obs	Mean	S.D.	Min	Max
No	No	Geographic Proximity to Consumer	182	353.9	428.8	5	1000
		Geographic Proximity to Supplier	154	206.0	330.7	5	1000
Yes	No	Geographic Proximity to Consumer	80	276.5	363.8	5	1000
		Geographic Proximity to Supplier	67	217.8	339.3	5	1000
No	Yes	Geographic Proximity to Consumer	26	332.7	385.0	5	1000
		Geographic Proximity to Supplier	28	462.1	437.4	5	1000
Yes	Yes	Geographic Proximity to Consumer	296	467.8	456.1	5	1000
		Geographic Proximity to Supplier	296	432.1	438.3	5	1000

It is natural for firms to create a JIT system with locally concentrated partners. Table 25 compares the geographic proximity of a firm to a main customer and supplier by the introduction of the JIT system. Firms who have a JIT system with their main customer and supplier are located nearer to their main trading partners than firms who have no JIT system with their main partners (333 km from customer with JIT, 232 km from supplier with JIT versus 448 km from customer without JIT, 442 km from supplier without JIT). The formation of the JIT system justifies colocation based on transport costs.

Table 25. Geographic Proximity to Customer/Supplier by JIT with Customer/Supplier

With Customer	With Supplier	Variable (km)	Obs	Mean	S.D.	Min	Max
No	No	Geographic Proximity to Consumer	307	448.9	445.9	5	1000
		Geographic Proximity to Supplier	289	442.8	435.4	5	1000
Yes	No	Geographic Proximity to Consumer	71	391.3	442.4	5	1000
		Geographic Proximity to Supplier	45	172.5	341.9	5	1000
No	Yes	Geographic Proximity to Consumer	15	294.6	440.9	5	1000
		Geographic Proximity to Supplier	18	369.2	439.9	5	1000
Yes	Yes	Geographic Proximity to Consumer	191	333.1	415.9	5	1000
		Geographic Proximity to Supplier	193	232.0	348.1	5	1000

Exchanging engineers between firms is also a main proxy of exchanging production-related knowledge on production linkages. Table 26 compares the geographic proximity of firms that accept engineers from their main trading partners to these same partners to the geographic proximity of firms that choose not to do so with their main partners. The results show that firms that decide to accept engineers from their main customers and suppliers tend to be located farther away from these same trading partners (669 km from customer and 567 km from supplier for firms that accept engineers versus 318 km from customer and 237 km from supplier for firms that do not accept engineers).

Table 26. Geographic Proximity to Customer/Supplier by Accept Engineers from Customer/Supplier

From Customer	From Supplier	Variable (km)	Obs	Mean	S.D.	Min	Max
No	No	Geographic Proximity to Consumer	359	318.5	403.2	5	1000
		Geographic Proximity to Supplier	331	237.6	340.1	5	1000
Yes	No	Geographic Proximity to Consumer	64	319.3	404.1	5	1000
		Geographic Proximity to Supplier	57	368.6	404.7	5	1000
No	Yes	Geographic Proximity to Consumer	23	282.8	389.2	5	1000
		Geographic Proximity to Supplier	23	501.4	454.1	5	1000
Yes	Yes	Geographic Proximity to Consumer	138	669.4	443.5	5	1000
		Geographic Proximity to Supplier	134	567.0	474.8	5	1000

Table 27 compares the geographic proximity of firms that dispatch engineers to their main customers and suppliers from those same trading partners to the geographic proximity of firms that do not dispatch engineers to their main partners.

Table 27. Geographic Proximity to Customer/Supplier by Dispatch Engineers to Customer/Supplier

To Customer	To Supplier	Variable (km)	Obs	Mean	S.D.	Min	Max
No	No	Geographic Proximity to Consumer	439	391.4	434.3	5	1000
		Geographic Proximity to Supplier	407	342.2	409.5	5	1000
Yes	No	Geographic Proximity to Consumer	48	295.5	397.3	5	1000
		Geographic Proximity to Supplier	41	361.1	418.8	5	1000
No	Yes	Geographic Proximity to Consumer	20	454.0	463.7	18	1000
		Geographic Proximity to Supplier	23	315.8	406.0	5	1000
Yes	Yes	Geographic Proximity to Consumer	77	500.6	464.3	5	1000
		Geographic Proximity to Supplier	74	348.7	439.9	5	1000

Firms save on communication costs to remote areas by accepting engineers from their main customers and suppliers if these trading partners are located far from them. This is also true for firms that decide to dispatch engineers to their main partners. By doing this, firms can save on communication costs, especially if the partners are located in remote areas (500 km from customer and 348 km from supplier for firms that dispatch engineers versus 391 km from customer and 342 km from supplier for firms that do not dispatch engineers).

Finally, there is the overlap between production linkages and innovations network. As reported in Table 28, many firms (341 out of 600) responded that their main consumers are an important consideration in any decision to upgrade business activities and implement innovations while many firms also said that their main supplier is not an important factor in any decision to upgrade and innovate their business processes and products. Geographic proximity to main customer and supplier, on average, is locally limited for firms who consider their main supplier as an important factor in upgrading and innovations (367 km from supplier if firms do not consider versus 141 km from supplier if firms consider).

Table 28. Geographic Proximity to Customer/Supplier by Importance of Customer/Supplier as Innovation Partner

Customer	Supplier	Variable (km)	Obs	Mean	S.D.	Min	Max
No	No	Geographic Proximity to Consumer	173	369.9	420.5	5	1000
		Geographic Proximity to Supplier	162	389.8	426.1	5	1000
Yes	No	Geographic Proximity to Consumer	341	444.5	450.0	5	1000
		Geographic Proximity to Supplier	312	367.8	427.5	5	1000
No	Yes	Geographic Proximity to Consumer	15	244.7	358.0	18	1000
		Geographic Proximity to Supplier	16	90.4	107.7	5	350
Yes	Yes	Geographic Proximity to Consumer	55	261.9	399.1	5	1000
		Geographic Proximity to Supplier	55	141.8	229.3	5	1000

6.2. The Effect of Face-to-face and Frequency of Communications on Innovations: Accepting/Dispatching Engineers and JIT System

We report the following internal effects of linkages in order to understand the information flow on production linkages. First, exchanging engineers could stimulate information flow based on face-to-face communication. Second, the formation of the JIT system could provide the opportunity for frequent communication between suppliers and customers. Since the last section reports on the effect of variety of linkages on product and process innovations, we relate the internal information flow of linkages to product and process innovations.

Table 29 reports the effects of accepting engineers from customers and suppliers on the introduction of new products. The dependent variable is equal to one if each firm introduces new products and is equal to zero otherwise. The independent variable, accepting engineers from customers or suppliers, is equal to one if each firm accepts engineers from the main customer or supplier. Marginal effects are presented. Other control variables are MNEs, age, firm size, and country dummy variables. We separately estimate the impacts of flows of engineers on product innovations by goods characteristics, that is, customized- and standard-goods production. As reported in Table 29, the coefficient for accepting engineers from suppliers is .329 with a standard error of .105, and it is statistically significant at the 1 percent level. Thus, firms that accept engineers from main suppliers are likely to experience significantly higher probability of product innovation than firms that do not accept engineers from main suppliers. This effect holds true if the main customers and suppliers produce standard goods. Overall, product innovation is positively related to accepting engineers from main suppliers and dispatching engineers to main customers.

Table 29. Engineer Acceptance from Customers/Suppliers and Introduction of New Good

Probit (Marginal Effects)	(1)	(2)	(3)	(4)	(5)
Dependent variables: Introduction of New Good (Yes/No)	All	Customer makes Customized Product	Customer makes Standard Product	Supplier makes Customized Product	Supplier makes Standard Product
Accept Engineers from Customer	-0.039	-0.024	-0.017	0.024	-0.076
	[0.067]	[0.085]	[0.115]	[0.097]	[0.098]
Accept Engineers from Supplier	0.104	0.059	**0.329****	-0.038	**0.343****
	[0.069]	[0.083]	**[0.105]**	[0.090]	**[0.081]**
Multinational Enterprises	-0.179**	-0.234**	-0.041	-0.162*	-0.077
	[0.059]	[0.069]	[0.110]	[0.077]	[0.103]
Age	0.001	0.003	-0.004	0.002	-0.001
	[0.002]	[0.002]	[0.003]	[0.003]	[0.003]
Full-time Employees	0.000**	0.000**	0.000	0.000**	0.000**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-0.213**	-0.174*	-0.348**	-0.230**	-0.217*
	[0.059]	[0.075]	[0.099]	[0.075]	[0.095]
Philippines	-0.068	-0.103	-0.053	-0.133	-0.093
	[0.062]	[0.085]	[0.091]	[0.089]	[0.083]
Vietnam	-0.249**	-0.253**	0.334*	-0.320**	0.217+
	[0.070]	[0.087]	[0.149]	[0.089]	[0.132]
Observations	587	376	211	325	262

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 30 presents the innovation impacts of dispatching engineers to main customers and suppliers. The dependent variable is product innovation. This is equal to one if each firm introduces new varieties and is equal to zero if otherwise. The independent variable, dispatching engineers to customers or suppliers, is equal to one if each firm dispatches engineers to the main customers or suppliers. As reported in Table 30, the coefficient for dispatching engineers to main customers is .153 with a standard error of .080 if the main customer produces customized goods. The coefficient for dispatching engineers to main suppliers is .248 with a standard error of .100 if the main supplier produces standard goods. These results suggest that the acceptance of engineers from the main supplier and the dispatching of engineers to the main partners is positively important for product innovations.

Table 30. Engineer Dispatch to Customers/Suppliers and Introduction of New Good

Probit (Marginal Effects)	(1)	(2)	(3)	(4)	(5)
Dependent variables: Introduction of New Good (Yes/No)	All	Customer makes Customized Product	Customer makes Standard Product	Supplier makes Customized Product	Supplier makes Standard Product
Dispatch Engineers to Customer	**0.122+**	**0.153+**	0.054	0.116	0.078
	[0.067]	**[0.080]**	[0.133]	[0.093]	[0.106]
Dispatch Engineers to Supplier	0.124	0.124	0.104	0.046	**0.248***
	[0.077]	[0.098]	[0.132]	[0.108]	**[0.100]**
Multinational Enterprises	-0.158**	-0.224**	0.020	-0.170*	-0.044
	[0.056]	[0.065]	[0.103]	[0.070]	[0.101]
Age	0.001	0.003	-0.003	0.002	-0.001
	[0.002]	[0.002]	[0.003]	[0.003]	[0.003]
Full-time Employees	0.000**	0.000**	0.000*	0.000*	0.000*
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-0.223**	-0.191*	-0.321**	-0.234**	-0.204*
	[0.059]	[0.076]	[0.101]	[0.075]	[0.095]
Philippines	-0.107+	-0.158+	-0.047	-0.153+	-0.097
	[0.063]	[0.083]	[0.091]	[0.088]	[0.082]
Vietnam	-0.265**	-0.278**	0.303+	-0.321**	0.178
	[0.064]	[0.080]	[0.162]	[0.082]	[0.141]
Observations	587	376	211	325	262

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Let us move to process innovations. Table 31 presents the impact of accepting engineers from the supplier on improving existing machines. The coefficient for accepting engineers from the supplier is -.140 with a standard error of .081 if the main customer produces customized goods. The coefficient for accepting engineers from the supplier is .173 with standard error of .080 if the main customer produces standard goods. The coefficient for accepting engineers from the supplier is -.242 with standard error of .094 if the main supplier produces customized goods. The coefficient for accepting engineers from the supplier is .191 with standard error of .053 if the main supplier produces standard goods. These results indicate that if the main partners produce customized goods, it is not easy to improve existing machines for firms that accept engineers from suppliers. On the other hand, if the main partners produce standard goods, accepting engineers from main suppliers stimulates the improvement of existing machines.

Table 31. Engineer Acceptance from Customers/Suppliers and Improved Existing Machines

Probit (Marginal Effects)	(1)	(2)	(3)	(4)	(5)
Dependent variables: Improved Existing Machines (Yes/No)	All	Customer makes Customized Product	Customer makes Standard Product	Supplier makes Customized Product	Supplier makes Standard Product
Accept Engineers from Customer	0.050	0.082	-0.023	0.116	0.004
	[0.062]	[0.083]	[0.100]	[0.101]	[0.074]
Accept Engineers from Supplier	-0.059	**-0.140+**	**0.173***	**-0.242***	**0.191****
	[0.065]	**[0.081]**	**[0.080]**	**[0.094]**	**[0.053]**
Multinational Enterprises	-0.219**	-0.277**	-0.089	-0.198*	-0.146
	[0.061]	[0.074]	[0.113]	[0.085]	[0.106]
Age	0.003	0.004	0.000	0.006+	-0.001
	[0.002]	[0.003]	[0.003]	[0.003]	[0.002]
Full-time Employees	0.000**	0.000**	0.000*	0.000**	0.000**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-0.053	-0.114	-0.073	0.046	-0.190+
	[0.067]	[0.094]	[0.104]	[0.093]	[0.097]
Philippines	-0.056	-0.115	-0.030	-0.031	-0.126+
	[0.064]	[0.104]	[0.080]	[0.109]	[0.068]
Vietnam	-0.293**	-0.351**	0.048	-0.263*	-0.063
	[0.082]	[0.103]	[0.159]	[0.113]	[0.136]
Observations	587	376	211	325	262

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 32 reports the result of dispatching engineers to the main partners on improving existing machines. The coefficient for dispatching engineers to the customer is .139 with a standard error of .074 if the main customer produces customized goods. The coefficient for dispatching engineers to the customer is .174 with a standard error of .089 if the main supplier produces customized goods. The coefficient for dispatching engineers to the supplier is .157 with a standard error of .060 if the main supplier produces standard goods. Thus, firms that dispatch engineers to customers and suppliers could experience significantly higher probability of process innovations toward internal firm-improving existing machines. In summary, process innovation toward internal production efficiency is negatively related to accepting engineers from suppliers if production linkages are connected to produce customized goods. On the other hand, process innovation is positively related to accepting engineers from suppliers if production linkages are connected to produce standard goods. Process innovation is also positively related to dispatching engineers to customers if production linkages are connected to produce customized goods.

Table 32. Engineer Disptach to Customers/Suppliers and Improved Existing Machines

Probit (Marginal Effects)	(1)	(2)	(3)	(4)	(5)
Dependent variables: Improved Existing Machines (Yes/No)	All	Customer makes Customized Product	Customer makes Standard Product	Supplier makes Customized Product	Supplier makes Standard Product
Dispatch Engineers to Customer	**0.118+**	**0.139+**	0.020	**0.173+**	0.027
	[0.060]	**[0.074]**	[0.121]	**[0.089]**	[0.076]
Dispatch Engineers to Supplier	**0.115+**	0.106	0.136	0.048	**0.157****
	[0.065]	[0.087]	[0.099]	[0.112]	**[0.060]**
Multinational Enterprises	-0.237**	-0.316**	-0.061	-0.278**	-0.114
	[0.058]	[0.068]	[0.110]	[0.074]	[0.103]
Age	0.002	0.003	0.001	0.005	-0.001
	[0.002]	[0.003]	[0.003]	[0.003]	[0.002]
Full-time Employees	0.000**	0.000**	0.000*	0.000**	0.000**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-0.062	-0.118	-0.060	0.054	-0.183+
	[0.067]	[0.095]	[0.101]	[0.092]	[0.095]
Philippines	-0.089	-0.152	-0.041	-0.036	-0.125+
	[0.064]	[0.104]	[0.081]	[0.107]	[0.069]
Vietnam	-0.298**	-0.348**	0.004	-0.227*	-0.086
	[0.077]	[0.096]	[0.180]	[0.101]	[0.152]
Observations	587	376	211	325	262

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 33 presents the effect of accepting engineers from suppliers for firms that are working on getting ISO certification. The first column indicates that the coefficient for accepting engineers from the main supplier is .250 with a standard error of .060. Thus, firms that accept engineers from the main supplier have a significantly higher probability of getting ISO certified. This is true if the main customer and supplier produce customized and standard goods, respectively. Table 34 reports the effect of dispatching engineers to the main customer. The coefficient for dispatching engineers to customers is .193 with a standard error of .067, indicating that firms that dispatch engineers to customers have a significantly positive impact of getting ISO certified, which is considered as a process innovation towards the external market.

Table 33. Engineer Acceptance from Customers/Suppliers and Adopted ISO

Probit (Marginal Effects)	(1)	(2)	(3)	(4)	(5)
Dependent variables: Adopted ISO (Yes/No)	All	Customer makes Customized Product	Customer makes Standard Product	Supplier makes Customized Product	Supplier makes Standard Product
Accept Engineers from Customer	0.069	0.057	0.131	0.023	0.138
	[0.065]	[0.084]	[0.112]	[0.092]	[0.095]
Accept Engineers from Supplier	**0.250****	**0.249****	**0.261***	**0.279****	**0.196+**
	[0.060]	**[0.073]**	**[0.111]**	**[0.077]**	**[0.101]**
Multinational Enterprises	0.240**	0.247**	0.242*	0.242**	0.269**
	[0.058]	[0.071]	[0.111]	[0.079]	[0.094]
Age	-0.001	-0.002	-0.002	-0.002	-0.002
	[0.002]	[0.003]	[0.003]	[0.003]	[0.003]
Full-time Employees	0.000**	0.000**	0.001**	0.000**	0.000**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-0.361**	-0.413**	-0.344**	-0.355**	-0.364**
	[0.061]	[0.078]	[0.103]	[0.090]	[0.079]
Philippines	-0.331**	-0.476**	-0.199*	-0.408**	-0.297**
	[0.062]	[0.079]	[0.094]	[0.098]	[0.081]
Vietnam	-0.270**	-0.361**	0.002	-0.279*	-0.208
	[0.078]	[0.097]	[0.230]	[0.109]	[0.133]
Observations	587	376	211	325	262

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 34. Engineer Dispatch to Customers/Suppliers and Adopted ISO

Probit (Marginal Effects)	(1)	(2)	(3)	(4)	(5)
Dependent variables: Adopted ISO (Yes/No)	All	Customer makes Customized Product	Customer makes Standard Product	Supplier makes Customized Product	Supplier makes Standard Product
Dispatch Engineers to Customer	**0.193****	**0.190***	**0.226+**	**0.198***	**0.197+**
	[0.067]	**[0.079]**	**[0.124]**	**[0.082]**	**[0.109]**
Dispatch Engineers to Supplier	0.087	0.025	0.178	0.005	**0.207+**
	[0.082]	[0.101]	[0.136]	[0.110]	**[0.116]**
Multinational Enterprises	0.323**	0.342**	0.289**	0.353**	0.291**
	[0.053]	[0.062]	[0.107]	[0.067]	[0.093]
Age	-0.002	-0.003	-0.002	-0.002	-0.001
	[0.002]	[0.002]	[0.004]	[0.003]	[0.003]
Full-time Employees	0.000**	0.000**	0.001**	0.000**	0.000**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-0.362**	-0.422**	-0.324**	-0.367**	-0.356**
	[0.060]	[0.077]	[0.103]	[0.088]	[0.080]
Philippines	-0.350**	-0.490**	-0.224*	-0.446**	-0.310**
	[0.061]	[0.077]	[0.095]	[0.095]	[0.080]
Vietnam	-0.213**	-0.315**	-0.055	-0.246*	-0.254+
	[0.076]	[0.095]	[0.254]	[0.106]	[0.137]
Observations	587	376	211	325	262

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Making investments to deal with disequilibria is another kind of process innovation. The dependent variable is equal to one if a firm invests in internal activities that will help it adjust to changes in the market. As reported in Table 35, the coefficient for accepting engineers from the supplier is .332 with a standard error of .053. Thus, firms that accept engineers from suppliers are more likely to make investments that will enable them to adjust to changes in the market. Table 36 shows that the coefficient for dispatching engineers to the customer is .218 with a standard error of .059 while the coefficient for dispatching engineers to the supplier is .150 with a standard error of .073. The impacts on process innovation of the practice of dispatching engineers is higher for firms that dispatch engineers to customers than for firms that dispatch engineers to suppliers in the face of market disequilibria or market turbulence. In summary, process innovation aimed at enabling a firm to respond to changes in the external market environment is positively related to the practice of accepting engineers from suppliers and dispatching engineers to main customers.

Table 35. Engineer Acceptance from Customers/Suppliers and Adjust Changes in the Market

Probit (Marginal Effects)	(1)	(2)	(3)	(4)	(5)
Dependent variables: Introduced Internal Acitivities to Adjust Changes in the Market (Yes/No)	All	Customer makes Customized Product	Customer makes Standard Product	Supplier makes Customized Product	Supplier makes Standard Product
Accept Engineers from Customer	0.061	0.102	-0.051	0.138	-0.025
	[0.066]	[0.080]	[0.112]	[0.091]	[0.094]
Accept Engineers from Supplier	**0.332****	**0.336****	**0.368****	**0.308****	**0.367****
	[0.053]	**[0.065]**	**[0.084]**	**[0.077]**	**[0.065]**
Multinational Enterprises	0.140*	0.103	0.201+	0.153+	0.147
	[0.062]	[0.078]	[0.114]	[0.082]	[0.102]
Age	-0.001	-0.002	0.003	0.000	-0.002
	[0.002]	[0.003]	[0.003]	[0.003]	[0.003]
Full-time Employees	0.000**	0.000**	0.000*	0.000**	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-0.612**	-0.584**	-0.695**	-0.553**	-0.667**
	[0.051]	[0.073]	[0.061]	[0.083]	[0.056]
Philippines	-0.370**	-0.386**	-0.379**	-0.397**	-0.374**
	[0.066]	[0.098]	[0.090]	[0.109]	[0.080]
Vietnam	-0.407**	-0.457**	0.042	-0.400**	-0.346*
	[0.081]	[0.100]	[0.249]	[0.111]	[0.135]
Observations	587	376	211	325	262

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 36. Engineer Dispatch to Customers/Suppliers and Adjust Changes in the Market

Probit (Marginal Effects)	(1)	(2)	(3)	(4)	(5)
Dependent variables: Introduced Internal Acitivities to Adjust Changes in the Market (Yes/No)	All	Customer makes Customized Product	Customer makes Standard Product	Supplier makes Customized Product	Supplier makes Standard Product
Dispatch Engineers to Customer	**0.218****	**0.228****	0.113	**0.215****	**0.236****
	[0.059]	**[0.067]**	[0.125]	**[0.079]**	**[0.089]**
Dispatch Engineers to Supplier	**0.150***	0.096	**0.282****	0.117	**0.198+**
	[0.073]	[0.093]	**[0.104]**	[0.103]	**[0.103]**
Multinational Enterprises	0.255**	0.256**	0.252*	0.305**	0.175+
	[0.053]	[0.063]	[0.105]	[0.065]	[0.099]
Age	-0.001	-0.003	0.004	-0.001	-0.002
	[0.002]	[0.003]	[0.003]	[0.003]	[0.003]
Full-time Employees	0.000**	0.000**	0.000*	0.000**	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-0.613**	-0.595**	-0.681**	-0.560**	-0.658**
	[0.050]	[0.071]	[0.062]	[0.081]	[0.056]
Philippines	-0.399**	-0.406**	-0.408**	-0.449**	-0.385**
	[0.066]	[0.098]	[0.089]	[0.106]	[0.080]
Vietnam	-0.343**	-0.382**	-0.107	-0.312**	-0.423**
	[0.083]	[0.103]	[0.283]	[0.113]	[0.129]
Observations	587	376	211	325	262

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Finally, the formation of a JIT system is also a proxy of information exchanges on production linkages. Table 37 reports the impacts of forming a JIT system with the main customer and supplier on earning ISO certification, which is a type of process innovation towards the external market. The independent variables of forming a JIT system with the customer or supplier are equal to 1 if a firm forms a JIT system for production and distribution with its main customer or supplier, respectively, and are equal to zero otherwise. Table 37 shows that the coefficient for a JIT system with the customer is .245 with a standard error of .100 if the customer produces a standard product. The coefficient for a JIT system with the supplier is .225 with a standard error of .098 if the supplier produces a customized product. These results indicate that firms that form a JIT system with a customer have a significantly higher probability of getting ISO certified than firms that do not have a JIT system with their main customer.

Table 37. JIT with Customers/Suppliers and Adopted ISO

Probit (Marginal Effects)	(1)	(2)	(3)	(4)	(5)
Dependent variables: Adopted ISO (Yes/No)	All	Customer makes Customized Product	Customer makes Standard Product	Supplier makes Customized Product	Supplier makes Standard Product
JIT with Customer	**0.122+**	0.106	**0.245***	**0.225***	0.071
	[0.068]	[0.095]	**[0.100]**	**[0.098]**	[0.092]
JIT with Supplier	-0.041	0.027	**-0.204+**	-0.015	-0.054
	[0.071]	[0.092]	**[0.113]**	[0.100]	[0.099]
Multinational Enterprises	0.310**	0.331**	0.252*	0.350**	0.278**
	[0.053]	[0.063]	[0.104]	[0.068]	[0.089]
Age	-0.002	-0.002	-0.002	-0.002	-0.001
	[0.002]	[0.002]	[0.003]	[0.003]	[0.003]
Full-time Employees	0.000**	0.000**	0.001**	0.000**	0.000**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-0.375**	-0.464**	-0.301*	-0.466**	-0.344**
	[0.063]	[0.077]	[0.118]	[0.092]	[0.084]
Philippines	-0.322**	-0.483**	-0.153	-0.493**	-0.241**
	[0.063]	[0.079]	[0.100]	[0.092]	[0.082]
Vietnam	-0.149+	-0.265**	0.174	-0.196+	-0.116
	[0.079]	[0.097]	[0.202]	[0.108]	[0.152]
Observations	587	376	211	325	262

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 38 presents the impact of forming a JIT system with a customer on a firm's ability to adjust to changes in the market. The empirical question here is whether a JIT system provides information flows in the face of market changes or market turbulence. The coefficient for a JIT system with the customer is .206 with a standard error of .102 if the customer produces a standard product, indicating that the firm that forms a JIT system with a customer has a higher probability of investing in internal activities that will help it adjust to changes in the market. Overall, a process innovation that helps a firm adjust to changes in the market environment, for example, ISO certification or market turbulence, is positively related to JIT system with a customer.

Table 38. JIT with Customers/Suppliers and Adjust Changes in the Market

Probit (Marginal Effects)	(1)	(2)	(3)	(4)	(5)
Dependent variables: Introduced Internal Acitivities to Adjust Changes in the Market (Yes/No)	All	Customer makes Customized Product	Customer makes Standard Product	Supplier makes Customized Product	Supplier makes Standard Product
JIT with Customer	**0.117+**	0.085	**0.206***	0.147	0.114
	[0.066]	[0.090]	**[0.102]**	[0.099]	[0.090]
JIT with Supplier	-0.042	0.030	-0.178	0.014	-0.089
	[0.067]	[0.087]	[0.111]	[0.098]	[0.095]
Multinational Enterprises	0.240**	0.235**	0.238*	0.295**	0.180*
	[0.052]	[0.064]	[0.100]	[0.065]	[0.091]
Age	-0.001	-0.003	0.003	0.000	-0.002
	[0.002]	[0.003]	[0.003]	[0.003]	[0.003]
Full-time Employees	0.000**	0.000**	0.000**	0.000**	0.000*
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	-0.606**	-0.608**	-0.661**	-0.603**	-0.637**
	[0.053]	[0.072]	[0.070]	[0.085]	[0.060]
Philippines	-0.361**	-0.378**	-0.347**	-0.457**	-0.325**
	[0.067]	[0.099]	[0.095]	[0.106]	[0.083]
Vietnam	-0.269**	-0.314**	0.147	-0.257*	-0.276+
	[0.085]	[0.103]	[0.202]	[0.113]	[0.155]
Observations	587	376	211	325	262

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

7. REASONS FIRMS WITH MANY LINKAGES AND FIRMS WITH DIRECT INFORMATION FLOWS FROM PARTNERS ARE MORE SUCCESSFUL

Empirical evidence based on both univariate comparisons and multivariate tests suggest two findings about the impacts of linkages on innovations. First, firms with many linkages achieve many types of product and process innovations. In particular, compared to firms that do not have many linkages, firms with many linkages achieved many types of organizational changes in response to changes in the market environment and market-based process innovations, such as earning ISO certification, investment in ICT to communicate to trade partners, investment in internal activities to adjust to market turbulence, and securing new suppliers and customers. Second, information flows, especially face-to-face communication and frequent exchanges in information, play an important role in achieving product and process innovations. In particular, compared to firms that do not accept engineers from main partners or dispatch engineers to main partners, firms that interact with main partners are more likely to introduce new product varieties, organizational changes in response to changes in the market environment, and market-based process innovations.

7.1. The Value of Knowledge Diversity

One reason for the success of firms with many linkages is that each type of linkage provides unique information about upgrading business processes and changes in the market. Linkages variable is constructed by two different types of linkages: production and intellectual linkages. The former means linkages with several production partners that are located within or between areas of concentration. The latter means linkages with universities, research, and public business organizations that are located within or between areas of concentration. The empirical results also imply that two extremely different types of linkages complement product and process innovations. These linkages do not cancel out each other's contributions. The empirical results clearly suggest that the combination of two different sources of knowledge is valuable for innovations.

7.2. Accuracy Arising from Interactions

Although the number of types of linkages increases the number of types of product and process innovations, internal resources have the most important impact for innovations. Product and process innovations are, by nature, a process of trial and error. One of the reasons why many types of linkages are beneficial to innovations is that the number of types of linkages and internal resources are interpreted using instruments that help produce more accurate information compared to trial and error. If firms have many types of production linkages, the number and diversity of linkages would insure accuracy when firms invest in innovations. This is supported by the empirical evidence that the variety of linkages increases the number of types of product innovations when firms do not do R&D activities while the variety of linkages does not increase the number of types of product innovations when firms experiment with R&D. If firms do not already have an instrument for internal trial and error, they can learn about other firms' trials and errors only through external linkages. Firms with sufficient internal resources or with R&D activities could acquire this information by themselves.

7.3. Information Flows from Customer and Supplier Linkages

Firms with direct information flow from partners tend to be more successful because of the value brought by face-to-face communication and frequent interaction. Accepting engineers from the main supplier insures the transfer of knowledge relating to raw materials, parts, and components. If the suppliers are based in a more competitive market, the main supplier has to pay the costs of knowledge transfer, i.e., dispatching engineers to the main customer. Dispatching engineers to the main customer also insures the transfer of knowledge about production processes and market changes. Since it is critically important for firms to acquire the most accurate information about market changes, the supplier dispatches the engineers from an upstream to a downstream level. The empirical results suggest that there are backward linkages of information flows from customer to supplier. Because most suppliers are keen to acquire ISO certification to help them expand their market, they need to communicate face to face with their main customer to pay the costs of dispatching engineers.

The JIT system also provides an opportunity for frequent interactions between customers and suppliers. Frequent interactions insure the accuracy of information about market changes.

7.4. Manager's Perceptions about Obstacles for Innovations

According to Bresnahan, Brynjolfsson, and Hitt (2002), managerial perceptions about computer effects on changes in work organization would suggest causality since a manager's perception about causality could be reflected in the difference between optimal and current investment level in IT, human capital, and changes in work organization. In our survey, we asked for a manager's perception on the obstacles for innovation and upgrading. The list given includes obstacles related to high tariffs, less support from R&D services industry, labor market rigidity, and lower access to public support organizations. In addition, the managers rated the seriousness of each of the different effects on a scale of 1-5, namely: (1) Not serious; (2) Not very serious; (3) Not sure; (4) Somewhat serious; and (5) Very serious.

Ideally, if there were no frictions, managers could adjust their resources into the optimal level and thereby achieve the optimal extent for innovations. If this is true, though, then the expected response of the managers should have been point number one or "Not serious." But since some bottlenecks usually exist in the market or workplace, the manager's response would normally reflect the existence of misallocations or misadjustments in the distribution of resources. This paper thus hypothesizes that managerial beliefs are driven by the difference between the optimal investment level for achieving innovations and the current intensity of obstacles for achieving innovations. We examine this hypothesis by directly borrowing the ideas from Bresnahan, Brynjolfsson, and Hitt (2002). Dependent dummy variables are based on the managerial evaluation of obstacles for innovation and upgrading. The rating equals to one if managers rate each obstacle as “Somewhat serious” or “Very serious” and is equal to zero if otherwise. Independent variables include the firm’s characteristics (linkages and capital structure which reflect information sources) and nationality.

We find that there is a clear difference in managerial perception about obstacles across firm and country characteristics. Table 39 shows the coefficient for Vietnam to be .446, with a standard error of .034 when we take the difference in the variety of linkages into account. Compared to firms in Thailand, Vietnamese firms, on average, feel that higher tariffs on equipments and materials are bottlenecks for innovations and upgrading. The variety of linkages also affects the managerial evaluation. The coefficient for the number of production linkages (number of intellectual linkages) is .017 (.029), with a standard error of .005 (.009). Firms with many types of linkages feel that higher tariffs are bottlenecks for innovations and upgrading. As reported in a previous section, firms with many linkages also achieve many types of innovations and a higher possibility of market-based innovations. The target level of innovations and intensity for such firm are usually higher and deeper compared to firms with fewer linkages. This result suggests the need for a policy reducing tariffs for innovations and upgrading, especially for Vietnam.

We also turn to the policy needs at the national level, that is, labor market rigidity, price and existence of R&D support, and Intellectual Property Right (IPR) policy. Table 40 reports that the coefficient for multinationals is positive and significant for ratings indicating serious country-wide market obstacles. These obstacles are not appropriate at the local level and should be targeted at the national level. It is beneficial especially for inviting and improving multinational activities to implement the policy of “wheel-greasing” or addressing problems of labor market rigidity, prevalence of less expensive R&D support, and limitation of copying.

Finally, we also show the policy needs at the local level, namely: (1) familiarity to local public support program; (2) addressing mismatch with public support program; (3) local public support in providing training courses or testing facilities; and (4) geographic proximity to local university and public research institute. Table 41 reports that the coefficient for multinationals is negative and significant for ratings indicating serious local level constraints. These results suggest that local and joint venture firms are not familiar with local public support, and public support is not designed appropriately for local firms. The current policy seems to be not beneficial for local firms to access and utilize public policy from local business organizations, chambers of commerce, local university, or public research institute. There is therefore much room for improvement of the situation regarding innovations and upgrading for local firms to maintain existing local public policy.

Table 39. Obstacles and Number of Linkages

Probit (Marginal Effects)	(1)	(2)	(3)	(4)
Dependent variables: Very Serious or Somewhat Serious (1) vs Others (0)	High tariffs on equipments and materials necessary for innovation			
Number of Linkages	0.012**			
	[0.003]			
Number of Production Linkages		0.017**		
		[0.005]		
Number of Intellectual Linkages			0.029**	
			[0.009]	
Number of Internal Resources				0.012
				[0.016]
Multinational Enterprises	0.023	0.023	0.024	0.032
	[0.055]	[0.055]	[0.055]	[0.054]
Age	0.001	0.001	0.001	0.001
	[0.002]	[0.002]	[0.002]	[0.002]
Full-time Employees	-0.000*	-0.000*	-0.000+	-0.000*
	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	0.433**	0.424**	0.431**	0.372**
	[0.036]	[0.036]	[0.037]	[0.039]
Philippines	0.324**	0.305**	0.314**	0.173**
	[0.060]	[0.059]	[0.060]	[0.060]
Vietnam	**0.446****	**0.422****	**0.473****	**0.397****
	[0.034]	**[0.034]**	**[0.034]**	**[0.036]**
Observations	587	587	587	587

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 40. Obstacles for Multinationals and Policy Needs at National Level

Probit (Marginal Effects)	(1)	(2)	(3)	(4)
Dependent variables: Very Serious or Somewhat Serious (1) vs Others (0)	Labor Mobility is too rigid for workers to bring with them technologies	Price of R&D support services is high	No R&D supporting industry such as consulting, financing	Protection of intellectual property right (IPR) is not sufficient
Number of Linkages	0.010**	0	0.007+	0.018**
	[0.004]	[0.003]	[0.004]	[0.004]
Multinational Enterprises	**0.176****	**0.130***	0.074	**0.147***
	[0.058]	**[0.055]**	[0.058]	**[0.060]**
Age	0.002	0.003	0.002	-0.002
	[0.002]	[0.002]	[0.002]	[0.002]
Full-time Employees	0	0	-0.000*	-0.000**
	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	0.336**	0.231**	0.426**	0.499**
	[0.067]	[0.062]	[0.054]	[0.050]
Philippines	0.102	0.113	0.230**	0.368**
	[0.090]	[0.079]	[0.081]	[0.080]
Vietnam	0.443**	0.310**	0.392**	0.581**
	[0.060]	[0.061]	[0.059]	[0.038]
Observations	587	587	587	587

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

Table 41. Obstacles for Local Firms and Policy Needs at Local Level

Probit (Marginal Effects)	(1)	(2)	(3)	(4)
Dependent variables: Very Serious or Somewhat Serious (1) vs Others (0)	My establishment is not familiar with public support programs and procedures to apply for support measures	Public support programs are not designed appropriately for innovation	No business organization or chamber of commerce which can provide training courses, seminar or testing facilities	No university or public institute in the neighborhood
Number of Linkages	0.012**	0.012**	0.007*	0.008**
	[0.003]	[0.003]	[0.003]	[0.003]
Multinational Enterprises	-0.289**	-0.147**	-0.201**	-0.109*
	[0.050]	[0.054]	[0.050]	[0.045]
Age	0.004*	0.002	-0.003	0
	[0.002]	[0.002]	[0.002]	[0.002]
Full-time Employees	0	0	0	0
	[0.000]	[0.000]	[0.000]	[0.000]
Indonesia	0.361**	0.444**	0.498**	0.357**
	[0.074]	[0.069]	[0.066]	[0.073]
Philippines	0.386**	0.368**	0.413**	0.215**
	[0.081]	[0.082]	[0.081]	[0.077]
Vietnam	0.399**	0.169+	0.126	0.135
	[0.077]	[0.089]	[0.093]	[0.083]
Observations	587	587	587	587

Notes: Robust standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%. Reference country is Thailand.

8. CONCLUSION

In East Asia, a complex production network has been constructed utilizing wage disparity and lower transportation costs across countries in the region. Lower transportation costs between regions foster the fragmentation of production processes over borders. In particular, the intermediate process is more complex, skill intensive, and higher paid while the final process is easier to build, unskilled-labor intensive, and lower paid. On the other hand, since both interfirm supplier-customer relationships and intrafirm upstream and downstream processes face higher transportation costs, firms with capital tie-up to their main trading partners tend to colocate near one another.

From the viewpoint of spatial economic theory, it is unclear whether geographic proximity between firms tends to spur knowledge transfer between upstream and downstream processes within a concentrated area. On one hand, colocation stimulates frequent communication between firms. On the other hand, the mobility of engineers (dispatching of workers to partners and accepting of workers from partners) between firms was shown to be more frequent for firms located in remote areas than nearer their main trading partners. Empirical work was needed to provide a solution. To detect the origin and destination of knowledge flow between upstream and downstream processes, we collected information on engineer mobility and implementation of the JIT system to estimate the strength of ties.

The empirical results suggest that firms with many linkages, with face-to-face communication at the engineer level, and with frequent interaction with production partners are able to innovate successfully, particularly in the areas of organizational reform toward external markets and market-based process innovations like creation of new markets and securing new sources of input. We offer the following three hypotheses as a possible explanation for these results: (1) Many types of linkages or combinations of different types of linkages provide the value of knowledge diversity; (2) Many types of linkages provide the opportunity to get accurate information about other firms' trials and errors for firms without their own R&D department or sufficient internal resources; (3) Face-to-face communication and frequent interaction with production partners provide a chance to acquire deep and correct information about changes in the market and market turbulence.

Finally, we derive two policy suggestions based on these empirical results. First, policy resources should target firms that have a few production and intellectual linkages, particularly small- and medium-sized firms in East Asia. Linked firms receive benefits from partners while providing important information about market changes to their other partners, especially their supplier. It is also important to devote policy resources to the implementation of a JIT system. If there are some obstacles to implementing a JIT system that will help firms upgrade, public assistance can be tapped to create such a network. Economies of network based on production linkages could create such externality.

Second, policy resources should be allocated to the reduction of obstacles to engineer mobility in East Asia. Since engineer mobility happens at the local and international levels, (1) insuring free mobility of engineers or simplifying immigration procedures and (2) creating common certification of engineers' skills in East Asia could stimulate the upgrading of firms and industries through face-to-face communication at the different stages of product and process innovation.

REFERENCES

Brambilla, I., (2006), “Multinationals, Technology, and the Introduction of Varieties of Goods,” *NBER Working Paper* No. 12217.

Bresnahan, T F., Brynjolfsson, E., and Hitt, L M., (2002), “Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm Level Evidence,” *The Quarterly Journal of Economics*, 117(1):339-376.

Bloom, N., Draca, M., and van Reenen, J., (2008), “Trade Induced Technical Change? The Impact of Chinese Imports on IT and Innovation,” mimeo, Stanford University and London School of Economics.

Comebs, P.P., Mayer, T., and Thisse, J-F., (2008), *Economic Geography: The Integration of Regions and Nations*, Princeton University Press, New Jersey.

Combes, P.P., Duranton, G., Gobillon, L., Puga, D., and Roux, S., (in progress) “The Productivity Advantages of Large Markets: Distinguishing Agglomeration from Firm Selection,” Manuscript, GREQAM, INED, University of Toronto, IMDEA and CREST.

Conley, T., and Udry, C., (2008), “Learning about a New Technology: Pineapple in Ghana,” forthcoming, *American Economic Review*.

Ellison, G., and Glaeser, E L., (1999), “The Geographic Concentration of Industry: Does Natural Advantage Explain Agglomeration?,” *American Economic Review Papers and Proceedings*, 89 (2), 311-316.

Ellison, G., Glaeser, E L., and Kerr, W R., (2009), “What Causes Industry Agglomeration? Evidence from Coagglomeration Patterns,” mimeo.

Glaeser, E L., Kallal, H D., Scheinkman, J A., and Shleifer A., (1992), “Growth in Cities,” *Journal of Political Economy*, 100(6): 1126-52.

Gorodnichenko,Y., Svejnar, J., and Terrell, K., (2008), “Globalization and Innovation in Emerging Markets,” *NBER Working Paper* No. 14481.

Greenstone, M., Hornbeck, R., and Moretti, E., (2008), “Identifying Agglomeration Spillovers: Evidence from Million Dollar Plants,” *NBER Working Paper* No. 13833.

Karpoff, J., 2001, Public versus Private Initiative in Arctic Exploration: The Effects of Incentives and Organizational Structure, *Journal of Political Economy*, 109(1): 38-78.

Lucas, R E. Jr., (1988), “On the Mechanics of Economic Development,” *Journal of Monetary Economics*, Vol. 22, No. 1: 3-42.

Machikita, T., and Ueki, Y (2009), “Linked versus Non-linked Firms in Innovation: The Effects of Economies of Network in Agglomeration in East Asia,” *IDE Discussion Paper* No. 188.

Ramstetter E. D., and Sjoholm F., (2006), *Multinationals Corporations in Indonesia and Thailand: Wages, Productivity, and Exports*, Palgrave Macmillan, Basingstorke.

Rosenthal, S. and Strange, W., (2004), “Evidence on the Nature and Sources of Agglomeration Economies,” in: Henderson, J.V. and J.-F. Thisse (eds.) *Handbook of Regional and Urban Economics*, Vol. 4, North-Holland: Elsevier, 2713-2739.

Syverson, C, (2004), “Market Structure and Productivity: A Concrete Example” *Journal of Political Economy*, 112(6): 1181–1222.

Teshima, K., (2008), “Import Competition and Innovation at the Plant Level: Evidence from

Mexico," mimeo, Columbia University.

6

The Second Generation of Geographical Simulation Model: Predicting the Effects of Infrastructure Development by Industry

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Abstract

The original IDE Geographical Simulation Model (IDE-GSM) has been developed with two major objectives: (1) to determine the dynamics of locations of populations and industries in East Asia in the long term, and (2) to analyze the impact of specific infrastructure projects on the regional economy at sub-national levels. The second generation of IDE-GSM has been expanded to predict changes in the location of populations and industries in regions for seven sectors, namely, agriculture, automotive, electric and electronics, textile and garment, food processing, other manufacturing and service. The simulations revealed that the effects of infrastructure development on each region are significantly different by industry. The economic impacts of such development depend on the initial distribution and characteristics of each industry. Determining such impacts is a complex process that is hard to predict without accurate data and a solid simulation model. As such, the IDE-GSM must be developed further while coordination of geographical statistical systems among Economic Research Institute for ASEAN and East Asia (ERIA) member countries must be facilitated.

1. INTRODUCTION

The original IDE Geographical Simulation Model (IDE-GSM) was developed with two major objectives: (1) to determine the dynamics of locations of populations and industries in East Asia in the long-term, and (2) to analyze the impact of specific infrastructure projects on the regional economy at sub-national levels.

The simulations using IDE-GSM revealed that (1) border costs play a big role and (2) nominal wages matter more than expected. In the simulations, the elimination of border costs seems to be much more effective than the development of physical infrastructure only. In continental South-East Asia (CSEA), there are huge disparities in nominal wages, not only internationally but also intra-nationally. They are so large that small advantages in location cannot counter the centripetal force of some central regions that induces the inflow of population and is caused by higher nominal wages.

Based on this study, Bangkok and its satellite regions, Ho Chi Minh and its satellite regions, and other capital cities and surrounding regions provide higher nominal wages than the national average, and most of these areas have location advantages (Kumagai *et al.* 2008).

To make it possible for IDE-GSM to derive more concrete policy implications, the model is further developed in this year's study. Most notably, the industrial sectors in the model are extended from three to seven. This extension allows a more precise prediction of the impacts of infrastructure development on each industry and more industry-specific policy implications.

This study is organized as follows: Section 1 shows the details of expansion of IDE-GSM. Section 2 explains the model and parameters used in the simulations. Section 3 explains scenarios and results of the simulations. The concluding section, 4, outlines the policy implications of this study.

2. POINTS OF EXPANSION FOR SECOND-GENERATION IDE-GSM

The first generation of IDE-GSM has three sectors: (1) agriculture, (2) manufacturing, and (3) service. On the other hand, the second generation of IDE-GSM is expanded to predict changes in the location of populations and industries in regions for seven sectors, namely, (1) agriculture, (2a) automotive, (2b) electric and electronics, (2c) textile and garment, (2d) food processing, (2e) other manufacturing and (3) service.

Dividing manufacturing sector into five sub-sectors enables various analyses that are not possible in the first generation of the model. For instance, now we can predict which industry locates where more precisely. We also estimate the impacts of a specific infrastructure project, e.g., East West Economic Corridor (EWEC) on a specific industry in a specific location, e.g., automotive industry in Bangkok.

3. UNDERSTANDING THE MODEL AND ITS PARAMETERS

The basic structure of the model is unchanged from the first generation of IDE-GSM, which is basically based on the model introduced in Fujita-Krugman-Venables (FKV) (1999).

The biggest difference between the first and the second generation of IDE-GSM lies in the definition of the manufacturing sector. In the first generation model, the sector is defined as one sector, with its own product and labor as inputs. In the second-generation model, the sector is divided into five sub-sectors, as earlier mentioned. Each sub-sector uses its own product and labor as inputs. This means that the input-output table in this world is zero-filled except for the diagonal elements. It seems to be a radical simplification, but not too unrealistic, since the five sub-sectors are sufficiently differentiated from each other.

3.1. Specifications for Five Sub-sectors in the Manufacturing Sector

The biggest problem is how to differentiate these five sub-sectors in the model. In addition to the initial geographical distribution of each sector, there are four possible sources of differences for this model:

- Transport costs (T)
- Elasticity of substitution (σ)
- Share of labor input (β)
- Share in consumption (μ)

Based on the foregoing sources, Table 1 shows the parameters for each sector, which are assumed to be common in all countries.

Table 1: Parameters specifying each industry

	T	σ	β	μ
Automotive	1.153	7	0.262	0.050
Electronics & Electric	1.071	10	0.228	0.063
Textile, Garment	1.153	8	0.329	0.045
Food Processing	1.218	5	0.303	0.046
Others	1.089	5	0.281	0.079

Source: Authors.

3.2. Parameters

3.2.1. Transport costs

Transport costs are defined by industry. (1) For the manufacturing sector, transport costs are presented in Table 1. These are based on the domestic-trade cost margin data from the Asian Input Output Table by Institute of Developing Economies (2006). Transport costs are standardized by assuming that goods are moving 634km, the average distance of arbitrary two points in the region covered by the model[i]. Thus, T=1.153 means that 1.00 out of 1.153 units of goods shipped from one part of continental South East Asia (CSEA) arrived in other parts of CSEA. It can be assumed that bringing goods from one part of CSEA to another requires a 15.3 percent overhead cost on the price of the goods. (2) T_S stands for the service sector and is typically equal to 50. T_S= 50 means that bringing a service to another place is exorbitantly costly; most service is consumed where the service is provided.

3.2.2. Elasticity of substitution

Elasticity of substitution between goods is also defined by industry. The elasticities for manufacturing sectors are defined in Table 1. These are based on the estimation by Hummels (1999). σ_S represents the service sector and typically equals 50[ii]. If σ=1.0, then two goods are perfectly differentiated and cannot be substituted for one another. Conversely, $\sigma = \infty$ means that the two goods are perfect substitutes for each other. Thus, σ_M=5 to 10 implies that goods are highly differentiated in the manufacturing sector, and σ_S=50 indicates that services are not highly differentiated; one can enjoy similar services wherever one is located.

3.2.3. Parameters for labor mobility

Parameters within a region for labor mobility are set in three levels: (1) international labor mobility (γ_N), (2) intra-national (or inter-city) labor mobility (γ_C), and (3) inter-industry labor mobility (γ_I). A value of $\gamma = 1.0$ indicates that a country or region having two times higher real wages than average induces 100 percent labor inflow in a year.

If γ_N=0 is set, international migration of labor is prohibited. Although this looks like an extreme assumption, it is reasonable given that most Association of Southeast Asian Nations or ASEAN countries strictly control incoming foreign labor[iii].

If γ_C=0.02 is set, a region having two times higher real wages than the national average will induce 2 percent labor inflow in a year.

If γ_I=0.05 is set, an industrial sector with two times higher real wages than average in the region will induce 5 percent labor inflow from other industrial sectors in a year.

3.2.4. Other parameters

The consumption shares of manufactured goods are shown in Table 1 and that of services (ν) is at 0.612. That of the agricultural good is at 0.105. These must be calibrated and differentiated for each country. However, for simplicity, an identical utility function is used for consumers in all countries, based on an aggregated consumption share of the CSEA regions in the model.

Set the cost share of labor in the production of agricultural good (α) at 0.633 and that of manufactured goods (β) at the values indicated in Table 1. The input share of intermediate goods in manufactured goods production is 1-β. In the future, these parameters should be more carefully calibrated for each industry. These are set based on the Input-Output table for Thailand[iv].

4. COMPARING INDUSTRY PERFORMANCE IN SPECIFIC SCENARIOS

Comparing the performance of each industry under certain scenarios poses some difficulty. If we use the absolute value of output or number of employees of a specific industry for each region in order to compare the performance of industrial sectors, big cities such as Bangkok and territories like Hong Kong will always emerge as outperforming other small regions. This problem is caused by the lack of uniform rules on division of region like the Nomenclature of Territorial Units for Statistics (NUTS) established more than 25 years ago by EUROSTAT.

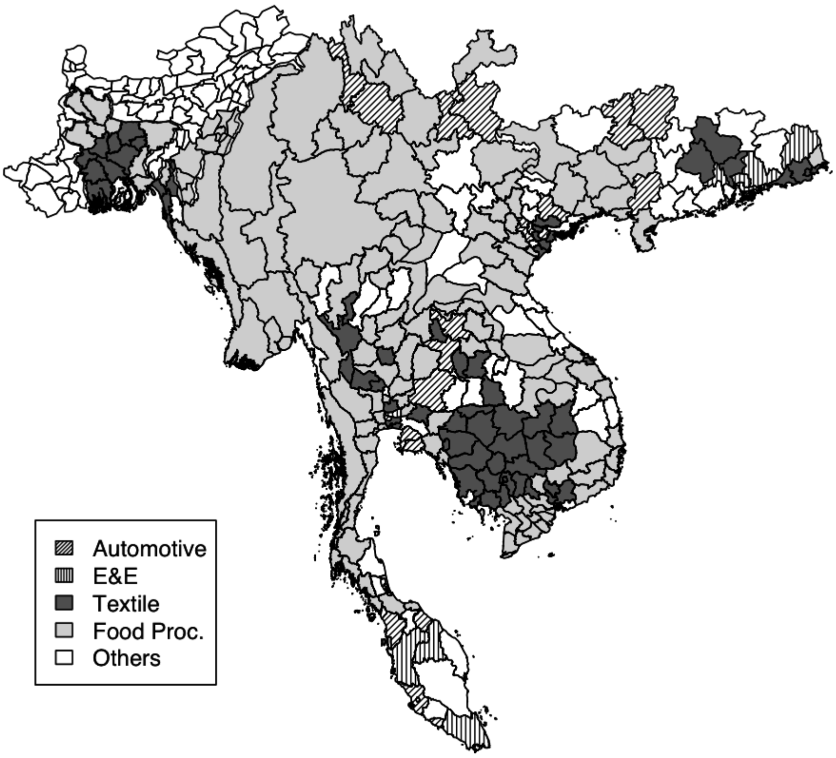
The growth rate of output or number of employee also has poses problems, because each region significantly differs from each other in size. The region whose automotive industry has very small production may initially grow at an extremely high rate, but the absolute value of production will still be very small even after such growth is achieved.

This paper essentially applies the relative importance of each industrial sector within a region. More specifically, it has used to a large extent, the Revealed Symmetry Comparative Advantage (RSCA[v]) index to determine the relative importance of each industrial sector in each region. The RSCA takes the value between -1 to +1. If the share of an industrial sector in a region exactly matches the CSEA regional average, the RSCA takes 0, meaning the industry in that region has neither advantage nor disadvantage. If the share of an industry in the region is larger than the CSEA average, the RSCA for the industry takes a positive value, and vice versa.

Figure 1 shows which of the five manufacturing sectors is in the most advantageous position in each region. It is 1) the electronics sector in Singapore, some regions in Malaysia, and some parts of China; 2) the automotive sector in Bangkok and northern Thailand, Selangor and Malacca in Malaysia, and northern Vietnam; 3) the textile and garment sector in Cambodia, northern Thailand, and some parts of Bangladesh; 4) while it is the food processing sector in many regions in CSEA, except for Singapore and Malaysia.

Figure 1 significant and even revolutionary because nothing comparable is available so far that could help one determine at a glance the geographical distribution of the manufacturing sectors in the CSEA region. The source data were compiled from various national statistics by the authors. Compiling these data was met with various difficulties such as the non-existence of standards for the generation of geo-economic data published by each government in the ERIA countries.

Figure 1: Most advantageous industry in each region (2005)



Source: Compiled from various national statistics by the authors.

5. SCENARIOS AND RESULTS

5.1. Scenarios

Two scenarios reveal the effects relative to the EWEC.

5.1.1. Baseline scenario with assumptions maintained

Several macroeconomic and demographic parameters may be held constant, and only logistic settings (by scenario) changed. The following macro parameters are then maintained across scenarios:

- Other things being equal, the gross domestic product (GDP) per capita of each country is assumed to increase by the average rate for the years 2000-2005[vi];
- The national population of each country is assumed to increase at the rate forecast

by the United Nations Population Fund until year 2025;

- There is no immigration between CSEA and the rest of the world.

The assumptions in the baseline scenario are as follows:

- Asian highway networks exist, and cars can run at 40km/h.
- Border costs, or times required for custom clearance, are as follows:

Singapore – Malaysia	2.0 hours
Malaysia – Thailand	8.0 hours
All other national borders	24.0 hours

5.1.2. East West Economic Corridor with customs facilitation

Following are the specific assumptions in this scenario:

- Cars can run in the EWEC at 80km/h after 2011 and on other Asian highways at 40km/h.
- Border controls along the EWEC are as efficient as those at the Singapore-Malaysia border (taking 2.0 hours to cross national borders) after 2011.

5.2. Results

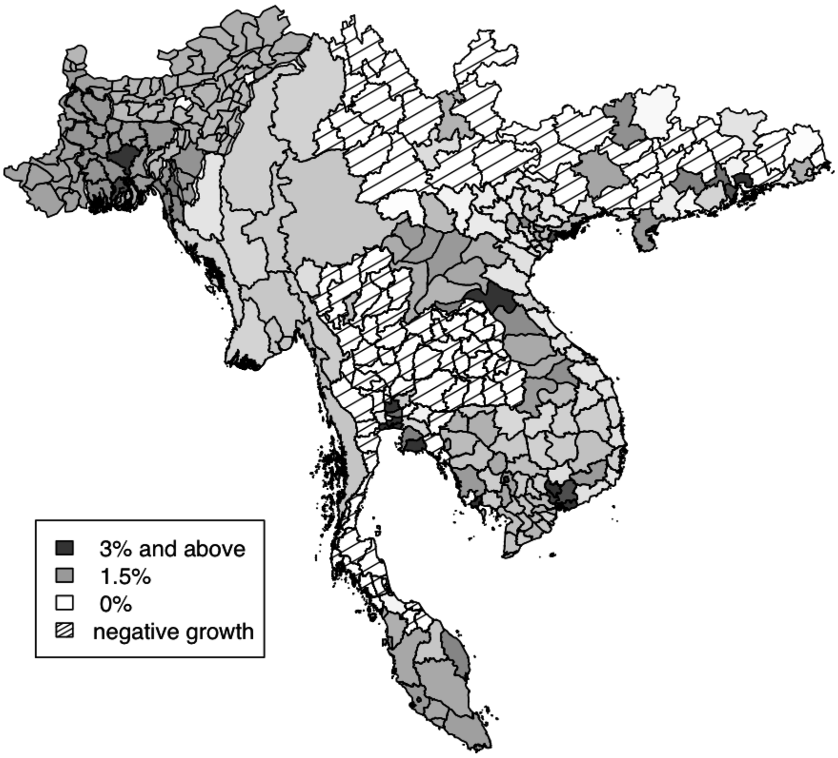
5.2.1. Baseline scenario

Population

Figure 2 shows the average population growth rate of each region from 2005 to 2025 under the baseline scenario**.** A clear trend in the agglomeration of population emerges. That is, a few regions gain population such as those surrounding Bangkok, Ho Chi Minh, and Dongguan as well as Vientiane and Krong Preah Sihanouk.

On the other hand, some regions lose population such as northern Thailand and some regions in China. Thailand seems to be a monocentric country in 2025, and China appears to have clear “core-periphery” structure at that time. The basic tendency of the population dynamics is unchanged from the first generation of IDE-GSM.

Figure 2: Average Population Growth Rate (2005-2025)



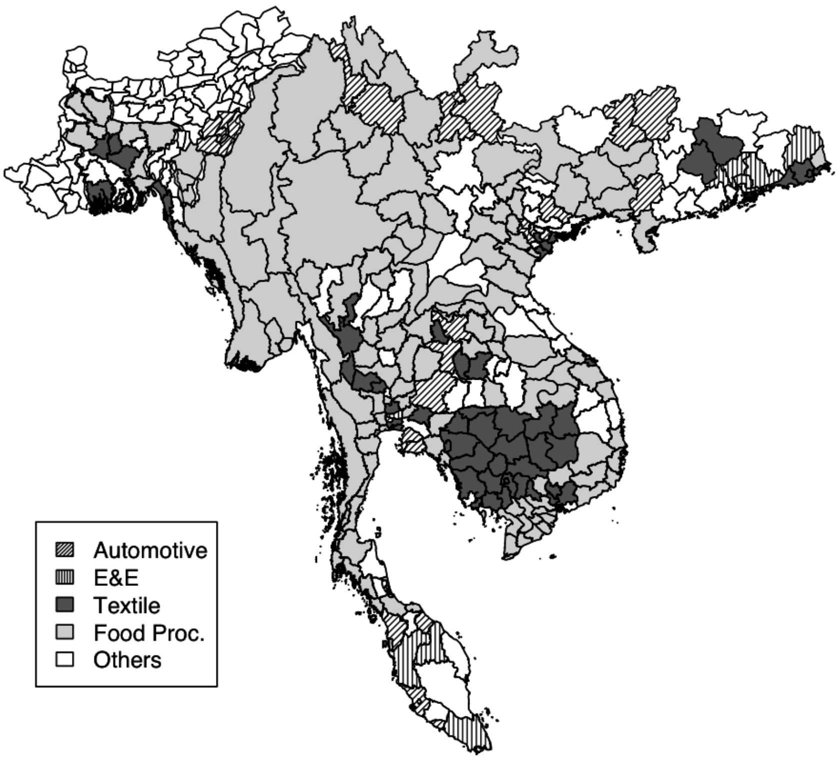
Source: IDE-GSM.

Most advantageous industry

Figure 3 shows which of the five manufacturing sectors is expected to be the most advantageous in 2025 according to the IDE-GSM. Figure 3 is not significantly different from Figure 1, which means that the advantageous sector is fairly stable in many regions.

However, some interesting changes arise, especially in the automotive sector, which is considered in an advantageous position in some regions in India. This is somewhat “mysterious” but it is understood that as India has a large population, it has a large demand for the automotive sector (partly because of homothetic consumption function across the region). This, while initial production of the sector is quite small. So, it is economically rational to start the production of automotive goods in India.

Figure 3: Most Advantaged Industry in Each Region (2025)



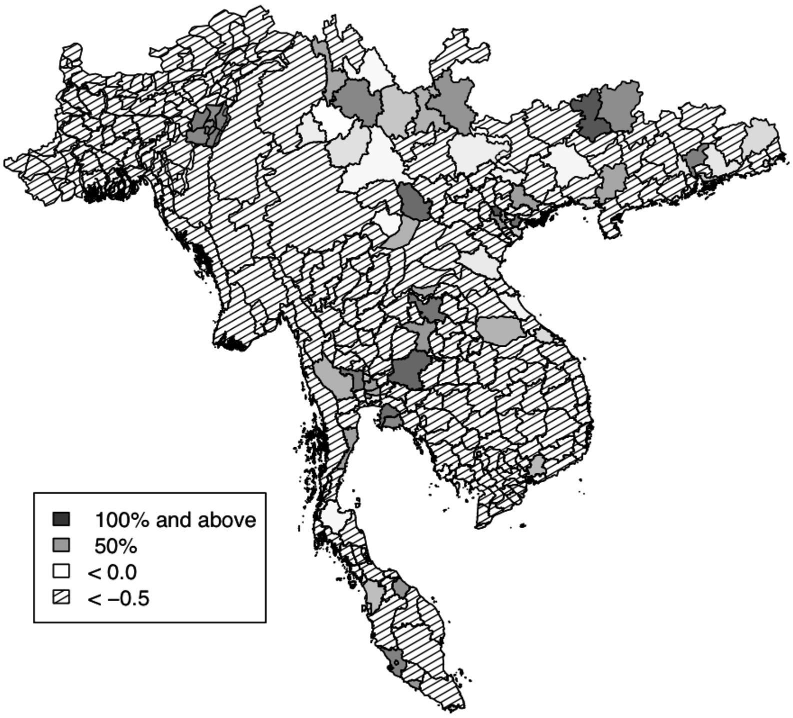
Source: IDE-GSM.

RCSA for each industry

(a) Automotive Industry.

Figure 4 shows the RSCA of automotive industry in each region in 2025. The regions that have a comparative advantage in the automotive industry are Bangkok and some areas in northern Thailand, the regions around Ho Chi Minh, Selangor and Malacca of Malaysia, and some parts of India and China. Table 2 shows the top 20 highest RSCA regions in the automotive industry. Liuzhou of China tops the rank, followed by Vinh Phuc (Vietnam) and Nakhon Ratchasima (Thailand).

Figure 4: RSCA of Automotive Industry (2025)



Source: IDE-GSM.

Table 2: Top 20 Highest RSCA Regions in Automotive Sector (2025)

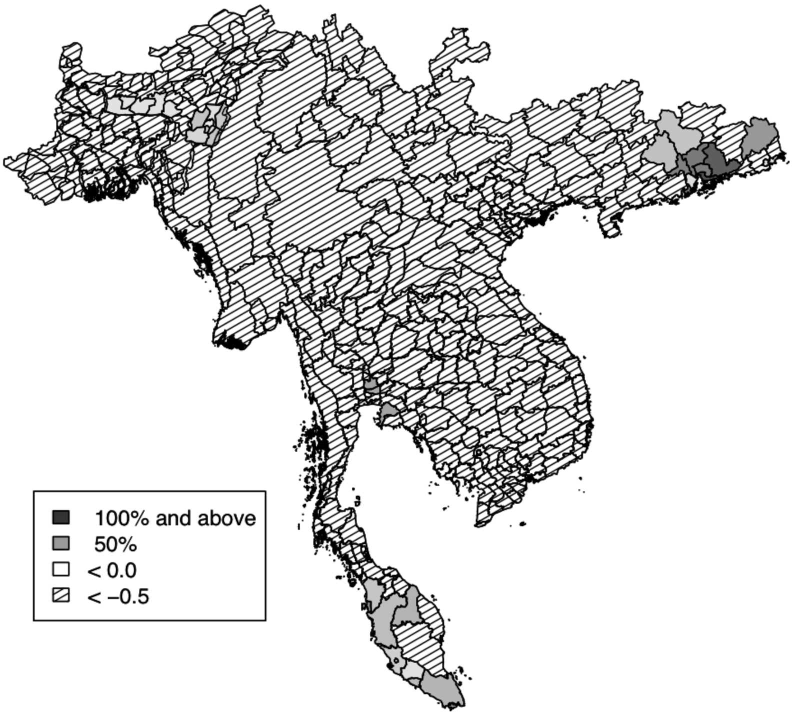
Rank	Region	Country	RSCA (2025)	RSCA (2005)
1	Liuzhou	China	0.83	0.82
2	Vinh Phuc	Vietnam	0.82	0.82
3	Nakhon Ratchasima	Thailand	0.75	0.78
4	Phongsali	Laos	0.73	0.70
5	Hai Duong	Vietnam	0.71	0.71
6	Chon Buri	Thailand	0.71	0.67
7	Udon Thani	Thailand	0.68	0.66
8	Suphan Buri	Thailand	0.67	0.68
9	Tamenglong	India	0.65	-0.79
10	Chandel	India	0.63	-0.80
11	Ukhrul	India	0.63	-0.81
12	Guangzhou	China	0.63	0.50
13	Selangor	Malaysia	0.61	0.65
14	Bishnupur	India	0.59	-0.83
15	Dali Baizu Zizhizhou	China	0.59	0.59
16	Churachandpur	India	0.58	-0.84
17	Rayong	Thailand	0.58	0.61
18	Hong Kong	Hong Kong	0.56	0.52
19	Guilin	China	0.56	0.57
20	Senapati	India	0.55	-0.86

Source: IDE-GSM.

(b) Electronics Industry

Figure 5 shows the RSCA of the electronics industry in each region. The regions that have a comparative advantage in the industry are concentrated in Singapore and Malaysia, a part of Thailand and China. Table 3 shows the top 20 highest RSCA regions in the electronics industry. Shenzhen tops the rank, followed by Heizhou (China) and Guangzhou (China). The top seven regions are in China.

Figure 5: RSCA of Electronics Industry (2025)



Source: IDE-GSM.

Table 3: Top 20 Highest RSCA Regions in Electronics Sector (2025)

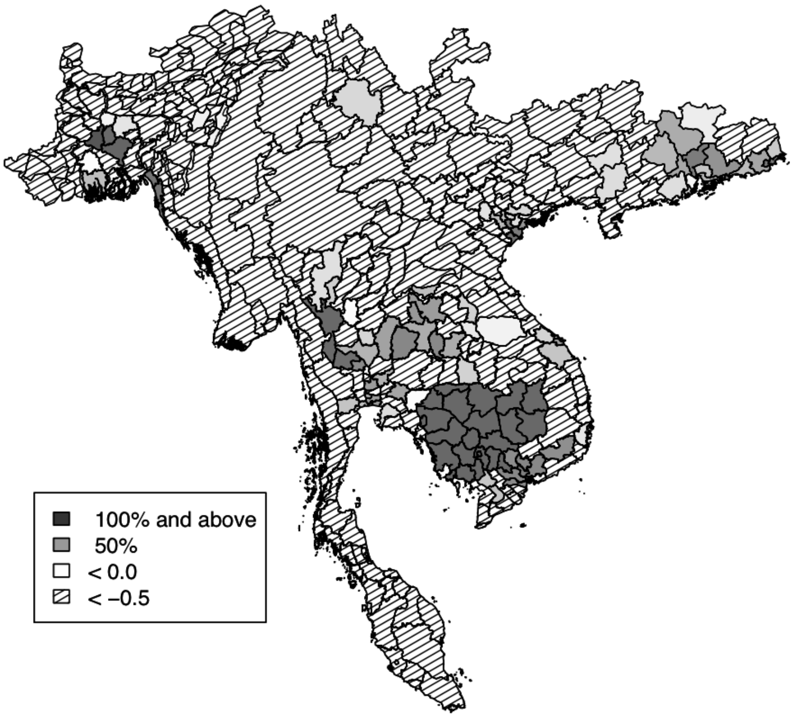
Rank	Region	Country	RSCA(2025)	RSCA(2005)
1	Shenzhen	China	0.85	0.75
2	Heizhou	China	0.79	0.69
3	Guangzhou	China	0.66	0.52
4	Zhuhai	China	0.65	0.57
5	Dongguan	China	0.63	0.56
6	Foshan	China	0.62	0.53
7	Meizhou	China	0.50	0.45
8	Pulau Pinang	Malaysia	0.50	0.54
9	Singapore	Singapore	0.45	0.51
10	Phra Nakhon Si Ayutthaya	Thailand	0.45	0.42
11	Chon Buri	Thailand	0.45	0.44
12	Pathum Thani	Thailand	0.43	0.45
13	Kelantan	Malaysia	0.37	0.41
14	Johor	Malaysia	0.36	0.42
15	Melaka	Malaysia	0.34	0.40
16	Perak	Malaysia	0.32	0.39
17	Zhaoqing	China	0.31	0.25
18	Tamenglong	India	0.30	-0.96
19	Qingyuan	China	0.29	0.22
20	Chandel	India	0.29	-0.96

Source: IDE-GSM.

(c) Textile/Garment Industry

Figure 6 shows the RSCA of the textile/garment industry in each region. The regions that have comparative advantage are dispersed in Cambodia, Vietnam, Thailand, China and Bangladesh. Table 4 shows the top 20 highest RSCA regions in the textile/garment industry. Pabna of Bangladesh tops the rank, followed by Dhaka (Bangladesh) and Phnom Penh (Cambodia). Bangladesh and Cambodia together occupy the top 20 regions.

Figure 6: RSCA of Textile/Garment Industry (2025)



Source: IDE-GSM.

Table 4: Top 20 Highest RSCA Regions in Textile/Garment Industry (2025)

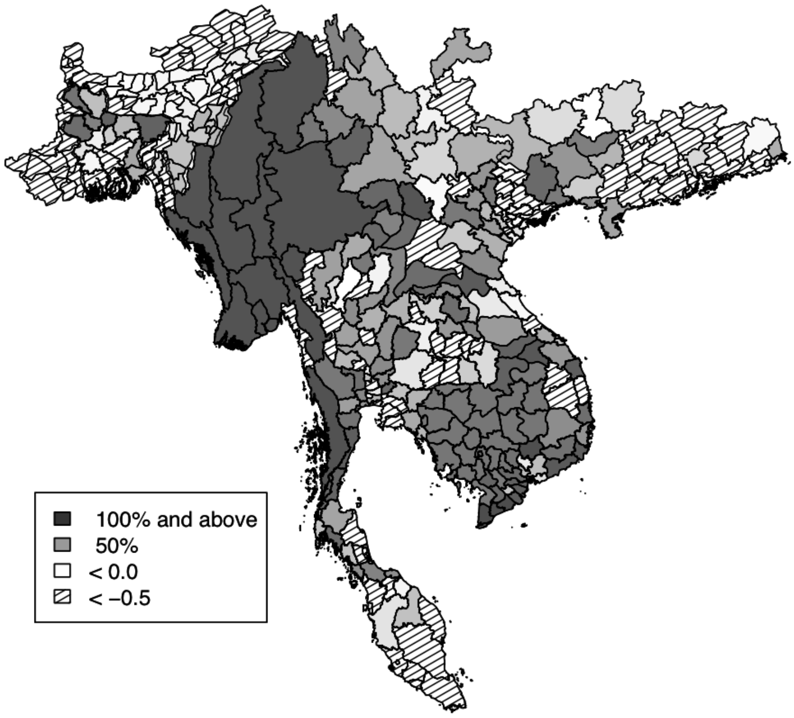
Rank	Region	Country	RSCA(2025)	RSCA(2005)
1	Pabna	Bangladesh	0.83	0.79
2	Dhaka	Bangladesh	0.75	0.76
3	Phnom Penh	Cambodia	0.74	0.69
4	Krong Pailin	Cambodia	0.74	0.69
5	Pouthisat	Cambodia	0.74	0.69
6	Batdambang	Cambodia	0.74	0.69
7	Kampong Chhnang	Cambodia	0.74	0.69
8	Krong Preah Sihanouk	Cambodia	0.74	0.69
9	Mondul Kiri	Cambodia	0.74	0.69
10	Otdar Mean Chey	Cambodia	0.74	0.69
11	Kaoh Kong	Cambodia	0.74	0.69
12	Kampong Thum	Cambodia	0.74	0.69
13	Siemreab	Cambodia	0.74	0.69
14	Kandal	Cambodia	0.74	0.69
15	Banteay Meanchey	Cambodia	0.74	0.69
16	Svay Rieng	Cambodia	0.74	0.69
17	Preah Vihear	Cambodia	0.74	0.69
18	Kampot	Cambodia	0.74	0.69
19	Kampong Speu	Cambodia	0.74	0.69
20	Kampong Cham	Cambodia	0.74	0.69

Source: IDE-GSM.

(d) Food Processing Industry

Figure 7 shows the RSCA of the food processing industry in each region. The regions that have a comparative advantage are scattered all over the CSEA. Table 5 shows the top 20 highest RSCA regions in the food processing industry. Ca Mau of Vietnam tops the rank, followed by Soc Trang (Vietnam) and Bac Lieu (Vietnam). Vietnam and Myanmar together occupy the top 10 regions.

Figure 7: RSCA of Food Processing Industry (2025)



Source: IDE-GSM.

Table 5: Top 20 Highest RSCA Regions in Food Processing Industry (2025)

Rank	Region	Country	RSCA(2025)	RSCA(2005)
1	Ca Mau	Vietnam	0.87	0.86
2	Soc Trang	Vietnam	0.87	0.86
3	Bac Lieu	Vietnam	0.87	0.86
4	Binh Phuoc	Vietnam	0.86	0.85
5	Mon	Myanmar	0.85	0.84
6	Tanintharyi	Myanmar	0.85	0.84
7	Kayin	Myanmar	0.85	0.84
8	Kayah	Myanmar	0.85	0.84
9	Shan	Myanmar	0.85	0.84
10	Bago	Myanmar	0.85	0.84
11	Yangon	Myanmar	0.85	0.84
12	Ayeyarwady	Myanmar	0.85	0.84
13	Mandalay	Myanmar	0.85	0.84
14	Sagaing	Myanmar	0.84	0.84
15	Magway	Myanmar	0.84	0.84
16	Kachin	Myanmar	0.84	0.84
17	Rakhine	Myanmar	0.84	0.84
18	Chin	Myanmar	0.84	0.84
19	Phongsali	Laos	0.83	0.83
20	Xekong	Laos	0.82	0.82

Source: IDE-GSM.

All in all, the electronics and automotive industries tend to agglomerate in a small number of regions while food processing and textile/garment industries tend to disperse.

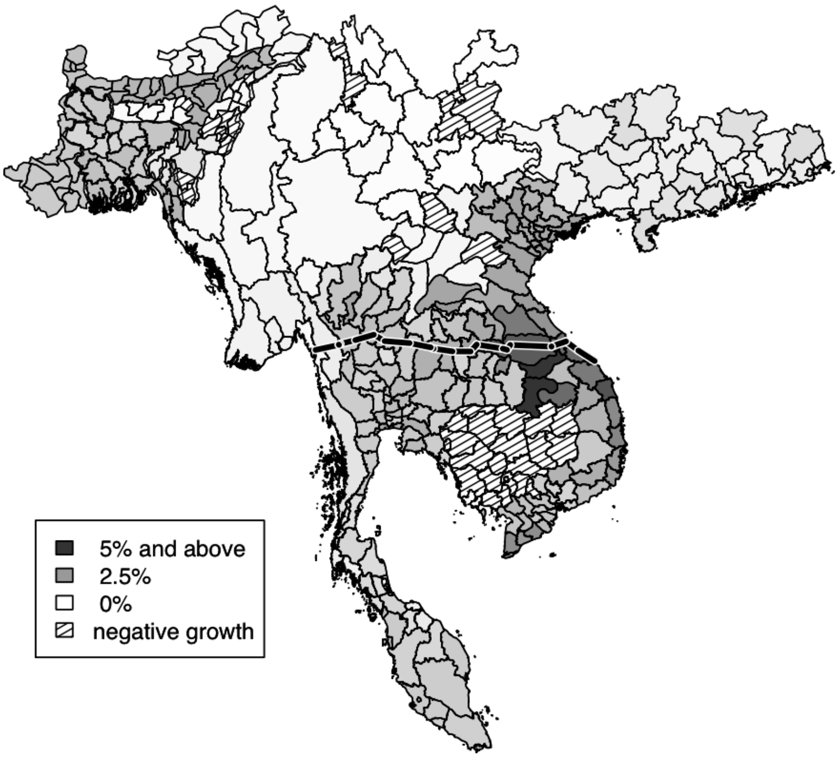
5.2.2. East West Economic Corridor with customs facilitation

Impacts on GDP

Figure 8 shows the differences from 2011 (the date the EWEC was supposed to have completed the simulation) up to 2025 in the average GDP growth rate between EWEC with customs facilitation and the baseline scenario in each region. Table 6 lists the top 10 GDP gainers for this scenario relative to the baseline. The top gainer in GDP growth is Champasak of Laos (gaining 6.1 percent growth a year, from 2011 to 2025) when compared with the baseline[vii]. The EWEC with customs facilitation mainly benefits some areas of Laos, Vietnam and northern Thailand, because EWEC connects and vitalizes them. What is interesting is that the geographical periphery of the region (specifically West India and Bangladesh, the Malay Peninsula, and Guangxi and Guandong provinces of China) benefits from the EWEC. This is because the EWEC reduces transport costs across all regions by going through four countries located in the center of the CSEA. This result is likely to remain unchanged from the first generation of IDE-GSM.

It should be also noted that many regions in Cambodia suffer a drop in GDP relative to the baseline scenario. This is exactly the feature of the model using new economic geography. The formation of agglomerations in a region could adversely affect the industry in neighboring regions.

Figure 8: GDP difference by EWEC with Customs Facilitation (2011-2025)



Source: IDE-GSM.

Table 6: Top 10 Regions Gaining GDP by EWEC with Customs Facilitation

(million USD)

Rank	Region	Country	Gain/year	Baseline	EWEC
1	Champasak	Laos	6.1%	1,288	3,118
2	Saravan	Laos	4.9%	779	1,607
3	Quang Ngai	Vietnam	4.2%	997	1,854
4	Mukdahan	Thailand	4.1%	556	1,010
5	Savannakhet	Laos	4.0%	4,294	7,752
6	Thua Thien-Hue	Vietnam	3.7%	899	1,549
7	Attapu	Laos	3.6%	271	463
8	Quang Tri	Vietnam	3.6%	511	863
9	Quang Nam	Vietnam	3.3%	1,156	1,875
10	Khammouan	Laos	3.3%	665	1,076

Source: IDE-GSM.

Impacts by industry

Tables 7 to 10 show the effects of the EWEC with customs facilitation on the RSCA of different industries in each region. They also show the top 20 regions in RSCA. All in all, regions in Vietnam, Laos and Thailand tend to gain ranks while those in the other countries tend to lose. The EWEC does not significantly boost the industrial development of the automotive and electronics industries, which is in contrast to its largely positive impact on the development of textile/garment and food processing industries. In case of the first two industries, the EWEC tends to improve once disadvantaged regions become slightly advantaged. In the case of the latter two industries, EWEC tends to further the development of already advantageous regions with some exceptions.

Table 7: Top 20 Highest RSCA Regions in Automotive Industry by EWEC (2025)

Rank	Region	Country	RSCA(EWEC)	Change
1	Vinh Phuc	Vietnam	0.90	0.08
2	Liuzhou	China	0.87	0.04
3	Hai Duong	Vietnam	0.82	0.11
4	Selangor	Malaysia	0.72	0.11
5	Chon Buri	Thailand	0.67	-0.03
6	Phra Nakhon Si Ayutthaya	Thailand	0.61	0.14
7	Rayong	Thailand	0.59	0.01
8	Melaka	Malaysia	0.59	0.07
9	Nakhon Ratchasima	Thailand	0.58	-0.17
10	Ha Tay	Vietnam	0.57	0.05
11	Guilin	China	0.56	0.00
12	Pathum Thani	Thailand	0.52	0.09
13	Lang Son	Vietnam	0.50	0.03
14	Khon Kaen	Thailand	0.46	-0.04
15	Guangzhou	China	0.46	-0.17
16	Dong Nai	Vietnam	0.44	0.09
17	Meizhou	China	0.43	0.25
18	Thai Binh	Vietnam	0.41	0.15
19	Kedah	Malaysia	0.40	0.08
20	Prachuap Khiri Khan	Thailand	0.40	-0.07

Source: IDE-GSM.

Table 8: Top 20 Highest RSCA Regions in Electronics Industry by EWEC (2025)

Rank	Region	Country	RSCA(EWEC)	Change
1	Shenzhen	China	0.76	-0.09
2	Heizhou	China	0.70	-0.09
3	Phra Nakhon Si Ayutthaya	Thailand	0.63	0.18
4	Pulau Pinang	Malaysia	0.62	0.12
5	Meizhou	China	0.61	0.11
6	Foshan	China	0.61	-0.01
7	Zhuhai	China	0.60	-0.05
8	Pathum Thani	Thailand	0.56	0.13
9	Dongguan	China	0.55	-0.09
10	Johor	Malaysia	0.53	0.17
11	Singapore	Singapore	0.48	0.03
12	Selangor	Malaysia	0.47	0.23
13	Melaka	Malaysia	0.47	0.13
14	Chon Buri	Thailand	0.45	0.00
15	Kedah	Malaysia	0.42	0.14
16	Guangzhou	China	0.41	-0.25
17	Perak	Malaysia	0.40	0.08
18	Negeri Sembilan	Malaysia	0.33	0.18
19	Kelantan	Malaysia	0.25	-0.12
20	Zhongshan	China	0.21	0.05

Source: IDE-GSM.

Table 9: Top 20 Highest RSCA Regions in Textile/Garment Industry by EWEC (2025)

Rank	Region	Country	RSCA(EWEC)	Change
1	Mondul Kiri	Cambodia	0.83	0.09
2	Hung Yen	Vietnam	0.82	0.19
3	Pabna	Bangladesh	0.81	-0.02
4	Nam Dinh	Vietnam	0.80	0.10
5	Thai Binh	Vietnam	0.78	0.14
6	Stung Treng	Cambodia	0.78	0.05
7	Binh Duong	Vietnam	0.74	0.15
8	Dhaka	Bangladesh	0.73	-0.02
9	Dong Nai	Vietnam	0.72	0.13
10	Ratanakiri	Cambodia	0.70	-0.03
11	Otdar Mean Chey	Cambodia	0.70	-0.04
12	Preah Vihear	Cambodia	0.70	-0.04
13	Krong Pailin	Cambodia	0.70	-0.04
14	Phra Nakhon Si Ayutthaya	Thailand	0.67	0.18
15	Samut Prakan	Thailand	0.66	0.17
16	Tak	Thailand	0.66	-0.07
17	Shantou	China	0.66	0.00
18	Haiphong	Vietnam	0.65	0.14
19	Chittagong	Bangladesh	0.63	-0.05
20	Kandal	Cambodia	0.62	-0.12

Source: IDE-GSM.

Table 10: Top 20 Highest RSCA Regions in Food Processing Industry by EWEC (2025)

Rank	Region	Country	RSCA(EWEC)	Change
1	Soc Trang	Vietnam	0.92	0.05
2	Ca Mau	Vietnam	0.92	0.04
3	Champasak	Laos	0.90	0.13
4	Bac Lieu	Vietnam	0.89	0.02
5	Saravan	Laos	0.88	0.12
6	Vientiane Capital	Laos	0.88	0.17
7	Vientiane	Laos	0.88	0.17
8	Binh Phuoc	Vietnam	0.87	0.01
9	Quang Ngai	Vietnam	0.82	0.03
10	Attapu	Laos	0.82	0.17
11	Ninh Thuan	Vietnam	0.82	0.03
12	Tra Vinh	Vietnam	0.81	0.01
13	Binh Thuan	Vietnam	0.81	0.00
14	Long An	Vietnam	0.80	0.07
15	Can Tho	Vietnam	0.80	0.07
16	Savannakhet	Laos	0.79	0.30
17	An Giang	Vietnam	0.79	0.03
18	Ben Tre	Vietnam	0.78	-0.01
19	Kien Giang	Vietnam	0.77	0.11
20	Tay Ninh	Vietnam	0.77	0.07

Source: IDE-GSM.

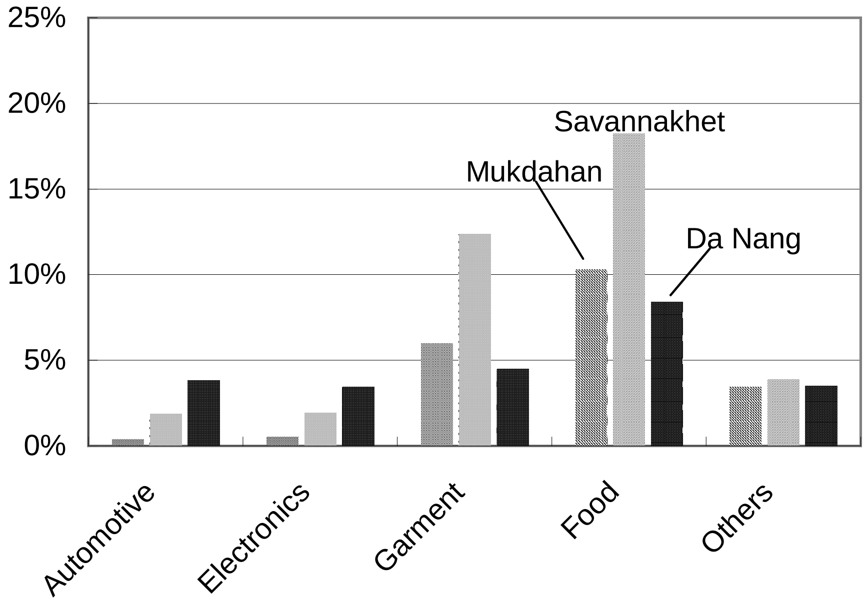
6. CONCLUSION AND POLICY IMPLICATIONS

6.1. Setting Target Industries

The simulations revealed that the effects of infrastructure development on each region are very much different by industry. For example, in Savannakhet of Laos, the development of the EWEC is expected to increase the GDP shares of the following sectors: automotive, by 1.9 percent; electronics, by 1.9 percent; textile and garment, by 12.4 percent; and food processing, by 18.2 percent (Figure 9). The development of the EWEC is also projected to reduce Savannakhet's RSCA of the automotive and electronics sectors by 0.42, and 0.17, respectively, while it will increase its RSCA of the textile and garment and food processing sectors by 0.28 and 0.30, respectively (Figure 10). The economic impact depends on the initial distribution and characteristics of each industry.

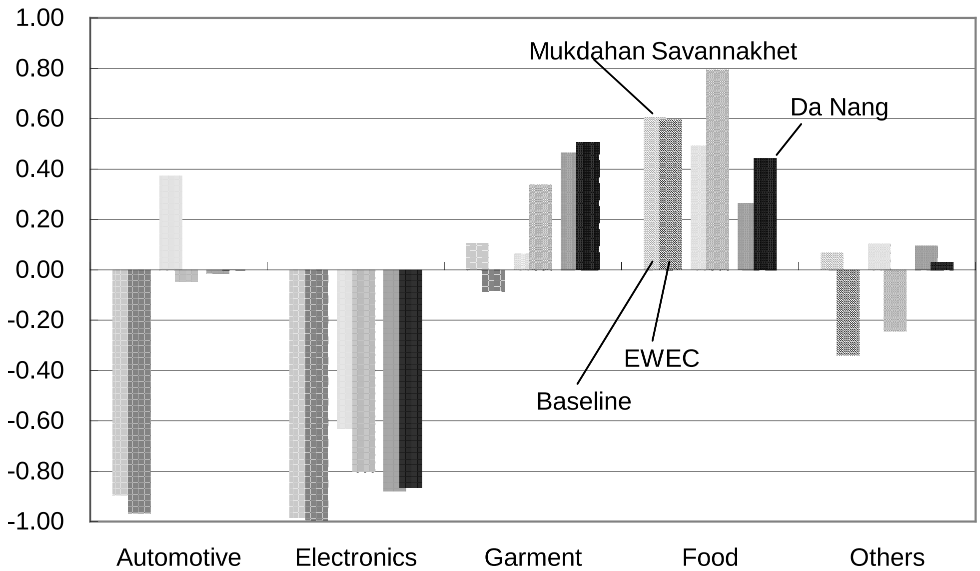
National and local governments need to set target industries to develop them properly. The IDE-GSM is "potentially" useful to find the target industries for each region with proper infrastructure development plan. If the government fosters the growth of an industry that has higher comparative advantage in that region, that industry is more likely to prosper.

Figure 9: Gaining GDP/year by EWEC with Customs Facilitation



Source: IDE-GSM.

Figure 10: RSCA of Baseline and EWEC with Customs Facilitation



Source: IDE-GSM.

6.2. The Need for Balanced and Strategic Development of Economic Corridors

As previously pointed out, the EWEC has been a bane to the development of many regions in Cambodia, as reflected in the decline of GDP vis-à-vis the baseline scenario. The formation of agglomerations by the development of corridors in neighboring regions may sometimes lead to deprive the industry.

Kumagai et al. (2008) revealed that the EWEC, the North-South economic corridor (NSEC), and the Southern economic corridor (SEC) are highly complementary projects. By implementing all three, most of the regions in the Greater Mekong sub-region are expected benefit.

The plans and implementation of infrastructure development need to be coordinated regionally. In this light, the establishment of an international body for planning and coordinating balanced and strategic development of infrastructure is highly recommended.

6.3. Establishment of Geographical Economic and Social Database in East Asia

The IDE-GSM is a complex system, making it difficult to make projections without accurate data and solid simulation model. This can be addressed by developing the IDE-GSM further and facilitating the coordination of a geographical statistical system among the ERIA member countries.

To conduct more accurate simulations with richer implications, more precise regional economic and demographic data are required at the sub-national level in each country and at the sub-provincial level in China and India. The establishment of uniform territorial units for geographical statistics like the NUTS in the European Union is needed. East Asia needs harmonized data as well as harmonized data collection method. The ERIA is a suitably equipped body to conduct capacity building for officials in national corridors connecting regions.

Just as important are more precise data on routes and corridors connecting regions. Information on the main routes between cities, times and modes of transport (road, railway, sea and air) appears indispensable. Data on border costs such as tariffs and non-tariff barriers due to inefficient customs clearance seem crucial as well.

NOTES

[i] Calculating the average distance between arbitrary two points in circle will yield $0.66(area/\pi)^{1/2}$. Put the area of CSEA, 2,902,093 km2, into the formula, and one will derive 634km.

[ii] Agricultural goods are treated as homogeneous goods and are not at all differentiated.

[iii] Despite the large numbers of foreign workers in Singapore and Malaysia, these two countries set strict quotas on foreign workers.

[iv] Since there is no explicit “capital” in this model, the difference between total output and intermediate input was assumed as the labor input.

[v] RCSA is compiled from well-known RCA (Revealed Comparative Advantage) indexes. RCSA is defined as (RCA-1)/(RCA+1).

[vi] For various reasons, the growth rate of GDP per capita in each city is likely to differ from the national average, and this is reflected in the simulation.

[vii] Note that GDP’s are nominal and equated in US dollars.

REFERENCES

Fujita, M., P. Krugman and A.J. Venables. 1999. *The Spatial Economy: Cities, Regions, and International Trade.* Cambridge, MA: MIT Press.

Haig, R.M. 1926. Toward an understanding of the metropolis. *The Quarterly Journal of Economics*, 40(2):179-208.

Hummels, D. 1999. Toward a Geography of Trade Costs. GTAP Working Papers 1162, Indiana: Purdue University.

Hirschman, A.O. 1958. *The Strategy of Economic Development.* Yale University Press: New Heaven.

Institute of Developing Economies. 2006. *Asian international input―output table 2000 Volume1*. *Explanatory Notes*, Chiba: IDE-JETRO

Krugman, P. 1991. Increasing returns and economic geography. *Journal of Political Economy* 99(3): 483-499.

Kumagai, S., T. Gokan, I. Isono and S. Keola. 2008. Geographical Simulation Model for ERIA: Predicting the Long-run Effects of Infrastructure Development Projects in East Asia," edited by N. Kumar. *International Infrastructure Development in East Asia:Towards Balanced Regional Development and Integration.* ERIA Research Report 2007 3:360-394. Chiba: IDE-JETRO.

Marshall, A. 1890. *Principles of Economics.* London: Macmillan, 8th edition, published in 1920.

Midelfart-Knarvik K.H., H.G. Overman, S. Redding and A.J.Venables. 2002. Integration and industrial specialisation in the European Union. *Revue Économique* 53(3):469-481.

Thien, Myat. 2004. *Economic Development of Myanmar*. Singapore: Institute of Southeast Asian Studies.

United Nations Economic and Social Commission in Asia and the Pacific. (2008). About the Asian Highway. [online] ://www.unescap.org/ttdw/?MenuName=AsianHighway [Accessed **April, 2008**]

APPENDIX: DATA COLLECTION

Bangladesh

The data on this country are based on three-sector (primary, manufacturing and service) GDP data by state from various sources. The manufacturing sector is divided into five sub-sectors, using value added data based on an industrial census in 2002 and 2003.

Cambodia

Japan International Cooperation Agency estimated provincial incomes and employee shares of three industries, namely, primary, secondary and tertiary based on the Cambodia Socio-Economic Survey (between 2003 and 2005). Provincial gross value added by industry was calculated by applying this income ratio to the national GDP. Nationwide M1 to M5 were calculated based on Socio-Economic Survey 2004 by National Institute of Statistics, and were used as coefficients to divide the provincial GDP of secondary industry in to five sectors.

China

In the case of China, regional GDP are divided by the employee share in industries, and then the derived values are regarded as industrial GDP in the region. The GDPs about the subdivisions of provinces are collected from the provincial statistical yearbooks 2004. The Employment data are collected from the provincial economic census yearbooks 2004.

Hong Kong

In the case of Hong Kong, Hong Kong report on the 2003 annual survey of industrial production and social and economic trends provided data on GDP and employment. Following the same procedure as China, simulation data are generated.

Macau

In the case of Macau, the 2005 yearbook of statistics was used. However, only the number of employments only in textile industries are could be collected from the statistics. Simulation data were obtained in the same manner as those of China.

India

The relevant data were taken from the Census of India website, http://www.censusindia.gov.in/.

Laos

Provincial-level industrial statistics on Laos were generated from several sources. First, population and value-added data on each province were culled mostly from the unpublished Annual Provincial Report on the Implementation of Socio-Economic Plan (between fiscal 2004 and 2006). These data are classified by industry, namely, agriculture, industry and service, in source. The value added by industry in each province was than used to create five value-added sectors by splitting them according to the provincial share of labor in M1 to M5. The labor share in M1 to M5 for each province was calculated based on nationwide business establishment survey of National Statistical Center.

Malaysia

Data on Malaysia were based on three-sector (Primary, Manufacturing and Service) GDP data by state from various sources. The manufacturing sector is then divided into five sub-sectors using value added data from the establishment survey provided by Department of Statistics, Malaysia.

Myanmar

Three-sector GDP data on Myanmar were compiled from the national three-sector GDP data and income par capita by state based on *Report of 1997: Household Income and Expenditure Survey,* which was prepared by the Central Statistical Organization. The manufacturing sector was divided into five using the data from Table 6.11 in *Economic development of Myanmar* (Thein 2004).

Singapore

Data on this city-state were based on the sectoral GDP data from the Economic Survey of Singapore, which divided the transport sector into automotive and others using the data provided by Singstat.

Thailand

The employments data were collected from manufacturing industrial survey for Bangkok and the statistical report of changwat: Chonburi in 1999; Ayutaya, Chaiyaphum, Chanthaburi, Chiangrai, Chumphon, Krabi, Lopburi, Mae Hong Son, Mukudahan, Nan, Songkhla, Yala and Yasothon in 2000; Nakhon Panom in 2002; Nakhon Ratchasima in 2005; and the other provinces in 2001. In some provincial data, the data on transport equipment were used for automobiles: the number of employments in automotive industries does not exists in the data source, but that in transport equipments. The small number of establishments in specific industries might be included in the group expressed as “Others.”

Vietnam

Data on Vietnam were based on three-sector (primary, manufacturing and service) GDP data by state from various sources. The manufacturing sector is divided into five sub-sectors using value added data from the establishment survey.

REFERENCES

Fujita, M., P. Krugman and A.J. Venables. 1999. *The Spatial Economy: Cities, Regions, and International Trade.* Cambridge, MA: MIT Press.

Haig, R.M. 1926. Toward an understanding of the metropolis. *The Quarterly Journal of Economics*, 40(2):179-208.

Hummels, D. 1999. Toward a Geography of Trade Costs. GTAP Working Papers 1162, Indiana: Purdue University.

Hirschman, A.O. 1958. *The Strategy of Economic Development.* Yale University Press: New Heaven.

Institute of Developing Economies. 2006. *Asian international input*—*output table 2000 Volume1*. *Explanatory Notes*, Chiba: IDE-JETRO

Krugman, P. 1991. Increasing returns and economic geography. *Journal of Political Economy* 99(3): 483-499.

Kumagai, S., T. Gokan, I. Isono and S. Keola. 2008. Geographical Simulation Model for ERIA: Predicting the Long-run Effects of Infrastructure Development Projects in East Asia," edited by N. Kumar. *International Infrastructure Development in East Asia:Towards Balanced Regional Development and Integration.* ERIA Research Report 2007 3:360-394. Chiba: IDE-JETRO.

Marshall, A. 1890. *Principles of Economics.* London: Macmillan, 8th edition, published in 1920.

Midelfart-Knarvik K.H., H.G. Overman, S. Redding and A.J.Venables. 2002. Integration and industrial specialisation in the European Union. *Revue Économique* 53(3):469-481.

Thien, Myat. 2004. *Economic Development of Myanmar*. Singapore: Institute of Southeast Asian Studies.

United Nations Economic and Social Commission in Asia and the Pacific. (2008). About the Asian Highway. [online] ://www.unescap.org/ttdw/?MenuName=AsianHighway [Accessed **April, 2008**]

APPENDIX: DATA COLLECTION

Bangladesh

The data on this country are based on three-sector (primary, manufacturing and service) GDP data by state from various sources. The manufacturing sector is divided into five sub-sectors, using value added data based on an industrial census in 2002 and 2003.

Cambodia

Japan International Cooperation Agency estimated provincial incomes and employee shares of three industries, namely, primary, secondary and tertiary based on the Cambodia Socio-Economic Survey (between 2003 and 2005). Provincial gross value added by industry was calculated by applying this income ratio to the national GDP. Nationwide M1 to M5 were calculated based on Socio-Economic Survey 2004 by National Institute of Statistics, and were used as coefficients to divide the provincial GDP of secondary industry in to five sectors.

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Vietnam

Data on Vietnam were based on three-sector (primary, manufacturing and service) GDP data by state from various sources. The manufacturing sector is divided into five sub-sectors using value added data from the establishment survey.