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Abstract

Increasing wages in coastal areas and the risk of Yuan appreciation in China will encourage firms in China to adopt "China plus One" strategy. More firms establish plants in Vietnam to take advantage of supporting industries in China and hedge China risk. Hanoi and its surrounding region will be one of the main destinations for FDIs into manufacturing sectors. Although Vietnam can provide cheap labor forces, firms in Vietnam do not have sufficient technological and managerial capabilities to participate in international production networks. International technology transfer is needed for Vietnam to achieve international business standards. This paper presents firm-level evidence on process innovation through technology transfer to firms in Hanoi. We emphasize engineer exchanges as a channel of technology transfer. A case study of Japanese firm invested from China to establish a plant in Hanoi is also introduced to complement the empirical result.

1. INTRODUCTION

Developing countries in East and Southeast Asia have succeeded in industrialization by promoting foreign direct investments (FDIs) and international trades. FDIs have been important for the region to diversify or upgrade their industrial structures. FDIs transfer knowledge owned by multinational companies (MNCs) to host countries. In other words, MNCs have played a role of teacher in technology transfer to indigenous firms in Asia. Intarakumnerd (2010) mentioned MNCs' production networks as "training school." Historically, Japanese MNCs had dominated manufacturing activities in Asia. It could be said that FDIs by Japanese MNCs had been substantially the only source of technologies from Asia.

But Ueki (2010) conceptualizes a newly emerging development model as a result of the economic integration in East and Southeast Asia. According to his discussion, the industrial development in the region in the 1980s is based on the bilateral model where Japanese MNCs provide materials and parts from Japan to developing countries in Asia, process them using cheap labors there and import final products to Japan. The new industrialization model named "α plus One" policy supposes MNCs' strategies based on multi-plants operations and multi-sources of inputs and technologies under South-South cooperation for FDI and trades.

An example of "α plus One" is "China plus One," where a MNC operating a factory in Guangdong, China transfer an assembly process for a specific export-bound product to a newly established factory in Hanoi, Vietnam as an export base. The factory in Hanoi can import inputs from existing suppliers in China and other countries in East Asia and ASEAN or develop new suppliers in Hanoi and other regions in Vietnam. Such FDIs from China to Vietnam can transfer technologies from China to Vietnam.

It is considered that exchanges of engineers can be effective channel of technology transfer. Hanoi has a geographical advantage because people can move between two countries by using public land transportation services such as bus and railways at a lower cost compared to air transportation. This strategy can be applicable for non-Japanese MNCs such as those from Taiwan and South Korea who can also import inputs from China, assemble products in Vietnam and export them to their home countries.

This industrialization model, which is enabled by internationalization of firms from more developed countries (MDCs) and the economic integration in Asia, will increase potential sources of technologies for less-developed countries (LDCs) and sub-regions in ASEAN including Cambodia, Lao PDR, Myanmar and Vietnam (CLMV). This development model may also provide more opportunities to indigenous firms from

LDCs for entering into MNCs' production networks that require adherence to technical standards different from those of Japanese firms. As exemplified by Truong (2010), although customers' requirements motivate firms to be more innovative, Japanese standards regarding quality control, cost and delivery (QCD) demand unbearable burden of investments for firms from Vietnam and other countries.

Although there are increasing case studies of firms using factories in Hanoi under their "China plus One" strategy, there is no evidence on the present situation and its effects on industrial upgrading and innovation by firms in Vietnam. This paper attempts to figure out the present production networks in which firms in Hanoi are involved and examine empirically effects of sourcing inputs from China on management improvement or process innovation using firm-level data collected through the questionnaire survey conducted in Hanoi and its surrounding regions in 2008. This paper also examines effects of exchanges of engineers with customers and suppliers of firms in Hanoi on management improvement or process innovation to verify significant importance of face-to-face communications among engineers for technology transfer and collaboration.

2. HYPOTHESIS, MODEL AND DATA

2.1 Hypothesis

Factors that can motivate firms to make efforts for improving managements and achieving innovation have been major concerns for businessmen, researchers and policy makers. Truong (2010), based on her in-depth case studies of firms in Vietnam, emphasize customers' requests are one of the important motivations for Vietnamese firms. A customer has concerns about QCD of parts and materials purchased from its suppliers. It is considered that QCD performances of a supplier providing parts for a final product could affect QCD of its customer and all other firms involved in the supply chain of the final product. Thus the customer gives technical assistances to their customers or cooperates with them to achieve its own QCD standard. A customer may also need collaborations with its suppliers to design new products and production processes to decrease costs of materials and parts and product defects. Therefore, customer relationship or competition for a customer should be considered as an important factor that can determine a firm's policy for upgrading managements and process control (Figure 1).

Facing requests from its customer, a supplier will need to make use of its internal resources to fulfill the requirements. If the supplier does not have sufficient resources,

the firm needs to seek for external resources that can be available through collaborate with its suppliers to satisfy customer's request. Thus supplier relationship should be significant as an important factor that can determine resources available for a firm to achieve targeted upgrading and innovation that are set according its customer's requirements.
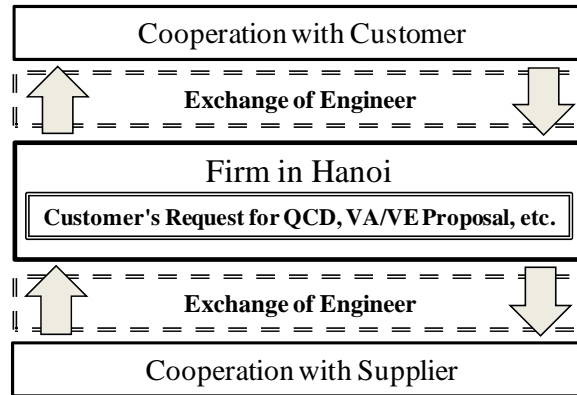
Figure 1: Conceptual Framework

Source: Authors.

Previous studies have focused on geographical proximities to customers and suppliers that affect transaction costs. Kimura (2009) proposes the concept of four layers of transactions in production/distribution networks stratified in terms of gate-to-gate lead time and the frequency of delivery. Machikita and Ueki (2010a) verifies that firm-level capabilities and transaction costs associated with specific inter-firm relationships would influence the distances between customers and suppliers, using firm-level data. Machikita and Ueki (2010b) also empirically examines the difference between importers and non-importers in the effects of geographic proximity on the procurement process.

Literature related to management of technology has also emphasized importance of production networks for industrial upgrading and innovation. There are previous studies that empirically examine relationships between production networks and industrial upgrading/innovation using firm-level data for Southeast Asian countries. Lessons learned from these studies enable to derive the following hypotheses to be verified empirically regarding the effect of customer and supplier relationships that firms in Hanoi have on industrial upgrading or innovation in Vietnam.

Hypothesis 1: Production networks linking Hanoi with suppliers and customers will have positive impacts on innovative efforts made by firms in Hanoi.

There are evidences supporting significant effects of production networks on process innovations in Southeast Asia including Vietnam. Machikita and Ueki (2010c) confirms that firms having more diversified linkages achieve more varieties of innovations. Their findings imply external sources are significantly important for firms to vary sources of knowledge and technologies. Customers and suppliers can be main potential collaborators because they have being fostering relationships of trust enabling to exchanging confidential information. Machikita *et al.* (2010) focuses on information sources for product innovation. They detect differences in information sources between indigenous firms and MNCs including joint ventures (JVs) even if they are equivalently innovative. Indigenous firms tend to access locally available information, while MNCs/JVs utilize internally available information.

These findings suggest that indigenous firms take advantage of diversify of local information sources. But more important is the fact that even though MNCs/JVs could have opportunities for accessing these sources, they do prefer using internal sources for product innovation. One of the possible backgrounds making differences between indigenous firms and MNCs is the difference in target improvements/innovations and necessary technologies for meeting market demands. This hypothesis could be tested, considering different types of process innovations.

Hypothesis 2: Exchanges of engineers or face-to-face communications with suppliers will facilitate process improvement/innovation by firms in Hanoi

Previous studies on the relationship between production networks and innovation implicitly assume that technologies can be transferred through production networks. But most studies do not pinpoint concrete channels of information exchanges. Machikita and Ueki (2010d) attempts to identify such channels, placing emphasis on exchanges of engineers among firms, using firm-level data for four Southeast Asian countries including Vietnam. They found that dispatch of engineers to customers promote product innovations, while such complementarities are not effective for product innovation.

This paper applies the similar methodologies to Machikita and Ueki (2010d), using a specific case of exchanges of engineers with firms in Hanoi, Vietnam, considering the first hypothesis described above. In particular, this paper focuses on exchanges of engineers between firms in Hanoi and suppliers in China as a key channel of technology transfer and their impacts on process improvements and innovations.

2.2 The Model and Variables

To empirically examine the hypotheses above, this paper explores the use of the following binary probit estimation in modeling the relation between process innovations and linkages with suppliers or customers that firms in Hanoi have.

$$\text{Probit}(INNOV_{ik}) = \alpha + \beta \ LINK_i + \gamma \, x_i + u_i.$$

The dependent variable *INNOV* is an indicator of the process innovation (*k*). This variable is coded 1 if the firm (*i*) adopted international standards between 2006 and 2008 or improved QCD performances between 2007 and 2008, otherwise 0. In the estimation five variables are identified as indicators of process innovations: (1) Adoption of international standards (*STAN*); (2) Product quality improved (*QUALITY*); (3) The number of product defects was reduced (*DEFECT*); (4) Production cost decreased (*COST*); and (5) Lead-time (the period between a customer's order and delivery of product) was reduced (DELIVERY). In addition, the dummy variable *QC* is defined as the case of improvement of quality control and cost reduction at the same time. In the same manner, the dummy variable *QCD* is coded 1 if the firm (*i*) improved *QUALITY*, *COST* and *DELIVERY* at once.

The independent variables are *LINK* and other control variables. The variable *LINK* is a dummy variable taking 1 if the firm (*i*) has a customer or supplier relationship with a country or a firm in a country, or exchanges engineer with its main supplier or customer. As explained later, the dataset used for the regression are developed from a questionnaire survey to firms in the Hanoi area, Vietnam. Regarding the variable *LINK*, firms were asked about (1) three most important markets and sources of raw materials and supplies, (2) countries where their main supplier and customer locate, and (3) whether they exchange engineers with their main supplier and customer. These three types of variables for linkages or supplier/customer relationships are applied to the regression model. Details of the variable *LINK* and other control variables are listed in Appendix Table.

The variables x_1 are other control variables such as asset size, nationality and industry. The variable *ASSET* is a size of asset firms have. The firms responding to the survey were asked to indicate the value of their total assets by choosing one of the 10 categories.[1] The variable ASSET is defined as the median value of each category. For

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[1] (1) less than 10,000 U.S. dollars; (2) 10,000-24,999 U.S. dollars; (3) 25,000-49,999 U.S. dollars; (4) 50,000-74,999 U.S. dollars; (5) 75,000-99,999 U.S. dollars; (6) 100,000-499,999 U.S. dollars; (7) 500,000-999,999 U.S. dollars; (8) 1 million-4.9 million U.S. dollars; (9) 5-9.9 million U.S. dollars; (10) 10 million U.S. dollars and above.

example, if the respondent chose "10,000-24,999 U.S. dollars," this *ASSET* is taken as 17,500 U.S. dollars.

The variable *LOCAL* is a dummy variable that is coded 1 if the firm (*i*) is indigenous. There are five industry dummy variables: *LIGHT*; *CHEMICAL*; *METAL*; *ELECTRONICS*; and *MACHINE*. The variable *LIGHT* includes food and textiles industries. *METAL* includes industries of iron, steel and metal products. The variable *CHEMICAL* corresponds to chemicals and chemical products. Manufacturing of electronics or electronic components other than computers and computer parts are categorized as *ELECTRONICS* while the other machinery products are aggregated into the variable *MACHINE*.

2.3 The Data

The dataset used in this paper was created from the ERIA 2008 Survey on Production and Logistics Networks (SPLN) for manufacturing firms in Hanoi and surrounding areas, Vietnam. The sample population is restricted to selected manufacturing districts. The survey was developed to collect firm-level data on production and logistics networks, with the aim of pinpointing sources of knowledge transfer facilitated by economic integration in Asia. An original questionnaire was designed solely for the survey by reference to the Oslo Manual developed by the Organization for Economic Co-operation and Development (OECD). The questionnaire was distributed in December 2008 and January 2009. A total of 138 firms agreed to participate in the survey.[2]

2.4 Firm Characteristics

The firms responded to the survey are mainly from Vietnam. By nationality of the firms' capital, 56 firms out of the 138 respondents (40.6%) are local (100% local capital), thus the remaining 82 firms (59.4%) are MNCs or JVs (Table 1). Among MNCs or JVs, 43 firms (52.4% of MNCs/JVs or 31.2% of the whole sample) are Japanese. It can be said that the sample is dominated by indigenous and Japanese firms.

The average asset size, or the mean of the variable *ASSET*, is about 5.6 million U.S. dollars. On the other hand, 118 firms or 85.5% of the respondents have less than 300 full-time employees. These suggest that the respondents are not small firms in terms of

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[2] The same questionnaire survey was conducted in three Southeast Asian countries including Indonesia, the Philippines, Thailand Vietnam (Limskul, 2009). (JABODETABEK area, i.e., Jakarta, Bogor, Depok, Tangerang, and Bekasi for Indonesia, CALABARZON area, i.e., Cavite, Laguna, Batangas, Rizal, and Quezon for the Philippines, Greater Bangkok area for Thailand).

asset size and SMEs in terms of number of employees according to Vietnam's definition of SME.[3]

Table 1: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Dependent Variables (0/1)					
STAN	138	0.659	0.476	0	1
QUALITY	138	0.659	0.476	0	1
DEFECT	138	0.717	0.452	0	1
COST	138	0.739	0.441	0	1
DELIVERY	138	0.710	0.455	0	1
QC	138	0.616	0.488	0	1
QCD	138	0.558	0.498	0	1
Independent Variables					
<LINK (0/1)>					
Three Most Important Sources and Markets					
VN_m	138	0.616	0.488	0	1
CN_m	138	0.261	0.441	0	1
JP_m	138	0.435	0.498	0	1
EASEA_m	138	0.181	0.387	0	1
VN_so	138	0.428	0.497	0	1
CN_so	138	0.659	0.476	0	1
JP_so	138	0.297	0.459	0	1
EASEA_so	138	0.565	0.498	0	1
Location of Main Supplier and Customer					
VN_c	98	0.469	0.502	0	1
JP_c	98	0.337	0.475	0	1
VN_s	91	0.198	0.401	0	1
JP_s	91	0.198	0.401	0	1
CN_s	91	0.429	0.498	0	1
Exchange of Engineer with Main Supplier and Customer					
ex_VN_c	98	0.327	0.471	0	1
ex_JP_c	98	0.316	0.467	0	1
ex_VN_s	91	0.088	0.285	0	1
ex_JP_s	91	0.176	0.383	0	1
ex_CN_s	91	0.275	0.449	0	1
<Other Control Variables>					
ASSET (US$)	129	5550252	3852937	10000	1.00E+07
LOCAL (0/1)	138	0.406	0.493	0	1
LIGHT (0/1)	138	0.101	0.303	0	1
CHEMICAL (0/1)	138	0.130	0.338	0	1
METAL (0/1)	138	0.138	0.346	0	1
ELECTRONICS (0/1)	138	0.145	0.353	0	1
MACHINE (0/1)	138	0.217	0.414	0	1

Source: ERIA 2008 SPLN.

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[3] Government Decree 90/2001/ND-CP, dated 23 November 2001, defines SMEs as independent production and business establishments, with registered capital not exceeding VND 10 billion or annual labor not exceeding 300 people (http://www.business.gov.vn/asmed.aspx?id=49&LangType=1033, accessed on 11August 2010).

There are significant differences in firm characteristics between MNCs/JVs and indigenous firms. The average asset size for MNCs/JVs is about seven million U.S. dollars, which is more than double the size of local firms with a mean of about 3.2 million U.S. dollars. In contrast, 6 firms of 82 MNCs/JVs or 7.3% of them are large firms hiring more than 300 employees, while 14 of 56 or 25.0% of the indigenous firms are large firms according to the definition of SME based on the number of employees.

Their main business activities are also different. Indigenous firms are mainly manufactures of machinery other than electronics (33.9%), metal-related products (19.6%), and light industries including food and textiles (14.3%). The main activities of MNCs/JVs are electronics or electronic components (22.2%) and chemicals or chemical products (16.0%).

2.5 Process Innovations

As shown in Table 1, firms in Vietnam make active efforts for process innovations. Some 65.9% of them adopt international standards. The same percentage of the firm improved quality of their products. About 71.7% of them reduced the number of product defects. Lead-time was decreased by 71.0% of them.

Unexpectedly, 61.6% of them achieved both improvements of quality control and reduction of production costs. Some 55.8% of them attained improvements of quality control, decrease in production costs, and reduction of lead-time at once.

There are significant differences in such QC and QCD performances between local firms and MNCs/JVs. Some 68.3% of the MNCs/JVs improved QC performances while the percentage for the local firms is 51.8%. About 64.6% of the MNCs/JVs improved QCD in parallel, while 42.9% of the local firms did it.

Factors that affect these process innovations are further invested by applying regressions later.

3. PRODUCTION NETWORKS IN HANOI

In this section, the present status of development of industrial district in Hanoi and surrounding areas are observed before conducting econometric analysis, using the dataset.

3.1 Agglomeration in Hanoi

Agglomeration in Hanoi is a recent phenomenon. Formation of the industrial district in the area was accelerated by Japan's official development assistance (ODAs) for renovating transportation infrastructure in the 1990s such as Hai Phong Port and

National Highway No.5 which connects Hanoi and Hai Phong. Such physical infrastructure is a statistically significant factor affected decisions made by firms on investments into this region (Truong, 2008). Additionally, it is said that FDIs made by large MNCs, especially Canon's new plant for assembling printers created in the Thang Long Industrial Park, generated a virtuous circle of investments, especially by Japanese MNCs, and growth of the manufacturing sector (Kuchiki and Tsuji, 2008).

Reflecting this historical progress of industrial development in Hanoi, the respondents to the survey are relatively fresh. Some 72.0% of the respondents (95 of 132 firms) were established in 2004 or later. This percentage is much higher for MNCs/JVs (82.5% or 66 of 80). Even more than half of the indigenous respondents (55.8% or 29 of 52) started operations in this period. Figure 2 indicates this rapid agglomeration of the manufacturing sector in Hanoi, making comparison with more sluggish industrial district in CALABARZON, the Philippines, where half of the respondents had already been established in or before 1995.
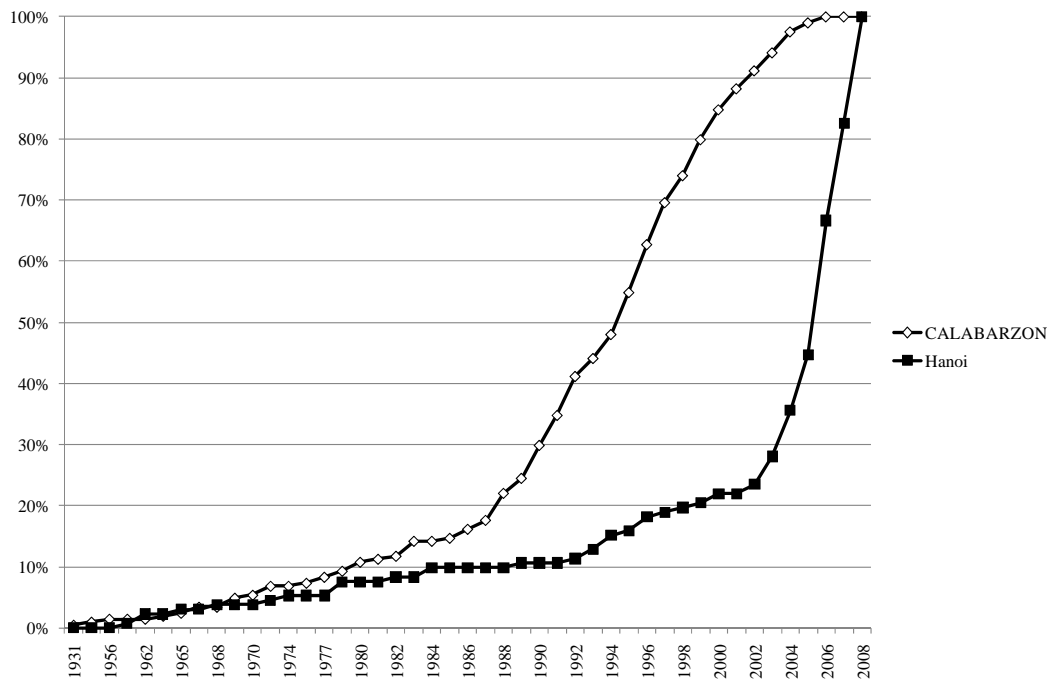

Figure 2: Year of Establishment (Cumulative Total)

Source: ERIA 2008 SPLN.

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3.2 Main Sources of Inputs and Target Markets

Industrial development in Hanoi is at an early stage. There are not well-established supporting industries in Hanoi. This is one of the disadvantages to the industrial district in Hanoi compared to the Southern region, in particular Ho Chi Minh and its suburban areas where industrial activities have been concentrated historically.

Hanoi is situated more than 1,700km away from Ho Chi Minh City. It situates closer to Guangdong than to Ho Chi Minh City. In addition, nationwide expressway networks in Vietnam are in the planning stage or under construction. Thus firms that established their assembly processes in Hanoi need to purchase raw materials and parts from neighboring countries, especially at the beginning of factory operation. As a result, imports of intermediate goods from Hong Kong through Hai Phong Port have been increasing recently (Ueki, 2010).

Table 2 presents such situation. In the survey, firms were asked to fill out the three most important countries as sources of raw materials and supplies and as target markets. As summarized in Table 2, Vietnam has not become the most important sources of inputs for the firms in Hanoi yet. About 65.9% of the respondents purchase necessary inputs from China. MNCs/JVs are more dependent on inputs from China that was identified as main source by 81.7% of them. On the other hand, for 62.5% of the local firms, the most important source of inputs is Vietnam. Yet China is the second most important. Importance of Vietnam and China for indigenous firms is overwhelming.

Contrary to sources of raw materials and supplies, Vietnam is the most important country as target market. Some 61.6% of the respondents target local market. Unlike sources of inputs, Japan is the second important market. About 43.5% of the respondents consider it as one of the target markets. There is a distinct difference in the target market between local firms and MNCs/JVs. Almost all (94.5%) of the indigenous firms aim at the domestic market. On the other hand, Japan is a major destination of the products made in Hanoi. Some 69.5% of the non-local respondents target the Japanese market. Vietnam, China and EU/US are also important markets for MNCs/JVs.

Table 2 also presents combinations of sources of inputs and markets, which clarify differences in production networks between indigenous firms and MNCs/JVs. Local firms mainly purchase inputs from suppliers in Vietnam and China and sell their products to customers in Vietnam. MNCs/JVs procure raw materials and parts from China and export to Japan. Such "Sourcing from China and exporting to Japan" is not a pattern typical of Japanese firms in Hanoi. Even 48.7% of the non Japanese MNCs/JVs do so, although more Japanese firms (74.4%) utilize operations in Hanoi as a base for assembling inputs from China into products for Japanese markets.

Table 2: Main Sources of Inputs and Target Markets

	<Markets>							
	Vietnam	China	Japan	Other ASEAN	Korea/ Taiwan	EU/US	Total	Obs.
<Sources>								
(Whole Sample)								
Vietnam	33.3%	11.6%	8.0%	2.9%	2.9%	10.1%	42.8%	59
China	33.3%	23.2%	38.4%	5.1%	7.2%	24.6%	65.9%	91
Japan	13.0%	12.3%	23.2%	2.9%	2.2%	11.6%	29.7%	41
Other ASEAN	16.7%	12.3%	20.3%	5.1%	7.2%	10.9%	35.5%	49
Korea/Taiwan	18.1%	8.7%	15.2%	3.6%	6.5%	11.6%	31.9%	44
EU/US	2.9%	1.4%	0.7%	0.7%	0.0%	1.4%	4.3%	6
Total	61.6%	26.1%	43.5%	8.7%	10.9%	29.7%	100%	138
Obs.	85	36	60	12	15	41	138	
(Local)								
Vietnam	60.7%	5.4%	1.8%	1.8%	3.6%	10.7%	62.5%	35
China	41.1%	1.8%	3.6%	0.0%	0.0%	8.9%	42.9%	24
Japan	10.7%	0.0%	0.0%	0.0%	0.0%	0.0%	10.7%	6
Other ASEAN	14.3%	3.6%	3.6%	0.0%	3.6%	1.8%	16.1%	9
Korea/Taiwan	26.8%	0.0%	3.6%	1.8%	0.0%	3.6%	28.6%	16
EU/US	7.1%	1.8%	1.8%	0.0%	0.0%	3.6%	8.9%	5
Total	94.6%	5.4%	5.4%	1.8%	3.6%	16.1%	100%	56
Obs.	53	3	3	1	2	9	56	
(MNC/JV)								
Vietnam	14.6%	15.9%	12.2%	3.7%	2.4%	9.8%	29.3%	24
China	28.0%	37.8%	62.2%	8.5%	12.2%	35.4%	81.7%	67
Japan	14.6%	20.7%	39.0%	4.9%	3.7%	19.5%	42.7%	35
Other ASEAN	18.3%	18.3%	31.7%	8.5%	9.8%	17.1%	48.8%	40
Korea/Taiwan	12.2%	14.6%	23.2%	4.9%	11.0%	17.1%	34.1%	28
EU/US	0.0%	1.2%	0.0%	1.2%	0.0%	0.0%	1.2%	1
Total	39.0%	40.2%	69.5%	13.4%	15.9%	39.0%	100%	82
Obs.	32	33	57	11	13	32	82	
(Japanese)								
Vietnam	9.3%	18.6%	20.9%	0.0%	0.0%	14.0%	27.9%	12
China	20.9%	39.5%	74.4%	4.7%	2.3%	37.2%	76.7%	33
Japan	16.3%	27.9%	53.5%	4.7%	2.3%	30.2%	58.1%	25
Other ASEAN	16.3%	11.6%	30.2%	4.7%	2.3%	11.6%	37.2%	16
Korea/Taiwan	9.3%	7.0%	18.6%	7.0%	0.0%	7.0%	18.6%	8
EU/US	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0
Total	41.9%	39.5%	88.4%	9.3%	2.3%	37.2%	100%	43
Obs.	18	17	38	4	1	16	43	
(non-Japanese)								
Vietnam	20.5%	12.8%	2.6%	7.7%	5.1%	5.1%	30.8%	12
China	35.9%	35.9%	48.7%	12.8%	23.1%	33.3%	87.2%	34
Japan	12.8%	12.8%	23.1%	5.1%	5.1%	7.7%	25.6%	10
Other ASEAN	20.5%	25.6%	33.3%	12.8%	17.9%	23.1%	61.5%	24
Korea/Taiwan	15.4%	23.1%	28.2%	2.6%	23.1%	28.2%	51.3%	20
EU/US	0.0%	2.6%	0.0%	2.6%	0.0%	0.0%	2.6%	1
Total	35.9%	41.0%	48.7%	17.9%	30.8%	41.0%	100%	39
Obs.	14	16	19	7	12	16	39	

Note: A grand total of observations is not necessarily equal to the sum of subtotals.
Source: ERIA 2008 SPLN.

3.3 Locations of Main Supplier and Customer

In the same manner to Table 2, Table 3 goes over locations of main supplier and customer for the respondents. The questionnaire asked them about details of their main business partners, including their locations, to which the respondents provide inputs or deliver products made in Hanoi. Key findings from this table are similar to those derived from the previous table.

The figures for whole sample indicate that raw materials and parts are mainly procured from suppliers in China. On the other hand products made of them are shipped mainly to customers in Vietnam. But the combination of main supplier and customer provides different views. One of the main patterns is procurement from Vietnam or China and shipment to the Vietnamese market. It can be considered that this sourcing strategy allow firms to decrease costs of inputs to satisfy low-end consumer needs. The other one is purchasing inputs from China or Japan to ship products to Japan. This strategy will make easier for manufacturers to bring prices down, fulfilling quality standards.

The figures for the sample of local firms present that the former strategies are applied mainly by indigenous firms in Vietnam. In the same way, the table for the MNC/JV sample illustrates the latter strategy for sourcing inputs are introduced mainly by MNCs or JVs. Among MNCs/JVs, Japanese firms are more dependent on raw materials and parts imported from suppliers in Japan and the Japanese market. On the other hand, non-Japanese MNCs/JVs make use of suppliers in China to send back them as products to China. They also deliver them more diversified markets, mainly Vietnam, and Japan, than Japanese firms.

Table 3: Locations of Main Supplier and Customer

	Vietnam	China	Japan	East and Southeast Asia	EU/US	Total	Obs.
			<Main Customer>				
<Main Supplier>							
(Whole Sample)							
Vietnam	16.7%	0%	0%	1.1%	1.1%	20.0%	18
China	15.6%	6.7%	15.6%	2.2%	3.3%	43.3%	39
Japan	3.3%	0%	15.6%	0%	1.1%	20.0%	18
East/Southeast Asia	3.3%	0%	5.6%	2.2%	1.1%	12.2%	11
EU/US	2.2%	1.1%	0%	0%	0%	3.3%	3
Total	42.2%	7.8%	36.7%	5.6%	6.7%	100%	90
Obs.	38	7	33	5	6	90	
(Local)							
Vietnam	37.9%	0%	0%	3.4%	3.4%	48.3%	14
China	34.5%	0%	0%	0%	0%	34.5%	10
Japan	0%	0%	0%	0%	0%	0%	0
East/Southeast Asia	3.4%	0%	3.4%	0%	0%	6.9%	2
EU/US	6.9%	0%	0%	0%	0%	6.9%	2
Total	86.2%	0%	3.4%	3.4%	3.4%	100%	29
Obs.	25	0	1	1	1	29	
(MNC/JV)							
Vietnam	6.6%	0%	0%	0%	0%	6.6%	4
China	6.6%	9.8%	23.0%	3.3%	4.9%	47.5%	29
Japan	4.9%	0%	23.0%	0%	1.6%	29.5%	18
East/Southeast Asia	3.3%	0%	6.6%	3.3%	1.6%	14.8%	9
EU/US	0%	1.6%	0%	0%	0%	1.6%	1
Total	21.3%	11.5%	52.5%	6.6%	8.2%	100%	61
Obs.	13	7	32	4	5	61	
(Japanese)							
Vietnam	9.7%	0%	0%	0%	0%	9.7%	3
China	3.2%	0%	29.0%	0%	3.2%	35.5%	11
Japan	6.5%	0%	41.9%	0%	0%	48.4%	15
East/Southeast Asia	0%	0%	6.5%	0%	0%	6.5%	2
EU/US	0%	0%	0%	0%	0%	0%	0
Total	19.4%	0%	77.4%	0%	3.2%	100%	31
Obs.	6	0	24	0	1	31	
(non-Japanese)							
Vietnam	3.3%	0%	0%	0%	0%	3.3%	1
China	10.0%	20.0%	16.7%	6.7%	6.7%	60.0%	18
Japan	3.3%	0%	3.3%	0%	3.3%	10.0%	3
East/Southeast Asia	7%	0%	6.7%	6.7%	3.3%	23.3%	7
EU/US	0%	3.3%	0%	0%	0%	3.3%	1
Total	23.3%	23.3%	26.7%	13.3%	13.3%	100%	30
Obs.	7	7	8	4	4	30	

Note: A grand total of observations is not necessarily equal to the sum of subtotals.
Source: ERIA 2008 SPLN.

3.4 Exchange of Engineer with Main Supplier and Customer

Table 4 summarizes exchange of engineer by the firms who responded to the question on locations of their main suppliers or customers. Here "exchange" with supplier (customer) means dispatch of engineer to its supplier (customer) or acceptance of engineer from its supplier (customer) by the respondent.

The sampled firms are actively exchanging engineers. Some 82.7% or 81 out of 98 respondents to the questions on their main customers' locations exchange engineers with their customers. In the same manner, 65.9% or 60 out of 91 respondents to the question on their main suppliers' locations did it with their suppliers. Therefore, more firms exchange engineers with customers than with suppliers.

There are significant differences between local firms and MNCs/JVs in the percentage of firms exchanging engineers. The percentage of the local firms exchanging engineers with their customer is 33.3%, whereas that for the MNCs/JVs is 82.0%. The percentage of the local firms exchanging engineers with their customer is 65.7%, whereas that for the MNCs/JVs is 92.1%. On the other hand there are not statistically significant differences between Japanese and non-Japanese MNCs/JVs in the percentages of firms exchanging engineer with supplier or customer.

To recognize factors causing such differences between indigenous firms and MNCs/JVs, the same analyses are conducted, restricting the sample to those having suppliers or customers in Vietnam and in foreign countries. When main suppliers or customers of the respondents are located in Vietnam, the differences in percentages of conducting engineer exchanges between local firms and MNCs/JVs disappear even though more MNCs/JVs exchanges information and technologies with indigenous firms through face-to-face communication. On the other hand, in the case of overseas business partners, the statistically significant differences in the percentages are remained. More than 90% of the MNCs/JVs participate in international networks for face-to-face communication networks among engineers, while only about 75% of the indigenous firms do so.

Table 4: Summary of Exchange of Engineer

	Whole Sample	Local	MNC/JV	Japanese	Non-Japanese
		With Supplier		With Supplier	
Obs.	91	30	61	31	30
% of the firms exchanging	65.9%	33.3%	82.0%	80.6%	83.3%
Difference (T-test)		Significant at the 1% level		Not significant	
		With Customer		With Customer	
Obs.	98	35	63	32	31
% of the firms exchanging	82.7%	65.7%	92.1%	93.8%	90.3%
Difference (T-test)		Significant at the 1% level		Not significant	

(Continued)

	Whole Sample	Local	MNC/JV	Whole	Local	MNC/JV
	With Supplier in Vietnam			With Overseas Supplier		
Obs.	18	14	4	72	15	57
% of the firms exchanging	66.7%	64.3%	75.0%	88.9%	73.3%	93.0%
Difference (T-test)	Not significant			Significant at the 5% level		
	With Customer in Vietnam			With Overseas Customer		
Obs.	46	31	15	52	4	48
% of the firms exchanging	69.6%	64.5%	80.0%	94.2%	75.0%	95.8%
Difference (T-test)	Not significant			Significant at the 5% level		

Note: The sample include firms responded to the question on location of its main supplier or customer. The sample for Tables 3 and 5 answered locations of both its main supplier and customer.
Source: ERIA 2008 SPLN.

Table 5 provides more details regarding location of the main suppliers and customers exchanging of engineers with the respondents. Among the respondents having experiences of exchanging engineers with suppliers, 27.8% of them do it with those in China, which is followed by those in Japan (17.8%). On the other hand, customers in Japan are main counterparts for the respondents to exchange engineers. Some 34.4% of the firms exchanging engineers replied Japan as their customers' location. If the combination of the suppliers' and customers' locations, the respondents exchanging engineers with suppliers in China and Japan tend to exchanges engineers with customers in Japan. Some 14.4% of the whole respondents exchanging engineers both with a supplier and a customer have their suppliers and customers in Japan. Some 13.3% of such whole respondents have their suppliers in China and customers in Japan.

There are differences in locations of the partners exchanging engineers between indigenous firms and MNCs/JVs. Indigenous firms exchange engineers with suppliers or customers in Vietnam: Among the respondents exchanging with suppliers and customers, 17.2% of them have suppliers and 58.6% of them have customers in Vietnam. On the other hand, 39.3% of the MNCs/JVs have such suppliers in China and 50.8% of them have customers in Japan. But exchanges of engineers with suppliers in Japan and customers in Japan are a usual pattern of customer and supplier relationships that MNCs/JVs have: 21.3% of them have such combination. This relationship pattern is more common to Japanese MNCs. 38.7% of Japanese MNCs exchanging engineers have a combination of supplier in Japan and customer in Japan. Non-Japanese MNCs have more usual face-to-face communications with suppliers and customers in China even though they exchanges engineers with customers in Japan.

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Table 5: Exchange of Engineer with Main Supplier and Customer

| | <Main Customer> | | | | | | |
	Vietnam	China	Japan	East and Southeast Asia	EU/US	Total	Obs.
<Main Supplier>							
(Whole Sample)							
Vietnam	5.6%	0%	0%	1.1%	0%	8.9%	8
China	3.3%	5.6%	13.3%	2.2%	3.3%	27.8%	25
Japan	2.2%	0%	14.4%	0.0%	1.1%	17.8%	16
East/Southeast Asia	3.3%	0%	2.2%	1.1%	1.1%	7.8%	7
EU/US	1.1%	1.1%	0%	0%	0%	2.2%	2
Total	30.0%	6.7%	34.4%	5.6%	6.7%	100%	90
Obs.	27	6	31	5	6	90	
(Local)							
Vietnam	6.9%	0%	0%	3.4%	0%	17.2%	5
China	3.4%	0%	0%	0%	0%	3.4%	1
Japan	0%	0%	0%	0%	0%	0%	0
East/Southeast Asia	3.4%	0%	0%	0%	0%	3.4%	1
EU/US	3.4%	0%	0%	0%	0%	3.4%	1
Total	58.6%	0%	0%	3.4%	3.4%	100%	29
Obs.	17	0	0	1	1	29	
(MNC/JV)							
Vietnam	4.9%	0%	0%	0%	0%	4.9%	3
China	3.3%	8.2%	19.7%	3.3%	4.9%	39.3%	24
Japan	3.3%	0%	21.3%	0%	1.6%	26.2%	16
East/Southeast Asia	3.3%	0%	3.3%	1.6%	1.6%	9.8%	6
EU/US	0%	1.6%	0%	0%	0%	1.6%	1
Total	16.4%	9.8%	50.8%	6.6%	8.2%	100%	61
Obs.	10	6	31	4	5	61	
(Japanese)							
Vietnam	6.5%	0%	0%	0%	0%	6.5%	2
China	0%	0%	29.0%	0%	3.2%	32.3%	10
Japan	3.2%	0%	38.7%	0%	0%	41.9%	13
East/Southeast Asia	0%	0%	0%	0%	0%	0%	0
EU/US	0%	0%	0%	0%	0%	0%	0
Total	12.9%	0%	77.4%	0%	3.2%	100%	31
Obs.	4	0	24	0	1	31	
(non-Japanese)							
Vietnam	3.3%	0%	0%	0%	0%	3.3%	1
China	6.7%	16.7%	10.0%	6.7%	6.7%	46.7%	14
Japan	3.3%	0%	3.3%	0%	3.3%	10.0%	3
East/Southeast Asia	6.7%	0%	6.7%	3.3%	3.3%	20.0%	6
EU/US	0%	3.3%	0%	0%	0%	3.3%	1
Total	20.0%	20.0%	23.3%	13.3%	13.3%	100%	30
Obs.	6	6	7	4	4	30	

Notes: The sample is restricted to the firms exchanging engineers with their main supplier or customer. A grand total of observations is not necessarily equal to the sum of subtotals.
Source: ERIA 2008 SPLN.

Table 6: Percentage of the Respondents who Exchange Engineers

| | <Main Customer> | | | | | |
	Vietnam	China	Japan	East and Southeast Asia	EU/US	Total
<Main Supplier>						
(Whole Sample)						
Vietnam	33.3%	N.A.	N.A.	100.0%	0.0%	44.4%
China	21.4%	83.3%	85.7%	100.0%	100.0%	64.1%
Japan	66.7%	N.A.	92.9%	N.A.	100.0%	88.9%
East/Southeast Asia	100.0%	N.A.	40.0%	50.0%	100.0%	63.6%
EU/US	50.0%	100.0%	N.A.	N.A.	N.A.	66.7%
Total	71.1%	85.7%	93.9%	100.0%	100.0%	
(Local)						
Vietnam	18.2%	N.A.	N.A.	100.0%	0.0%	35.7%
China	10.0%	N.A.	N.A.	N.A.	N.A.	10.0%
Japan	N.A.	N.A.	N.A.	N.A.	N.A.	
East/Southeast Asia	100.0%	N.A.	0.0%	N.A.	N.A.	50.0%
EU/US	50.0%	N.A.	N.A.	N.A.	N.A.	100.0%
Total	68.0%	N.A.	0.0%	100.0%	100.0%	
(MNC/JV)						
Vietnam	75.0%	N.A.	N.A.	N.A.	N.A.	75.0%
China	50.0%	83.3%	85.7%	100.0%	100.0%	82.8%
Japan	66.7%	N.A.	92.9%	N.A.	100.0%	88.9%
East/Southeast Asia	100.0%	N.A.	50.0%	50.0%	100.0%	66.7%
EU/US	N.A.	100.0%	N.A.	N.A.	N.A.	100.0%
Total	76.9%	85.7%	96.9%	100.0%	100.0%	
(Japanese)						
Vietnam	66.7%	N.A.	N.A.	N.A.	N.A.	66.7%
China	0.0%	N.A.	100.0%	N.A.	100.0%	90.9%
Japan	50.0%	N.A.	92.3%	N.A.	N.A.	86.7%
East/Southeast Asia	N.A.	N.A.	0.0%	N.A.	N.A.	0.0%
EU/US	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Total	66.7%	N.A.	100.0%	N.A.	100.0%	
(non-Japanese)						
Vietnam	100.0%	N.A.	N.A.	N.A.	N.A.	100.0%
China	66.7%	83.3%	60.0%	100.0%	100.0%	77.8%
Japan	100.0%	N.A.	100.0%	N.A.	100.0%	100.0%
East/Southeast Asia	100.0%	N.A.	100.0%	50.0%	100.0%	85.7%
EU/US	N.A.	100.0%	N.A.	N.A.	N.A.	100.0%
Total	85.7%	85.7%	87.5%	100.0%	100.0%	

Source: Calculated from Tables 3 and 5.

Table 6 presents exchange of engineers is not usual among respondent firms purchasing inputs from suppliers in Vietnam and China. Only 44.4% of the respondents who have main suppliers in Vietnam exchanges engineers between them. Exchange with customers in Vietnam is more common. Some 71.1% of the firms having main customers in Vietnam do it. Indigenous firms are not keen on knowledge sharing through exchange of engineers. Only 10.0% and 35.7% of the local firms exchange engineers with their suppliers in China and Vietnam respectively. It seems that price of input is the most important factor when these Vietnamese firms choose suppliers in

Vietnam and China. In practice, the adoption rate of exchanges of engineers is lower among firms using inputs purchased from Vietnam (18.2%) and China (10.0%) to ship their products to price-sensitive Vietnamese markets. As the rates for MNCs/JVs are ひ higher than those for local firms, it seems that MNCs/JVs utilize inputs from these sources to decrease costs, satisfying quality standards required by quality-conscious customers.

4. EMPRICAL RESULT

It became obvious from the discussions above that main sources of inputs for firms in Vietnam are Vietnam, China and Japan and main customers of their products are Vietnam and Japan. Thus empirical analyses focus on the relation between indicators for process innovations and location of main supplier and customer.

Mainly three types of independent variables regarding production networks are applied to binary probit estimations to check correlations between these independent variables with process innovations. Firstly, correlations between process innovations and countries of sources of inputs and target markets will be observed as the first benchmark to consider the effect of exchanging engineers on process innovations. This result will also be helpful to understand potential sources of technologies and motivations for firms to improve processes. Secondly, correlations between process innovations and location of main supplier and customer for respondents will be examined, supposing that main customer encourage the respondents to improve processes or main supplier and customer of the respondents transfer their technologies to the respondents through any business activities requiring collaborations between them. This result will be the second benchmark. Thirdly, effects of exchange of engineer on process innovation will be verified, assuming that face-to-face communication among engineers is one of the main channels of information exchange and technology transfer.

4.1 Process Innovation and Sources of Inputs/Target Markets

Table 7 presents marginal effects of sources of inputs and target markets on process innovations. As shown in the column (1), the coefficient on Japanese market is positively significant at the 5% level. This indicates that firms adopted international standards during 2006 and 2008 (variable STAN) tend to consider the Japanese market as one of the three target markets. The result suggests that adoption of international standards is a requirement from customs in Japan.

As shown in the columns (2) to (7), marginal effects of the variables for Chinese market on various types of process innovations are significantly positive, suggesting that requirements from Chinese customers may encourage the respondents who consider China as one of the main target market to improve quality control (QUALITY), reduce product defects (DEFECT), decrease production costs (COST) or reduce lead-time (DELIVERY). The firms improved quality control and reduced production cost simultaneously (QC) and those improve delivery in addition to QC (QCD) identify Chinese market as their main target market.

Among main countries supplying inputs, firms that recognize Japan as one of the three most important sources of raw materials and supplies tend to achieve more frequently process innovations except adoption of international standards (STAN) and reduction of lead-time (DELIVERY). This result implies that high-quality raw materials, parts, and other supplies imported from Japan facilitate process improvements by firms in Vietnam.

Although these findings provide important overviews on potential technology transfer channels, they do not necessarily indicate technical cooperation or collaboration with customers in China or suppliers in Japan. Firm-level analyses are needed to investigate these issues as examined later.

Among other control variables, asset size of the respondents (ASSET) is significantly positive marginal effects on all of the variables for process innovation. This reflects the situation that firms are often needed to invest in machines or equipments to improve managements and process controls. Such financial burden hinders process innovations by local firms, especially SMEs.

Table 7: Process Innovation and Sources Inputs and Target Market

Marginal Effect	(1)	(2)	(3)	(4)	(5) DELIVERY	(6)	(7)
	STAN	QUALITY	DEFECT	COST		QC	QCD
<LINK>							
VN_m	0.123	0.214	0.051	0.394	0.254	0.271	0.105
	(0.344)	(0.332)	(0.333)	(0.375)	(0.334)	(0.336)	(0.314)
CN_m	-0.124	0.648**	0.917***	1.381***	0.629*	0.790**	0.691**
	(0.319)	(0.315)	(0.309)	(0.409)	(0.330)	(0.331)	(0.306)
JP_m	1.064**	-0.088	-0.147	0.036	-0.007	0.004	0.121
	(0.419)	(0.395)	(0.386)	(0.407)	(0.400)	(0.405)	(0.385)
EASEA_m	0.086	-0.377	-0.313	-0.574	-0.457	-0.348	-0.071
	(0.379)	(0.351)	(0.342)	(0.375)	(0.344)	(0.361)	(0.361)
VN_so	0.434	-0.048	0.145	0.329	0.049	0.132	0.292
	(0.364)	(0.327)	(0.311)	(0.357)	(0.355)	(0.343)	(0.345)
CN_so	-0.110	0.137	-0.387	0.334	0.505	-0.086	0.082
	(0.379)	(0.332)	(0.344)	(0.358)	(0.339)	(0.330)	(0.334)
JP_so	0.282	0.607*	0.595*	0.735**	0.165	0.838***	0.675**
	(0.374)	(0.316)	(0.324)	(0.358)	(0.322)	(0.319)	(0.311)
EASEA_so	-0.350	-0.266	-0.052	-0.160	-0.644*	-0.133	-0.160
	(0.343)	(0.307)	(0.307)	(0.344)	(0.342)	(0.312)	(0.316)
< Control Variables>							
ASSET	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)
LOCAL	-0.385	0.197	0.271	0.276	0.003	0.013	-0.002
	(0.442)	(0.414)	(0.422)	(0.427)	(0.436)	(0.406)	(0.409)
LIGHT	-0.095	-0.657	-0.448	-0.780*	-0.712	-0.531	-0.331
	(0.479)	(0.465)	(0.440)	(0.466)	(0.479)	(0.487)	(0.503)
CHEMICAL	-0.078	0.156	-0.229	-0.320	-0.282	0.099	0.103
	(0.482)	(0.504)	(0.487)	(0.526)	(0.508)	(0.482)	(0.451)
METAL	0.540	0.441	0.332	0.773*	-0.534	0.888*	0.399
	(0.523)	(0.438)	(0.446)	(0.454)	(0.445)	(0.453)	(0.433)
ELECTRONICS	-1.103**	0.006	-0.216	0.384	-0.044	0.002	-0.139
	(0.501)	(0.451)	(0.456)	(0.518)	(0.463)	(0.478)	(0.477)
MACHINE	0.713*	-0.313	-0.180	0.038	0.102	-0.206	0.090
	(0.398)	(0.354)	(0.358)	(0.389)	(0.394)	(0.354)	(0.348)
Constant	-0.995	-0.266	0.081	-0.738	0.077	-0.733	-1.082*
	(0.615)	(0.565)	(0.558)	(0.614)	(0.581)	(0.563)	(0.559)
Observations	129	129	129	129	129	129	129
Pseudo R2	0.293	0.153	0.137	0.225	0.178	0.204	0.184

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors are in parentheses.

4.2 Process Innovation and Location of Main Supplier and Customer

To consider the constraints of country-level analyses presented in Table 7, firm-level customer or supplier relationship is investigated with details in Table 8. Independent variables for the binary probit estimations are main customer and supplier for the respondents by location. As shown in Table 3 that their main customers are located mainly in Vietnam and China and their suppliers are in Vietnam, China and Japan, the econometric analysis focuses on main customers and suppliers in these countries.

Contrary to the estimation results using variables for country-level linkages in Table 7, only two coefficients on the variable "CN_s" are positively significant. In other words, firms having a main supplier in China succeed in reducing production costs (column 11) and lead-time (column 12). The coefficient on suppliers in China is significant at the 1% level. This indicates that inputs from China are used for reducing production costs. This result implies that firms in Hanoi can take advantage of economies of scale achievable in China. In addition, it seems that Hanoi's geographical proximity to China may make it easier firms to manage lead-time.

On the other hand, the coefficient on the main customer in Vietnam is negative and statistically significant at the 5% level in the estimation for the adoption of international standards. This indicates that customers in Vietnam do not require their suppliers to adopt international standards such as ISO. The Vietnamese customers will be not quality conscious but price-sensitive.

The comparison between the results of probit estimations used country-level supplier/customer information in Table 7 and those based on data for location information of individual customer/ supplier in Table 8 illustrates insufficiency of analyses on technology transfer or knowledge spillover based on international trade data. All business transactions cannot be channels to exchange information, knowledge or technologies. Thus further investigation focusing on exchange of engineer is attempted in the following section.

An additional important finding is robustly significant positive coefficients on variable for asset size (ASSET). This result is also presented in Table 7.

Table 8: Process Innovation and Location of Main Supplier and Customer

Marginal Effect	(8) STAN	(9) QUALITY	(10) DEFECT	(11) COST	(12) DELIVERY	(13) QC	(14) QCD
<LINK>							
VN_c	-1.171**	0.343	0.707	-0.302	-0.382	-0.132	-0.526
	(0.560)	(0.588)	(0.557)	(0.527)	(0.508)	(0.586)	(0.573)
JP_c	-0.187	0.419	0.547	0.574	0.717	0.309	0.441
	(0.641)	(0.511)	(0.497)	(0.550)	(0.546)	(0.523)	(0.525)
VN_s	0.687	0.460	0.738	0.817	0.702	0.736	0.481
	(0.658)	(0.569)	(0.642)	(0.528)	(0.557)	(0.559)	(0.555)
JP_s	-0.196	-0.097	-0.227	0.680	-0.124	0.277	-0.249
	(0.597)	(0.578)	(0.582)	(0.617)	(0.589)	(0.574)	(0.573)
CN_s	0.471	-0.109	-0.406	1.172***	1.087**	0.325	0.280
	(0.574)	(0.410)	(0.437)	(0.416)	(0.466)	(0.413)	(0.448)
< Control Variables>							
ASSET	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)
LOCAL	-0.548	-0.610	-0.877	0.433	0.248	-0.316	-0.540
	(0.544)	(0.559)	(0.588)	(0.515)	(0.529)	(0.553)	(0.573)
LIGHT	-1.195**	-1.099*	-0.691	-1.741***	-1.552**	-1.531**	-1.578**
	(0.601)	(0.626)	(0.614)	(0.639)	(0.685)	(0.651)	(0.677)
CHEMICAL	-0.714	0.187	0.409	-0.215	-0.479	0.191	-0.076
	(0.906)	(0.639)	(0.663)	(0.708)	(0.720)	(0.623)	(0.622)
METAL	-0.814	-0.087	0.086	-0.529	-1.697***	-0.069	-1.068*
	(0.637)	(0.575)	(0.572)	(0.643)	(0.627)	(0.596)	(0.563)
ELECTRONICS	-1.274**	-0.709	-1.115**	-0.238	-0.774	-0.527	-0.937*
	(0.641)	(0.512)	(0.566)	(0.587)	(0.589)	(0.519)	(0.560)
MACHINE	0.225	-0.290	0.292	-0.293	-0.175	-0.395	-0.167
	(0.636)	(0.493)	(0.550)	(0.576)	(0.564)	(0.505)	(0.521)
Constant	0.479	-0.178	-0.203	-0.457	-0.336	-0.463	-0.070
	(0.693)	(0.658)	(0.657)	(0.682)	(0.650)	(0.685)	(0.664)
Observations	87	87	87	87	87	87	87
Pseudo R2	0.366	0.243	0.206	0.241	0.270	0.290	0.334

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors are in parentheses.

4.3 Process Innovation and Exchange of Engineer

The estimation results presented in Tables 7 and 8 implies that daily business transactions do not automatically facilitate knowledge and technology diffusions among firms involved in such transactions. More in-depth investigations are needed to detect channels of knowledge transfer to firms in Vietnam. This paper supposes face-to-face communications are one of the important channels.

Table 9 presents effects of exchanging engineers with customers in Japan and Vietnam and suppliers in Vietnam, Japan, and China on process innovations. These variables for linkages are the same as those in Table 8, except that analyses in Table 9 focus on exchange of engineer.

The estimated effects of supplier or customer relationships accompanying exchange of engineer are quite different from the previous estimation results. As shown in the column (15), the coefficient on exchange of engineer with supplier in China is positive and statistically significant at the 1% level. This indicates that engineers working for the firms in Hanoi adopt international standards in technical cooperation with engineers from their main suppliers in China.

Exchanges of engineers with customers in Vietnam and Japan also encourage firms in Hanoi to improve quality control. The coefficient on the exchange of engineer with customers in Vietnam is positively significant at the 1% level (column (16) of Table 9). In a sense, this result is contradictory to the negative effect of linkages with customer in Hanoi on the adoption of international standards, which can include ISO9000 series, in the column (8) of Table 8. This finding indicates that firms in Hanoi paying attention to quality control exchange engineers with their suppliers to satisfy their quality standards without fault.

On the other hand, exchange of engineer with customers in Japan has a positive and significant effect on improvement in quality control at the 1% level (column (16) of Table 9). It is often said that Japanese customers are the most quality-conscious in the world. In practice, they used to exchange engineers with their business partners periodically and in each problematic case.

Cooperation with customers in Japan also helps firms in Hanoi decrease product defects. The coefficient on exchange of engineer with customer in Japan is positively significant at the 10% level (column (17) of Table 9). Exchange of engineer with customer in Japan improves production management of firms in Hanoi.

The column (18) of Table 9 also presents positive and significant effects on cost reduction of exchange of engineers with customers in Japan at the 10% level and that

with suppliers in Vietnam at the 5% level. Although Vietnam is expected as a new manufacturing base that enables to decreasing production cost, this objective can be achieved when customers who need cheaper products and suppliers who provide necessary inputs should collaborate through face-to-face communication with their counterparts in Vietnam.

Contrary to the positive effect of supplier in China on lead-time in the column (12) of Table 8, exchange of engineer with supplier in China does not have a positive effect on it as shown in the column (19) of Table 9.

More variables for exchange of engineer are significant when firms simultaneously improve quality control and cost reduction (QC), or QC and lead-time (QCD). The column (20) of Table 9 indicates that effects on QC of exchange of engineer with customer in Vietnam and Japan and with supplier in Vietnam are positively significant at the 5%, 10% and 1% levels.

Positive marginal effects of exchanging engineers on the improvement of QCD are also observed as shown in the column (21). In addition to exchanges of engineers with customer in Vietnam and Japan and supplier in Vietnam that have positive effects on QC, exchange of engineer with supplier in China has a positive and significant impact on improvements of QCD.

These estimation results disclose reasoning behind the location choice by firms using Hanoi as assembling base. Firms can use various sources of inputs from, for example, from local sources and China to sell products in markets in Asia including Vietnam and Japan. This enables firms to optimize procurements of raw material and parts and decrease labor costs by using Vietnamese workers. In addition, closer relationships involving exchange of engineers with diversified suppliers or customers in these countries make it possible to incrementally improve QCD at the same time and competitiveness in the international market.

In addition to these empirical findings, the coefficients on variable for asset size (ASSET) are significantly positive again as presented in Tables 7 and 8.

Table 9: Process Innovation and Sources Location of Main Supplier and Customer

Marginal Effect	(15) STAN	(16) QUALITY	(17) DEFECT	(18) COST	(19) DELIVERY	(20) QC	(21) QCD
<LINK>							
ex_VN_c	0.626	1.564***	0.567	0.108	0.005	0.973**	0.874*
	(0.474)	(0.557)	(0.473)	(0.428)	(0.457)	(0.494)	(0.530)
ex_JP_c	0.800	1.223**	0.834*	0.893*	0.830	1.054*	1.404**
	(0.588)	(0.599)	(0.502)	(0.541)	(0.525)	(0.554)	(0.604)
ex_VN_s	1.337			1.390**		3.056***	3.531***
	(0.833)			(0.657)		(0.779)	(0.799)
ex_JP_s	0.234	-0.607	-0.205	-0.213	-0.008	-0.224	-0.295
	(0.726)	(0.727)	(0.626)	(0.631)	(0.644)	(0.668)	(0.718)
ex_CN_s	2.254***	0.262	0.073	0.270	0.504	0.398	0.859*
	(0.660)	(0.525)	(0.435)	(0.415)	(0.432)	(0.498)	(0.522)
< Control Variables>							
ASSET	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)
LOCAL	-0.322	-0.836	-0.181	0.189	0.132	-0.481	-0.850
	(0.607)	(0.561)	(0.488)	(0.467)	(0.516)	(0.543)	(0.598)
LIGHT	-1.132	-1.909**	-1.185*	-1.530***	-1.391**	-1.902***	-1.984**
	(0.839)	(0.758)	(0.673)	(0.573)	(0.619)	(0.706)	(0.774)
CHEMICAL	-1.394	-0.430	-0.123	-0.312	-0.251	-0.211	-0.681
	(1.018)	(0.757)	(0.668)	(0.666)	(0.696)	(0.719)	(0.828)
METAL	-1.170	-0.426	-0.363	-0.245	-1.153**	-0.162	-1.302*
	(0.776)	(0.697)	(0.555)	(0.569)	(0.552)	(0.660)	(0.712)
ELECTRONICS	-1.352*	-0.932*	-0.986*	-0.500	-0.941	-0.640	-1.128*
	(0.754)	(0.553)	(0.543)	(0.545)	(0.615)	(0.555)	(0.613)
MACHINE	0.344	-0.742	-0.121	-0.122	0.216	-0.674	-0.308
	(0.654)	(0.541)	(0.502)	(0.499)	(0.547)	(0.502)	(0.605)
Constant	-1.217*	-0.962	-0.368	-0.118	-0.502	-1.066	-1.213
	(0.728)	(0.702)	(0.532)	(0.528)	(0.599)	(0.692)	(0.744)
Observations	87	80	80	87	80	87	87
Pseudo R2	0.444	0.421	0.235	0.221	0.274	0.411	0.474

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors are in parentheses.

Note. Variable "ex_VN_s" is dropped when it predicts dependent variable perfectly.

5. "CHINA PLUS ONE" STRATEGY OF FIRMS IN HANOI

The results of the regressions propose that firms can make use of the gap in industrial development among countries in Asia. Firms establish factories in Hanoi to decrease production costs. Disadvantages of Hanoi are compensated by domestic and international production networks. Although the industrial district in Hanoi has weakness in supporting industries, necessary raw materials and parts can be imported from China, Japan and other Asian countries. The shortage of skilled labors or poorly-controlled production and other managements can be gradually solved by technological transfers from advanced industrialized countries to Vietnam. The

geographical proximity to China enables firms to transport goods and people at lower cost.

There are Japanese firms applying this strategy effectively by operating plants in both China and Hanoi. An example is a firm that produces domestic sewing machines in Guangdong and additionally established a factory in the Hanoi area. In its system of international division of labor, the firm assigned the factory in Guangdong to produce mechanically-controlled domestic sewing machines that necessitate skilled workers; and the factory in Hanoi to assemble electronically-controlled ones that require workers to put modular units together.

In addition, the factory in Guangdong is expected to play a role of mother factory. When the firm decided to establish a factory near Hanoi in addition to a factory in Guangdong, its Chinese staff provided the new factory in Vietnam with significant supports: Chinese engineers were sent to Hanoi as technical trainer, and Chinese skilled workers were dispatched to assist the factory in Hanoi. On the other hand, a group of Vietnamese workers was also sent to Guangdong for training.

These labor movements were achieved by using buses as an inexpensive means of transport. Geographical proximity allows intra-firm technology and knowledge transfer from China to Vietnam at a low transportation cost. In addition, the factory in Vietnam uses manuals written in Chinese and Vietnamese. Chinese engineers can speak Chinese when training Vietnamese workers. About 10 Vietnamese can understand Chinese even though they are not ethnic Chinese. Thus, less language barrier promotes technology transfer. In addition, the factory in Vietnam relies on materials and parts made in China and Taiwan although about 60 percent of the raw materials and parts are procured from suppliers in Vietnam (Ueki, 2010).

More firms can adopt this kind of intra-firm international division of labor to avoid the expected appreciation of the Chinese Yuan, shortage of workers, and inflation of wages in China. According to the survey conducted by JETRO in 2009, the monthly salary for workers in the manufacturing sector is US$227 in Guangzhou, China, which is almost same as that in Bangkok (US$230) and much higher than Hanoi (US$104). In reality, higher wage level of the coastal area in China than Bangkok is pointed out by a Japanese firm that operates its own factory in the Bangkok area and subcontract manufacturing to non-Japanese venders in Guangdong and its surrounding area.

Such spillover effect of FDIs on the technology upgrade in Vietnam will not be limited to intra-firm technology transfer under the China plus One strategy. If more FDIs are flown into Vietnam, competition among firms in Vietnam will become fiercer.

These firms will need to seek closer cooperation with customers and suppliers, which will promote inter-firm technology transfer to firms in Vietnam.

6. CONCLUSION

This paper attempted to detect channels of technology transfer to firms in Hanoi, Vietnam, which will improve their QCD performances. As potential channels, three types of customer or supplier relationships are taken into consideration: (1) three most important countries as target markets and sources of raw materials and supplies; (2) main supplier and customer; and (3) exchange of engineer with the main supplier and customer.

The empirical results suggest that requirements from customers, in particular those in China, will be one of the key factors that motivate firms to improve QCD. Suppliers in China also support firms in Hanoi to improve QCD by providing inputs and exchanging engineers.

The Vietnamese market and customers in Vietnam do not necessarily encourage firms in Hanoi to be innovative in general. Positive effects of inputs from Vietnam and suppliers in Vietnam did not verified empirically. But both customers and suppliers in Vietnam exchanging engineers contribute to improve QCD performances of the respondents to the survey.

Knowledge spillover from firms in Japan is also significant. High-quality inputs imported from Japan will be important to achieve incremental process innovations. But positive effects of customer and supplier in Japan and exchange of engineer with firms in Japan on QCD performances of the respondents. On the other hand, exchange of engineer with customers in Japan has a significant impact on QCD performances.

In sum, exchange of engineer is one of the significant channels of technology transfer to Vietnam. It is not sufficient to observe production networks at the country level to detect such channels. This is a very important finding for future empirical studies on this issue. As policy implication, importance of promoting exchange of engineer through economic integration should be emphasized.

An additional finding from the regressions is positively significant and robust effect of asset size on process innovations. This indicates the necessity of special attention to small and medium sized enterprises to diffuse new technologies and know-how.

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APPENDIX

Appendix Table: List of Variables

Variable	Definition
<u>Dependent Variables</u>	
STAN	Coded 1 if a firm adopted an international standard between 2006 and 2008
QUALITY	Coded 1 if a firm improved quality of products substantially between 2007 and 2008
DEFECT	Coded 1 if a firm reduced product defects substantially between 2007 and 2008
COST	Coded 1 if a firm decreased production cost substantially between 2007 and 2008
DELIVERY	Coded 1 if a firm reduced lead-time (the period between a customer's order and delivery of product) between 2007 and 2008
QC	Coded 1 if QUALITY=1 and COST=1
QCD	Coded 1 if QUALITY=1 and COST=1 and DELIVERY=1
<u>Independent Variables</u>	
<LINK>	
<u>Three Most Important Sources and Markets</u>	
VN_m	Coded 1 if Vietnam is one of the three main markets for a firm
CN_m	Coded 1 if China is one of the three main markets for a firm
JP_m	Coded 1 if Japan is one of the three main markets for a firm
EASEA_m	Coded 1 if South Korea, Taiwan, and ASEAN other than Vietnam is one of the three main markets for a firm
VN_so	Coded 1 if Vietnam is one of the three main sources of inputs for a firm
CN_so	Coded 1 if China is one of the three main sources of inputs for a firm
JP_so	Coded 1 if Japan is one of the three main sources of inputs for a firm
EASEA_so	Coded 1 if South Korea, Taiwan, and ASEAN other than Vietnam is one of the three main sources of inputs for a firm
<u>Location of Main Supplier and Customer</u>	
VN_c	Coded 1 if a main customer for a firm is in Vietnam
JP_c	Coded 1 if a main customer for a firm is in Japan
VN_s	Coded 1 if a main supplier for a firm is in Vietnam
JP_s	Coded 1 if a main supplier for a firm is in Japan
CN_s	Coded 1 if a main supplier for a firm is in China
<u>Exchange of Engineer with Main Supplier and Customer</u>	
ex_VN_c	Coded 1 if a firm exchanges engineers with its main customer in Vietnam
ex_JP_c	Coded 1 if a firm exchanges engineers with its main customer in Japan
ex_VN_s	Coded 1 if a firm exchanges engineers with its main supplier in Vietnam
ex_JP_s	Coded 1 if a firm exchanges engineers with its main supplier in Japan
ex_CN_s	Coded 1 if a firm exchanges engineers with its main supplier in China
<Other Control Variables>	
ASSET	Size of asset in U.S. dollars
LOCAL	Coded 1 if a firm is a local firm (100% local capital)
LIGHT	Coded 1 if the main business activity of a firm is food/beverages/tobacco, or textiles/apparel/leather
CHEMICAL	Coded 1 if the main business activity of a firm is chemicals/chemical and plastic products/rubber
METAL	Coded 1 if the main business activity of a firm is iron/steel, or metal products
ELECTRONICS	Coded 1 if the main business activity of a firm is electronics/electronic components other than computer/computer parts
MACHINE	Coded 1 if the main business activity of a firm is machinery/equipment/tools, computers/computer parts/precision instruments, automobile/ auto parts, or other transportation equipments and parts