

External Engagements and Innovation of Firms: Evidence from Vietnamese Manufacturing SMEs.

LUU Duc Thi *

Yushi INABA **

I. Introduction

From the 1950s, there have been many studies explaining innovation at both macro and micro levels. Within these levels, it is generally accepted that innovation is a key factor contributing to economic growth and firm performance: for a country, enhancing innovation is a solution to stable economic growth and rise in living standard, and for a firm, innovation is a key determinant towards bettering firm's performance with higher productivity, and higher competitive advantage (e.g. OECD, 2005; Osamu, 2008).

In the economy, firms are the most important producers of innovation. Nowadays, inputs of firm innovation also become more dynamic and open than before. It is investigated in many countries that external engagements are the pipelines from outside innovative flows to the firms (e.g. Criscuolo, Haskel & Slaughter, 2005; Pittiglio, Sica, Villa, 2009; Wagner, 2006; OECD, 2005; Osamu, 2006).

In the case of Vietnam, there are few studies on the innovation of Vietnamese firms in general, and the role of external factors in particular. The only one study directly related to this issue is that of Anh et al. (2008). Their study analyzes the relationship between export performance and innovation outputs of Vietnamese private manufacturing small medium enterprises (SMEs).

Therefore, this study aims to fill in the gap in research on firm innovation in general and the impacts of external engagements on the innovation of

* PhD student, University of Kiel, Germany. M.A. in Public Economics,
from International Christian University. (luuducthi@gmail.com).

** Senior Associate Professor of Management, International Christian University. (inabay@icu.ac.jp).

Vietnamese private manufacturing SMEs in particular. We hypothesize that external engagements have positive impact on innovation of Vietnamese private manufacturing SMEs. For the theoretical framework, this study is based on knowledge production function model (Griliches, 1979, 1990) and network model of innovation (OECD, 2005; Osamu, 2008). We examine a microeconomic data set of Vietnamese manufacturing SMEs conducted in 2009 by ILSSA, CIEM, and DoE⁽¹⁾.

Three indicators for innovation outputs are used: new product innovation, product modification, and process innovation. In terms of external engagements, we analyze both international engagements (export, import of intermediate goods, and supports from foreign donors/NGOs) and other domestic engagements (outsourcing, purchasing outside business service, subcontracting, and being a member of business/trade association activities).

Because all innovation indicators are binary, for each indication we build a logistic regression model showing the relationship between that indicator on external engagements and other explanatory variables.

This article has four additional sections. Section two briefly reviews main theoretical framework. Section three explains data, and empirical models, variables used. Section four reports the main findings and discussions. The article ends at Section five with conclusions and implications.

II. Analytical Models

In this section, we review two important analytical models, the knowledge production function (KPF) and the network model of innovation (NMI). KPF model explains how knowledge can be systematically produced, and NMI explains the sources of knowledge flows coming into a firm in more detail.

(1) ILSSA: Institute for Labor Science and Social Affairs

CIEM : Central Institute for Economic Management

DoE: Department of Economics, Copenhagen University

1. The Knowledge Production Function Model

In economics, innovation and technological progress are often indirectly measured through its effect on the economic outcomes. However, because of interests in innovation emergence, it is needed to build a production function for innovation.

Griliches is seen as one of the first contributors who develop the KPF systematically modeling relationship between inputs and outputs of knowledge. Griliches (1979) divides the inputs of economic outcome (Y) into vector of conventional inputs such as capital and labor (X), vector of technological knowledge (K), and vector of other unmeasured determinants of outputs (u). The shorten form of function of economic outcome is $Y = F(X, K, u)$, where K is a function of current state of technological knowledge, accumulated expenditures for technological knowledge, and other determinants. According to Griliches (1979), difficulty to measure and determine aggregate knowledge outputs is that knowledge outputs are often embodied in employers, patents/know-how, equipments, books, in oral tradition, and so on. In addition, he emphasizes that the main components of knowledge inputs are the investment in knowledge (e.g. R&D investment) and the level of existing knowledge coming from any sector of industry.

The completed KPF model is first introduced by Griliches (1990), and this model has significantly influenced survey and empirical studies on innovation. The simplest model of KPF and relative issues is:

$$\Delta K = R + u$$

$$\text{Indicator} = a. \Delta K + v = a.R + a.u + v$$

$$Z = b. \Delta K + e = b.R + b.u + e$$

where:

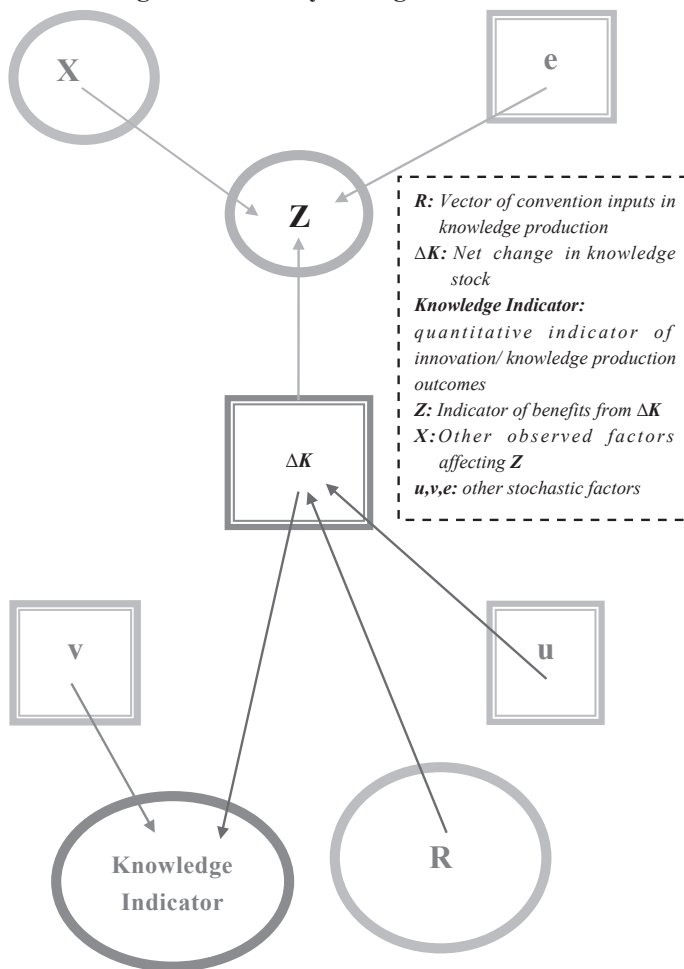
- The first equation is KPF function, ΔK stands for the net change in knowledge stock, R stands for conventional inputs, and u represents for stochastic and other sources of ΔK
- The second equation shows the relationship between the quantitative indicator of knowledge production outputs and ΔK , and v represents for

stochastic and other factors.

- The last equation explains the impact of ΔK on economic outputs determination (Z), and e represents for stochastic and other factors.

The analysis diagram for knowledge production function and the role of knowledge in economic outcomes are sketched as in the Figure 1.

Figure 1. An analysis diagram for KPF



(Source: Griliches, 1990, pp.1671)

The KPF framework gives an important analytical aspect that a firm may create knowledge not only from the own R&D laboratories but can also take the advantages from the flows generated by external sources. Moreover, it allows measuring innovation/knowledge outputs and determinants systematically and flexibly.

Based on KPF framework, many empirical works have investigated the role of international engagements on innovation of firms. For instance, one of the most popular studies was conducted by Criscuolo et al. (2005) estimating KPF on a UK firm data set. They rewrite more generally the KPF model as:

$$\Delta Ki = F(Hi, Kii, Ki_i),$$

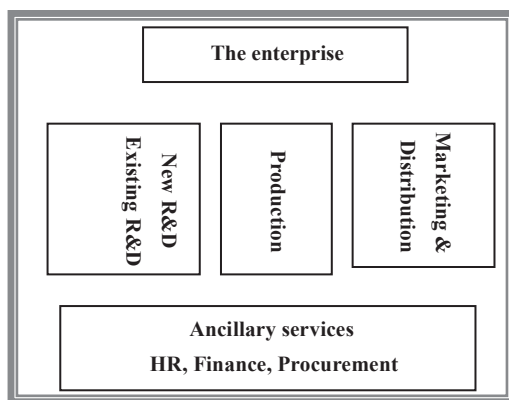
where ΔKi is the change in knowledge stock; Hi is investment in knowledge; Kii and Ki_i are within flows and outside flows of ideas/ knowledge to firm i , respectively; u stands for other unmeasured determinants of outputs.

The basic message from this model is that if firm receives within and or outside flows of ideas from existing stocks of knowledge, this may reflect greater investment in Hi .

2. Network Model of Innovation

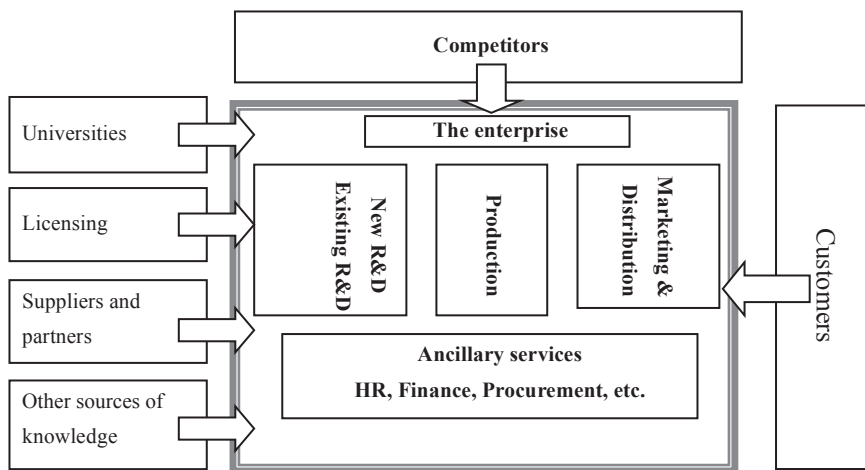
The Network model of innovation (NMI) in closed economy is developed from the model of innovation activities within firm (OCED, 2005; Osamu, 2008). Figure 2 represents the innovation sources within firm including R&D activities, production activities, marketing and distribution activities, and other ancillary services. Figure 3 represents the innovation sources of firm in a closed economy where we see the role of both firm's inside activities and firm's external engagements on innovation. The knowledge flows may come from universities/ academic institutions, suppliers and or business partners, customers, competitors, licensing, business/trade associations, and from the government.

Figure 2. Innovation within a firm



(Source: Osamu, 2008, pp.9)

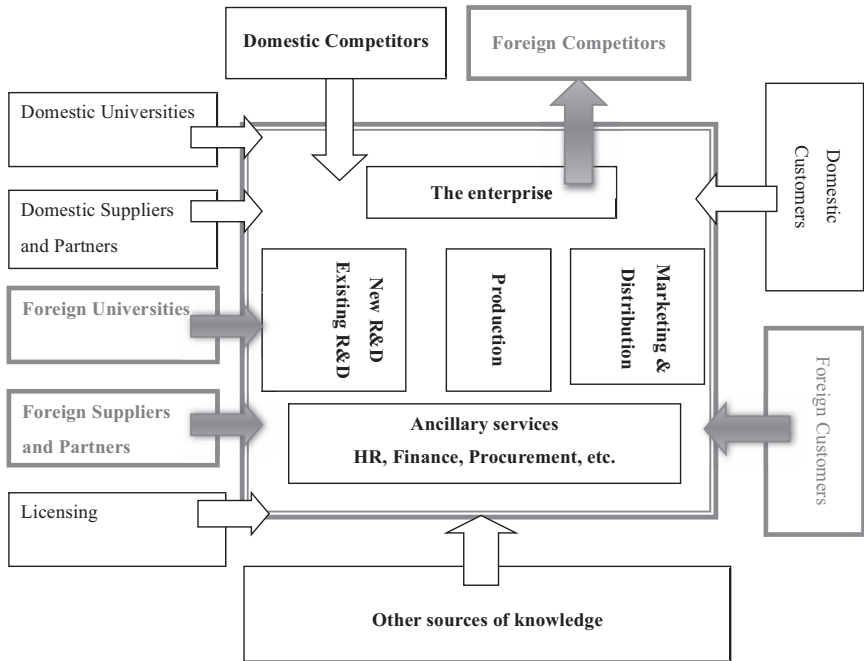
Figure 3. Network model of Innovation in the closed economy



(Source: Osamu, 2008, pp.9)

NMI in closed economy can be expanded into NMI in open economy as shown in Figure 4. It allows the participation of foreign sectors: foreign universities and academic institutes, foreign suppliers, foreign buyers, foreign competitors, other foreign business and non business partners, and so on (OCED, 2005; Osamu, 2008).

Figure 4. Network model of innovation in the open economy



(Source: Osamu, 2008, pp.14)

By briefly reviewing the network model explaining sources of innovation, we can understand where the inputs and knowledge/idea flows come from. Firm innovation outputs are influenced by internal factors, external domestic factors, and international factors.

III. Data, Empirical Models, and Variables Used

1. Data

We use cross-sectional survey data set on Vietnamese private manufacturing SMEs conducted in 2009 by CIEM, ILSSAMOLISA, DoE. The survey agents have carried out seven survey rounds in 1991, 1997, 2002, 2005, 2007, 2009, and 2011⁽²⁾.

(2) The 2011 survey data set is not available yet.

The survey in 2009 interviewed more than 2,500 private manufacturing SMEs in Vietnam⁽³⁾ (CIEM, DoE, ILSSA, 2009). It should be noted that Viet Nam has significantly reformed its business environment since 2005, and become the 150th member of World Trade Organization since January 2007. Among 6 available survey rounds, the changes in business environment are most updated in the 2009 round.

2. Empirical Model

Firstly, applying KPF and NMI, we build three general innovation production function models as bellows:

$$I(j) = Fj(H, C, X, DA, E, IA, Z, u) \quad (1),$$

where:

$I(j)$: $j = 1$: New product innovation, $j = 2$: Product modification innovation,

$j = 3$: Process Innovation,

H : Vector of investments in innovation,

C : Vector of innovation capabilities,

X : Vector of firm characteristics other than size and age,

DA : Vector of domestic activities,

E : Vector of characteristics of business environment,

IA : Vector of international activities,

Z : Vector of control variables,

u : error term.

Because all dependent variables are binary, (1) should be modeled by models of binary choice such as probit model or logistic model (e.g., Wooldridge, 2006; Baltagi 2008). From (1), there are three separate logistic regression models for three different measures of the innovation output, respectively:

$$\begin{aligned} Pr(I_j) &= I | H, C, X, DA, E, IA, Z = Fj(H, C, X, DA, E, IA, Z, u) \\ &= \frac{1}{1 + e^{-(\alpha_j + \beta_j.H + \gamma_j.C + \delta_j.X + \theta_j.DA + \rho_j.E + \varphi_j.IA + \omega_j.Z + u_j)}} \quad (2), \end{aligned}$$

(3) Manual – guidelines: Survey of small medium scale manufacturing enterprises (SMEs) in Vietnam in 2009.

where:

F_j is cumulative standard logistic distribution function for dependent variable I_j , $j=1, 2, 3$;

for each j , dependent variable I_j is binary, $I_{ij}=1$ if firm i has introduced innovation j and $I_{ij}=0$ otherwise;

α_j is intercept, and $\beta_j, \gamma_j, \delta_j, \theta_j, \rho_j, \varphi_j, \omega_j$ are logistic coefficients;

$Pr(I_{ij}=1)$ indicates the probability that firm i has introduced innovation (j).

From (2), it is clear that $Pr(I_{ij}=1)$ takes value from 0 to 1.

Denotes $L_j = \alpha_j + \beta_j.H + \gamma_j.C + \delta_j.X + \theta_j.DA + \rho_j.E + \varphi_j.IA + \omega_j.Z + u_j$, $j=1, 2, 3$ (3), then models in (2) can be rewritten as in (4):

$$\ln \frac{Pr(I_j=1)}{Pr(I_j=1)-1} = L_j \quad (4)$$

3. Variables Used

Table 1 provides detailed explanation for three indicators of innovation outputs, and explanatory variables (internal factors, international engagements, other domestic engagements, change in business environment, and control variables).

Table 1. Variables and indicators

Variables	Indicators	Scales
Innovations		
- New product innovation	Has firm introduced new product innovation since last survey?	1 if Yes, 0 if No
- Product modification innovation	Has firm introduced product modification innovation since last survey?	1 if Yes, 0 if No
- New process innovation	Has firm introduced process/ technological innovation since last survey?	1 if Yes, 0 if No
Independent variables		
Internal factors		
New investment	Has the firm made any new investments since last survey?	1 if Yes, 0 if No
Professionals	Of the total regular workforce, what is the share of professionals?	%
PCs	How many personal computers firm has?	Number of PCs
Debt rate	The rate of debt over total assets	Rate
Diversification	Has firm diversified product/ services?	1 if Yes, 0 if No
External factors other than international engagements		
<i>Domestic activities:</i>		
Outsource	Does firm outsource production?	1 if Yes, 0 if No
Subcontract	Does firm itself produce as subcontractor?	1 if Yes, 0 if No
Outside business service	Does firm purchase business services outside the enterprise?	1 if Yes, 0 if No
Member of business association	Is your firm member of one or more business associations?	1 if Yes, 0 if No
<i>Business environment</i>		
Finance crisis	Is firm affected by finance crisis happened from 2007?	1 if Yes, 0 if No
International engagements		
Export	Does firm export (directly and indirectly)?	1 if Yes, 0 if No
Import	Did firm import main equipment/machineries?	1 if Yes, 0 if No
Donor	Has firm involved in training courses supported by (or received other assistance) from foreign donors? (*)	1 if Yes, 0 if No
Control variables		
<i>Firm age</i>	Years firm has been doing business since establishment	Number of years
<i>Firm size</i>	How many regular labors firm has?	Number of regular labors
Location controls		
HANOI	Whether main business activity of firm is located in HANOI or not?	1 if Yes, 0 if No
HAIPHONG	Whether main business activity of firm is located in HAIPHONG or not?	1 if Yes, 0 if No
HATAY	Whether main business activity of firm is located in HATAY or not?	1 if Yes, 0 if No
HOCHIMINH	Whether main business activity of firm is located in HOCHIMINH or not?	1 if Yes, 0 if No
LONGAN	Whether main business activity of firm is located in LONGAN or not?	1 if Yes, 0 if No
QUANGNAM	Whether main business activity of firm is located in QUANGNAM or not?	1 if Yes, 0 if No
PHUTHO	Whether main business activity of firm is located in PHUTHO or not?	1 if Yes, 0 if No
NGHEAN	Whether main business activity of firm is located in NGHEAN or not?	1 if Yes, 0 if No
KHANH HOA	Whether main business activity of firm is located in KHANH HOA or not?	1 if Yes, 0 if No
Industry controls		
Food and Beverage	Main area of business and production activity: Food or Beverage	1 if Yes, 0 if No
Textiles, Apparel, Leather	Main area of business and production activity: Textiles, or Apparel, or Leather	1 if Yes, 0 if No
Wood and Paper	Main area of business and production activity: Wood or Paper	1 if Yes, 0 if No
Printing and publishing	Main area of business and production activity: Printing or publishing	1 if Yes, 0 if No
Metal	Main area of business and production activity: Metal	1 if Yes, 0 if No
Furniture, jeweler, music equip.	Main area of business and production activity: One of furniture, jeweler, music equipment	1 if Yes, 0 if No
Electronic machinery, computers, etc	Main area of business and production activity: Electronic machinery, computers, etc	1 if Yes, 0 if No
Transport vehicles	Main area of business and production activity: Transport vehicles	1 if Yes, 0 if No
Petroleum chemic mineral rubber	Main area of business and production activity: One of Petroleum, chemic mineral, rubber	1 if Yes, 0 if No

(*) Foreign donors and NGOs give supports and assistances to SMEs in Vietnam:

a) Danida (Business Sector Program Support (BSPS))

- b) EU (Vietnam Private Sector Support Program (VPSSP))
- c) GTZ (Development of Small and Medium Enterprises)
- d) VIEDC, India (Vietnam India Entrepreneurship Dev. Centre)
- e) VNCI, USAID (Vietnam Competitiveness Initiative)
- f) ADB (SME Development Programme Loan)
- g) UNIDO (Establishing an SME Support Infrastructure)
- h) ILO (Poverty Reduction through SME Development)
- i) Other foreign government aid support

(1) Innovation Outputs

We use three available indicators of innovation: *new product innovation*, *product modification innovation*, and *process innovation*. All these three variables are binary. We report the detail descriptive analysis for three indicators of innovation outputs in Table 2.

Table 2. Descriptive analysis for innovation indicators

	Proportion	Std. Dev
New product innovation		.17
<i>No</i>	97%	
<i>Yes</i>	3%	
Product modification innovation		.49
<i>No</i>	59%	
<i>Yes</i>	41%	
Process innovation		.35
<i>No</i>	86%	
<i>Yes</i>	14%	

Obs. 2654

(2) Explanatory Variables

Internal factors: not only conventional inputs for innovation, but many other internal factors such as innovation capabilities, firm characteristics may

also affect innovation outputs (OECD, 2005; Osamu, 2006). Based on available information from the data set, we employ some variables related to ***conventional inputs for innovation, innovation capabilities, and firm's production characteristics*** as bellows:

Conventional inputs: investment in innovation such as investment in R&D is theoretically conventional input for innovation. However, there are 1100 missing values of this variable among 2655 observations. Therefore, instead of using investment in R&D, we use variable ***New investment*** representing all new investment activities of a firm. This variable is expected to have positive effect on innovation.

Innovation capabilities: these variables should show firm's capabilities available for innovation such as human resources, innovation facilities, and financial resources. Variable ***Professionals*** represents the share of professionals and experts on total labors, and variable ***PCs*** indicates number of personal computers showing the facility for innovative activities. For the estimation of new product innovation, we employ an additional variable, variable ***Debt rate*** indicating the effect of financial constrains to innovation. We expect that variable Debt rate has negative effect on new product innovation, and both variable Professionals and variable PCs have positive effect on innovation.

Production characteristics other than size and age: our study uses variable ***Diversification*** indicating diversification strategy of firm. Diversification is one of the most important characteristics of firm production. Because both diversification and specialization are investigated that they may have positive effect on innovation, therefore, the expected sign of diversification is uncertain.

Domestic engagements: for external domestic engagements, this study uses four variables, variable ***Outsource***, variable ***Subcontract***, variable ***Outside service***, and variable ***Member of business association***.

International engagements: we use three key independent variables indicating international engagements, variable ***Export***, variable ***Import***, and variable ***Donor***.

Business environment: variable ***Financial crisis*** represents the fluctuation

in external business environment (occurred in 2007-2009) and may have effect on firms' activities. Because this crisis may force firm to innovate or may give some challenges to firm business activity, the sign of this variable is uncertain.

Control variables: *Firm size, Firm age, Location and Industry*

Among control variables, we use variable ***Firm size*** based on labor size and variable ***Firm age*** based on number of years calculated from firm's establishment. Controlling the possibility of the effect from geographical and industrial factors, we generate dummy variables indicating the province/city where firm is located in, and dummy variables represent industry that firm belongs to.

The descriptive analysis for explanatory variables are two control variables (Firm size and Firm age) is reported in Table 3, and the descriptive analysis for control variables representing location and industry firm located in Figure 5 and Table 4.

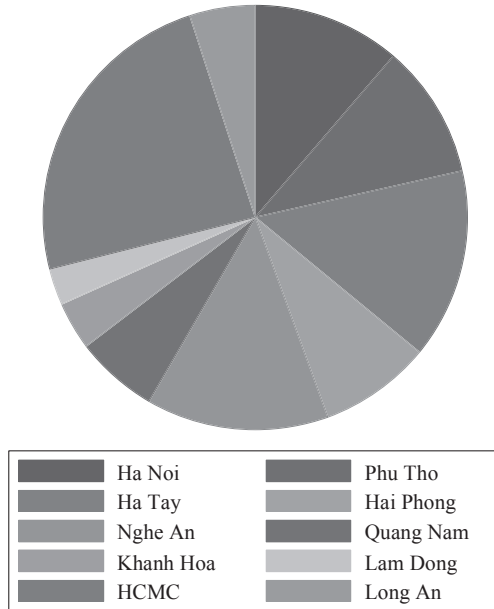
Table 3. Descriptive analysis for other explanatory variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
New Investment	2655	0.6071563	0.4884746	0	1
PCs	2655	1.39661	4.502422	0	100
Share of professionals	2646	0.037	0.076	0	0.8461539
<i>Debt rate</i>	2527	0.762597	0.1805928	0	2.667323
Diversification	2647	0.1511145	0.3582281	0	1
Financial crisis	2652	0.6523379	0.4763179	0	1
Outsource	2655	0.0636535	0.2441806	0	1
Subcontract	2655	0.1077213	0.3100865	0	1
Outside bu. services	2655	0.6354049	0.4814071	0	1
Mem. of Business Ass.	2654	0.1013564	0.301857	0	1
Export	2655	0.06	0.235	0	1
Import	2655	0.6	0.43	0	1
Donor	2654	0.066	0.2488788	0	1
Labor size	2655	18.99736	61.84128	1	2561
Firm age	2655	14.51827	11.34303	2	55

Table 4. Descriptive statistics of industry firms belong to

Industries	Proportion	Std. Err.
Food and beverages	.2828398	.0087771
Textiles, Apparel, Leather		
Textiles	.0470767	.0041277
Apparel	.0410023	.0038644
Leather	.0182232	.0026067
Wood and Paper		
Wood	.1161731	.0062447
Paper	.0265756	.0031345
Publishing and printing	.0284738	.0032413
Petroleum Chemical Rubber Mineral		
Refined petroleum etc.	.0037965	.0011985
Chemical products etc.	.0155657	.0024124
Rubber	.0539104	.0044013
Non-metallic mineral products	.0520121	.0043274
Metals		
Basic metals	.0132878	.0022315
Fabricated metal products	.1643888	.0072229
Electronic machinery, computers,	.0265756	.0031345
Transport Vehicles		
Motor vehicles etc.	.0091116	.0018518
Other transport equipment	.0026576	.0010033
Furniture, jeweler, music equip.	.0649203	.0048016
Others		
Recycling etc.	.001139	.0006573
Services	.0288535	.0032622
Agriculture	.0022779	.0009291

Figure 5. Firm locations



IV. Findings and Discussions

1. Findings

(1) Estimation for New Product Innovation (See Table 5)

For international engagements, our findings suggest that export has positive impact on the propensity to new product innovation. On the other hand, there is no statistically significant evidence for import and donor.

In terms of other domestic engagements, subcontracting and purchasing outside business service are also positively correlated with new product innovation propensity. Similar to import and donor, other external engagements such as outsourcing activities and being a member of business association are not important determinants of new product innovation.

In addition, variable financial crisis is positive and statistically significant at 10% level. It seems that this crisis forced firm to make new product.

Regarding internal factors, the results show that diversification and number

of personal computers are positive and statistically significant at 1% level, while debt rate is negative and statistically significant at 10%. Diversification has biggest change in odds ratio among significant factors. If firm has diversification strategy, it multiplies the odds of success by 15.3.

For control variables, regarding locations, HATAY and NGHEAN are negative and statistically significant determinants of new product innovation propensity. Among industries, only Transportation vehicles industry is not significant in explanation of new product innovation, all others are negative and statistically significant at 5% or 10%. Other two control variables firm age and firm size are not important determinants.

Table 5. Estimation results of new product innovation

NEW PRODUCTS	Coef.	Std. Err.	z	P>z	Change in odds
NEW INVESTMENT	.2336857	.3538937	0.66	0.509	1.2632
PROFESSIONALS	.9790135	1.784277	0.55	0.583	1.0676 (#)
PCs*	.0486149	.0158863	3.06	0.002	1.2216 (#)
DEBT RATE***	-2.26777	1.202456	-1.89	0.059	0.6635 (#)
DIVERSIFICATION*	2.727343	.3044837	8.96	0.000	15.2922
OUTSOURCE	.3796109	.4284627	0.89	0.376	1.4617
SUB CONTRACT**	.7561314	.3771932	2.00	0.045	2.1300
OUTSIDE BUSINESS SERVICE **	.9310386	.4305705	2.16	0.031	2.5371
MEMBER OF BUSINESS ASS.	-.228242	.4609821	-0.50	0.621	0.7959
FINANCIAL CRISIS ***	.7349098	.3829582	1.92	0.055	2.0853
EXPORT**	.8738506	.4382641	1.99	0.046	2.3961
IMPORT	-.3758569	.3230312	-1.16	0.245	0.6867
DONOR	.4479541	.4199091	1.07	0.286	1.5651
FIRM SIZE	.0018975	.0025141	0.75	0.450	1.0724 (#)
FIRM AGE	.0152976	.0130775	1.17	0.242	1.1898 (#)
HANOI	-1.118579	.7119944	-1.57	0.116	0.3267
HAIPHONG	-.8069722	.7819369	-1.03	0.302	0.4462
HATAY**	-1.602206	.7784899	-2.06	0.040	0.2015
HOCHIMINH	-.7708965	.6866799	-1.12	0.262	0.4626
LONGAN	-1.135492	.9796804	-1.16	0.246	0.3213
QUANGNAM	-1.270214	.7913852	-1.61	0.108	0.2808
PHUTHO	-.8927965	.7826832	-1.14	0.254	0.4095
NGHEAN*	-3.887251	1.223834	-3.18	0.001	0.0205
KHANH HOA	.8241219	.754334	1.09	0.275	2.2799
Food and Beverage**	-2.617419	1.249041	-2.10	0.036	0.0730
Textiles, Apparel, Leather**	-2.753558	1.277979	-2.15	0.031	0.0637
Wood and Paper**	-2.946118	1.258344	-2.34	0.019	0.0525
Printing and publishing***	-2.483398	1.433804	-1.73	0.083	0.0835
Metal**	-3.055978	1.243826	-2.46	0.014	0.0471
Furniture, jeweler, music equip. ***	-2.371615	1.274493	-1.86	0.063	0.0933
Electronic machinery, computers, etc **	-3.214036	1.415689	-2.27	0.023	0.0402
Transport vehicles	-.9046186	1.349126	-0.67	0.503	0.4047
Petroleum chemic mineral rubber ***	-2.189163	1.24572	-1.76	0.079	0.1120
_cons	-2.690375	1.456418	-1.85	0.065	

Number of obs = 2509, Log likelihood = -218.0824, LR chi squared (33) = 188.68, Prob > chi-squared is less than 1%, Pseudo R- squared = 0.3020.

Notes: * p < 1%, ** p < 5%, *** p < 10%. (#): odds ratio for non-binary predictor.

(2) Estimation for Product Modification Innovation (See Table 6)

In terms of international engagements, the results show that all three international engagements are important determinants of product modification innovation propensity. Import, export, and donor are positive and statistically significant at 1%, 5%, and 10%, respectively.

Other external engagements of firm, subcontracting activity, purchasing outside business service, being member of business association are also positive and statistically significant at 1% level. Only outsourcing activity is not statistically significant.

Regarding finance crisis, if firm is affected by that crisis, there is also propensity that firm will have product modification innovation.

For internal factors, new investment and diversification strategy are positive and statistically significant at 1% and 5%, respectively. Surprisingly, the share of professionals is negative and statistically significant at 5%. PCs is not important determinant of product modification.

Regarding the locations, firms coming from HOCHIMINH and HAIPHONG are more likely active in product modification than others. NGHEAN, again, shows it has disadvantage in term of product modification than others do. Industry dummies are found to be positive and significant determinants of product modification. Firm age is negative and statistically significant at 5%, while firm size is not statistically significant.

Table 6. Estimation results of product modification innovation.

PRODUCT MODIFICATION	Coef.	Std. Err.	z	P>z	Change in odds
NEW INVESTMENT*	.472693	.1016615	4.65	0.000	1.6043
PROFESSIONALS**	-1.481486	.6696866	-2.21	0.027	0.8933 (#)
PCs	.0189967	.0125349	1.52	0.130	1.0894 (#)
DIVERSIFICATION*	.4144066	.1274577	3.25	0.001	1.5135
OUTSOURCE	.2861649	.1851697	1.55	0.122	1.3313
SUB CONTRACT*	.5200833	.1425351	3.65	0.000	1.6822
OUTSIDE BUSINESS SERVICE*	.4339504	.1065852	4.07	0.000	1.5433
MEMBER OF BUSINESS ASS.*	.7755359	.1536705	5.05	0.000	2.1718
FINANCIAL CRISIS *	.3660154	.1006714	3.64	0.000	1.4420
EXPORT**	.4642285	.2092977	2.22	0.027	1.5908
IMPORT*	.3633605	.0990722	3.67	0.000	1.4382
DONOR***	.3569679	.1855053	1.92	0.054	1.4290
FIRM SIZE	-.0004389	.0013677	-0.32	0.748	0.9838 (#)
FIRM AGE*	-.0159176	.0043527	-3.66	0.000	0.8348 (#)
HANOI	.2316255	.302734	0.77	0.444	1.2606
HAIPHONG***	.5462026	.3090294	1.77	0.077	1.7267
HATAY	.0602925	.2993835	0.20	0.840	1.0621
HOCHIMINH**	.6802623	.2880031	2.36	0.018	1.9744
LONGAN	.1616563	.3358551	0.48	0.630	1.1755
QUANGNAM	.1400329	.3246432	0.43	0.666	1.1503
PHUTHO	.0931819	.3074007	0.30	0.762	1.0977
NGHEAN**	-.7137066	.3044216	-2.34	0.019	0.4898
KHANH HOA	.1580423	.3571989	0.44	0.658	1.1712
Food and Beverage**	.5604013	.2775656	2.02	0.043	1.7514
Textiles, Apparel, Leather*	1.41585	.2924142	4.84	0.000	4.1200
Wood and Paper*	1.048587	.2845413	3.69	0.000	2.8536
Printing and publishing*	.958599	.352059	2.72	0.006	2.6080
Metal*	1.391158	.2776236	5.01	0.000	4.0195
Furniture, jeweler, music equip.*	1.557869	.307485	5.07	0.000	4.7487
Electronic machinery, computers, etc *	.9996665	.3609532	2.77	0.006	2.7174
Transport vehicles**	.9070524	.4567916	1.99	0.047	2.4770
Petroleum chemic mineral rubber*	1.213017	.2832884	4.28	0.000	3.3636
_cons	-2.692361	.3869182	-6.96	0.000	

Number of obs = 2635, Log likelihood = -1526.5114, LR chi-squared (32) = 505.56, Prob > chi-squared is less than 1%, Pseudo R-squared = 0.1421

Notes: * p < 1%, ** p < 5%, *** p < 10%. (#): odds ratio for non-binary predictor.

(3) Estimation for Process Innovation (See Table 7)

According to Table 6, three international engagements are positively correlated with the propensity to new process innovation. Export, donor, and import are statistically significant at 10%, 5%, and 1%, respectively.

Other external engagements, subcontracting, purchasing outside business service, and being member of business association are also positive and important determinants of process innovation. Again, there is no statistically significant evidence for outsourcing activity.

Surprisingly, although financial crisis has positive effect on two first types of innovation related to product, it is not statistically significant determinant of new process innovation.

Regarding internal factors, again, new investment and diversification are positive and statistically significant at 1% and 5% level, respectively.

Among locations and industries, only PHUTHO is negative and statistically significant at 10%. Similar to the product modification, firm size is not statistically significant, but firm age is negative and statistically significant at 5%.

Table 7. Estimation results of process innovation.

PROCESS INNOVATION	Coef.	Std. Err.	z	P>z	Change in odds
NEW INVESTMENT*	1.603139	.1825832	8.78	0.000	4.9686
PROFESSIONALS	1.144695	.7581794	1.51	0.131	1.0911 (#)
PCs	.0173817	.0142075	1.22	0.221	1.0815 (#)
DIVERSIFICATION**	.3149174	.1592523	1.98	0.048	1.3701
OUTSOURCE	.3392112	.2144588	1.58	0.114	1.4038
SUB CONTRACT*	.6168841	.1773403	3.48	0.001	1.8531
OUTSIDE BUSINESS SERVICE*	.5302583	.1635881	3.24	0.001	1.6994
MEMBER OF BUSINESS ASS. **	.3600073	.1814279	1.98	0.047	1.4333
FINANCIAL CRISIS	.2447485	.1515243	1.62	0.106	1.2773
EXPORT***	.4138224	.2192646	1.89	0.059	1.5126
IMPORT*	.5485089	.1484381	3.70	0.000	1.7307
DONOR**	.4469142	.2088487	2.14	0.032	1.5635
FIRM SIZE	.0021448	.0015193	1.41	0.158	1.0830 (#)
FIRM AGE**	-.0161508	.006919	-2.33	0.020	0.8326 (#)
HANOI	-.0487486	.4250269	-0.11	0.909	0.9524
HAIPHONG	-.4653416	.4562607	-1.02	0.308	0.6279
HATAY	-.494993	.4327829	-1.14	0.253	0.6096
HOCHIMINH	.5131763	.4132588	1.24	0.214	1.6706
LONGAN	-.6666433	.5046196	-1.32	0.186	0.5134
QUANGNAM	-.3486164	.4684987	-0.74	0.457	0.7057
PHUTHO***	-.7925609	.4632985	-1.71	0.087	0.4527
NGHEAN	-.4064551	.4290662	-0.95	0.343	0.6660
KHANH HOA	-.0733815	.4941368	-0.15	0.882	0.9292
Food and Beverage	.5407974	.3423058	1.58	0.114	1.7174
Textiles, Apparel, Leather	-.2560099	.3754828	-0.68	0.495	0.7741
Wood and Paper	-.0080075	.3576328	-0.02	0.982	0.9920
Printing and publishing	.0978637	.4442081	0.22	0.826	1.1028
Metal	-.0008599	.3482437	-0.00	0.998	0.9991
Furniture, jeweler, music equip.	.0373031	.392792	0.09	0.924	1.0380
Electronic machinery, computers, etc	.2435694	.4505204	0.54	0.589	1.2758
Transport vehicles	-.5986734	.6467459	-0.93	0.355	0.5495
Petroleum chemic mineral rubber	.2908912	.3482269	0.84	0.404	1.3376
_cons	-4.18273	.5375928	-7.78	0.000	

Number of obs = 2635, Log likelihood = -883.74468, LR chi- squared (32) = 345.14, Prob > chi-squared is less than 1%, Pseudo R-squared = 0.1634.

Notes: * p < 1%, ** p < 5%, *** p < 10%. (#): odds ratio for non-binary predictor.

2. Discussions

(1) International Engagements

In general, our findings confirm the positive effect of international engagements, export, import, and donor on innovation. These findings are consistent with previous studies on the positive impact of international engagements on innovation in other countries (e.g. Crisculo, Haskel, Slaughter, 2005; Wagner, 2006; Pittiglio, Sica, Villa, 2009). Export is positive and statistically significant in all three indicators. Import and donor are positive and statistically significant determinants of product modification and new process innovation.

According to our analysis, there are 70% exporters received technology or expertise supports from foreign buyers. These supports are very important to small and young exporters. Therefore, it seems that the detailed effect of export on innovation can be partly explained by the effect of technology or expertise supports receiving from foreign buyers. As explained in trade theory, trade is considered as the channel of technology diffusion from the developed countries to developing countries. Because new knowledge is embodied in those goods, import of intermediate goods is expected as a substitute to innovation. The positive effect of supports from foreign donors and or NGOs is one of very interesting findings for the case of SMEs in developing and transitional economy like Vietnam.

Training courses and other technical/business assistances from foreign donors and or NGOs can share good business experiences, new business knowledge, and information about new technology and foreign market to domestic firms. In addition, training courses to upgrade human resource is also important to the innovation capacity of firm.

There are some reasons that neither import nor donors is important determinant of new product innovation. First, making new product requires time and investment. Second, import is often seen that it has more important effect on improvement product and production process unless firm imports new equipment/ machinery in order to produce new product. Third, for the donors,

perhaps the supports and assistances from donors rarely share ideas about new product.

In addition, according to Crisculo, Haskel, and Slaughter (2005), the importance of knowledge sources systematically varies with the types of innovation. Our findings also show that the level of effect of international engagement on innovation varies with the indicators of innovation and engagements, but does not vary systematically.

(2) Other External Engagements

Subcontracting activity and purchasing outside business service is positive and significant in all three indicators of innovation, and being member of business association is only not significant in new product innovation. These findings are relevant to NMI and relative studies showing how the linkages to other partners affect the knowledge flows into firm (e.g. Santos et al., 2004; OECD, 2005; Osamu, 2008).

Perhaps, because knowledge and information related to new product innovation are strategically important to firm's business firm rarely shares them to others. It can explain why being member of business association is not important determinant of new product innovation.

The findings on the positive effect of financial crisis indicate that this crisis forced affected firm to modify their product or even introduce new product. However it did not force firm to make process innovation. This finding can be also considered as an evidence for firm's response to the changes in business environment. According to Pugh & Hickson (1997), external business environment affects organization's structure, firm's business strategy, and firm's activities.

For those main findings about the role of international engagements and other external factors above, we see that innovation activities of firm become more open and connected to other partners.

(3) Internal Factors

New investment has positive effect on the propensity of product modification and process innovation. Although new investment is always indicated as an important conventional input (e.g. Griliches, 1979, 1990), it is not an important determinant of new product innovation in this study. There are two possible reasons. Firstly, because of limited internal resources SMEs cannot invest much in R&D for generating new product innovation. Secondly, it may be because we have gathered different types of new investment to one variable (variable New investment) in this study.

Our findings show that share of professionals is not important positive determinant of innovation, while PCs is a positive determinant of new product innovation. In fact, professionals in the survey are defined as people who have university and higher degrees. However, it is worth to emphasize that the quality of education system and labor force in Vietnam is not highly appreciated. That may be why the share of professionals is not positive important determinant of innovation. In addition, because SMEs may use personal computers for searching new knowledge available from online resources the number of personal computers is a positive determinant of new product innovation.

Diversification strategy is positive and statistically significant in all three models. As suggested by Nelson (1959), because diversification means more chances for exploiting and exchanging it promotes the innovation activities.

Our findings indicate the negative effect of debt rate on new product innovation. This may be because debt rate is suggested as one of financial constraints to making new product (e.g. Antonelli, 1989; Hall, 2002), and financial constrains is also considered as the main weakness of SMEs.

V. Conclusions

Our study explored the impact of external engagements on innovation of Vietnamese private manufacturing SMEs. In terms of international engagements, export, import of equipment and machinery, and supports from foreign donors, NGOs were found to be positive significant determinants of firm innovation.

Moreover, there was also a positive effect of other domestic engagements on firm innovation. Subcontracting activity, purchasing outside business service, and being member of business association were found to be positive and significant determinants of innovation. It is worth to emphasize that utilizing external resources through external engagements is very sufficient method for SMEs to overcome limitation in their internal resources.

This study has some limitations. The following limitations are acknowledged but cannot consider as the threats of research effort. They raise some recommendation for future researches. Firstly, there are some limitations related to data availability. To predict the probability in logistic models, it is better if the database has information for some potential explanatory variables. Additionally, innovation performance of firm is dynamic, and our cross-sectional analysis cannot capture the dynamic effects. Therefore, future survey and research should consider these limitations. This study is even better if it can provide additional analysis for the impact of innovation on firm performance, for instance, whether innovation activities increase firm performance or not, which type of innovation is most important to the performance of firm, and so on.

This study gives some theoretical and managerial implications. For theoretical implications, the findings support KPF and NMI. Firm innovation becomes open and interconnected to external factors. These models give comprehensive view about the sources and factors affecting innovation, and they can be applied flexibly in empirical studies. For managerial implication, this study suggests that, SMEs should utilize benefits from domestic engagements and international engagements. Increasing external engagements is not only a good strategy for firms to overcome their weaknesses of limited internal resources but also can force firms to innovate more.

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External Engagements and Innovation of Firms: Evidence from Vietnamese Manufacturing SMEs.

<Summary>

LUU Duc Thi

Yushi INABA

This study explores the effect of external engagements on innovation outputs of firms using a cross-sectional survey data set on Vietnamese private manufacturing SMEs conducted in 2009.

For theoretical framework, we use the knowledge production function model (PKF) (Griliches, 1979, 1990) and the network models of innovation (NMI) (OECD, 2005; Osamu, 2008).

Based on PKF and NMI models, we found that there was generally a positive impact of international engagements (export, import of equipment/machinery, and the supports from foreign donors/NGOs) and other domestic engagements (subcontracting, purchasing outside business service, and being member of business association activities) on innovation outputs. This may be because externally engaged firms invested more in innovation, and/or because these firms were able to learn from their worldwide partners or access to a wider source of knowledge flows.

Our study gives some theoretical and managerial implications. For theoretical implications, the findings support PKF and NMI. Firm innovation becomes open and interconnected to external factors. For managerial implication, increasing external engagements is a good strategy for firms to overcome their weaknesses of limited internal resources. Increasing external engagements can also force firms to innovate more.

