

Which are determinants of firm innovation in Vietnam?

A micro analysis

LE THI NGOC BICH

Post and Telecommunication Institute of Technology – bichltn@ptit.edu.vn

VU TRONG PHONG

Post and Telecommunication Institute of Technology

LE THI NGOC DIEP

Post and Telecommunication Institute of Technology

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ABSTRACT

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This study sets out to investigate the factors influencing Vietnam firms' innovation in various sectors by using World Bank (2015) enterprise survey of 996 firms across the country. We employ ordinary least squares (OLS), probit model, and marginal effect to estimate the impact of firm characteristics, industry characteristics, and business climate on different facets of innovation, including technology and non- technology. Quantitatively, we find that direct exporters, firm size, state ownership, email using, and competition increase the probability of technology innovation. Meanwhile, foreign ownership impacts negatively on innovation in all aspects, technology and non-technology innovation. Firm age and bribery are not influential factors to innovation in all cases. From the findings of analysis, a few policy implications regarding the studied factors are drawn for better environment for firm innovation.

1. Introduction

Vietnam, according to World Bank, is assessed as a development success story. After the reforms launched in 1986, Vietnam has made remarkable progress and transformed from one of the poorest countries to a lower middle income country with per capita income of \$1960 by the end of 2013. Vietnam's growth rate has been around 6.4% per year on average for the last decade. In addition, the country has been successful in reducing poverty, and the people living in poverty decreased from approximately 60% in 1990s to below 10% recently. However, the economic growth remains moderate and below its potentials, relying mostly on physical capital, natural resources, and cheap labor. The power of these sources is diminishing while Vietnam is likely to face the so-called middle income trap. To boost its economy and develop sustainably it is time for Vietnam to make innovation to become the drive of productivity gains, especially when the nation is facing fierce competition in globalizing markets.

Certain innovative improvements have recently been reflected, yet it still lagged far behind developed countries. According to Global Innovation Index (GII), which is annually co-published by the World Intellectual Property Organization, US-based Cornell University and France-based INSEAD Business School, the country ranked 71st and 76th out of 141 countries in 2013 and 2014, respectively. In 2015, Vietnam was among a group of countries

that upgraded their innovation performance ranking compared to that of 2014, stood at the 52nd place out of 141 economies worldwide, and improved 19 places from 2014.

The improvement in GII can be a good sign for the upgraded innovation in Vietnam; nevertheless, it reflects only a part of the whole picture of the Vietnamese situation. It is undeniable that innovation in both private and public sectors in Vietnam has lately emerged and there is still a lot of room for improvement. Capability of innovation is weak and the national innovation system is uncoordinated and fragmented. In the business sector, research and development is not properly noticed and faces resistant obstacles, while in the public sector, despite specific privileges, it seems to work inefficiently.

World Bank (2017), in an analysis of the Vietnam' science, technology and innovation (STI) system, highlighted strengths and weaknesses of the country. Accordingly, there are some advantages for STI such as strong economic performance, geographical location, sizeable labor force, or certain achievement in basic education. However, like many other developing countries, there are still many existing problems deterring Vietnam from the development of STI. The resistant weaknesses include infrastructure deficiencies, inefficient education system, limited access to finance for enterprises, and inadequate STI government arrangements and policy implementation.

To have further understanding of these strengths and weaknesses this study aims to

empirically investigate the factors influencing innovative activities of Vietnamese enterprises from different aspects, technological and non-technological innovation. Using a firm-level data set, the study is intended to draw insights into the deterrents of innovation in order to draw possible suggestions for policies. It will point out the impacts of each element on innovation using empirical evidence, which will be persuasive clues for further implication to help government and other stakeholders perceive where to target their efforts in an attempt to provide favorable conditions for innovation.

The remainder of the paper is structured as follows. Section 2 reviews literature on innovation. Section 3 describes methodology and data used in the study. While Section 4 presents the findings and discusses the results, Section 5 concludes the paper and provides some implications.

2. Literature review

Different views have been held on measurement of innovation and innovation determinants. Generally, innovation is still an ambiguous concept with different definitions, and there are many controversial opinions on its determinants.

Schumpeter (1976) shaped the theoretical framework for innovation, categorizing innovation into five types: (i) launch of a new product or a new species of existing product; (ii) application of new methods in production or sales of a product; (iii) opening of a new market (the market for which a branch of the industry was not yet

represented); (iv) acquiring of new sources of supply of raw material or semi-finished goods; and (v) new industry structure such as the creation or destruction of a monopoly position. He claimed that there is a trade-off between innovation and market power of large firms. In other words, to have a rapid technology progress we must be willing to accept imperfectly competitive markets for the reason that in perfect competitive market, where firms produce and sell the same products, there is no incentive to innovate. In contrast, innovative activity is more likely to be favored by large firms and high concentration in imperfectly competitive markets.

To examine Schumpeter's hypothesis, Symeonidis (1996) reviewed many empirical works on the relationships among innovation, market structure, and firm size. The idea that market power and large firms stimulate innovation was found inconsistent. Precisely, this positive relationship can occur when certain conditions are met, such as sunk cost per individual project and economies of scale and scope in the production of innovation rent.

Hansen (1992) used the proportion of the sales from new products and total sales as the indicator of innovation and found that both firm size and firm age tend to be inversely related to innovative output.

In order to measure the correlation between corporate ownership structure and innovation, Francis and Smith (1995) employed empirical techniques, indicating that diffusely held firms are less innovative than firms with higher ownership concentration. In other words, concentrated

ownership and shareholder monitoring are effective at lessening the high agency and contracting cost associated with innovation.

Defining innovation as activities related to improvement of production and/or process, Lee (2004) examined the linkage that innovation has with characteristics of firms and industries in Malaysian manufacturing sector. The findings suggested that firm size is positively related to innovation because large firms have more chances to access substantial resources and have greater capacity to innovate. Furthermore, ownership structure also impacts innovative activity due to its determination on financial resource through equity market, while sole proprietorship firms are less innovative than private limited and public limited firms. In a study on innovative activity of small- and medium-sized Australian manufacturing businesses, Bhattacharya and Bloch (2004) found that size, R&D intensity, market structure, and trade shares are productive of further innovative activity for the full sample and high-tech enterprises while fewer variables are significant for low-tech ones.

Wan et al. (2005) employed data of 71 companies in Singapore, investigating innovation in a more complex and broader context as a process of generation, adoption, and implementation of new ideas or practices. The findings show the positive linkage between innovation and five elements, namely decentralized structure, presence of organizational resources, belief in importance of innovation, willingness to take risks, and willingness to exchange ideas.

Almeida and Fernandes (2007) studied the correlation between openness and technological innovation by employing firm-level data in developing countries. They considered technological innovation in terms of whether firms introduced new technology that substantially improved production of its main product in the last three years to the surveyed time. The results showed that firms involving in international trade, export and import, are more likely to adopt new technology. Moreover, it was found that majority foreign-owned firms tend to be more involved in innovative activity than minority foreign-owned firms or domestic firms. Unlike Almeida and Fernandes (2007), this study detects the less innovative tendency in exporting firms, explained by the overwhelming presence of firms with no export in data.

Divided innovations of small- and medium-sized enterprises in a low-tech sector (food and beverage) into two aspects: green and non-green innovation, Cuerva et al. (2014) analyzed the differences between factors influencing these two kinds of innovation. The results indicated that technological capabilities such as R&D and human capital are drivers for the conventional innovation, but not the green innovation.

Regarding the effects of FDI on the innovative performance of domestic manufacturing firms in India, Khachoo and Sharma (2016) revealed that FDI has a moderate impact on innovative activity of firms residing in identical industries.

About the linkage between governance and innovation, precisely the effect of

corruption on innovation, Veracierto (2008) indicated that under certain parameter ranges, small increases in the penalties to corruption likely result in large increases in product innovation.

Remarkably, Aghion et al. (2005) found strong empirical evidence of an inverted U-shaped relationship between product market competition and innovation, implying that competition discourages laggard firms from innovating while encourages neck-and-neck ones to innovate.

For the case of Vietnam, the studies on innovation are still limited in quantity and detailed analysis. Nguyen et al. (2013) gave a diagnostic overall review on national innovation systems, analyzing strengths and weaknesses of the institutions, and policies and linkages that characterize the country's national innovation systems. When it comes to empirical research, there are few papers providing insights into innovative activities of Vietnamese enterprises as a whole and determinants of innovation in particular. Nguyen et al. (2008) empirically examined different aspects of innovation and argued that they are major determinants innovation of exports by Vietnamese SMEs. Employing data from small and medium manufacturing enterprises in Vietnam, Nguyen et al. (2016) demonstrated a positive linkage between corruption and innovation. Precisely, informal payments by Vietnamese firms are shown to foster overall innovation and product innovation. Due to the lack of statistic investigation for Vietnam, this paper would be one of studies taking initiatives in gathering empirical evidence on innovation of Vietnamese firms, which is

likely to imply meaningful implications for government and enterprises to positively act and change the situation.

In order to analyze innovation in various facets, we take a clear and broad view of World Bank (2004) as the main reference on the understanding of innovation. It suggested that innovation should cover not only "technological innovation," which is defined as the diffusion of new products and services, but also non-technological forms of innovation. The latter is defined as the introduction of new management or marketing techniques, the adoption of new supply or logistic arrangements, or improved approaches to internal or external communication and positions. Accordingly, this study will examine various aspects of innovation, namely: (i) whether firms have new or significantly improved products or services; (ii) whether firms have new or significant improved method of manufacturing or offering services; and (iii) whether firms have new organizational structure or management practice.

Regarding innovation atmosphere in developing countries like Vietnam, the aforementioned study pointed out that firms are deterred from innovation by weaknesses detected from three important elements, including levels of educational attainment, business environment, and infrastructure. Different phases of industrialization require different educational needs, from basic literacy to tertiary education, and these economies fail in matching education and labor demand. The quality of business environment can be measured by governance conditions, values, and cultural

specificities, which can cause obstacles for business operation in these countries. Finally, the issue of infrastructure in developing world relates to the troubles in telephone infrastructure, transport infrastructure, and other primary components such as sanitation, water, or electricity. These common deterrents, nevertheless, seem to have been neglected in previous studies, probably due to the fact that they are not problems for operation of enterprises in those countries.

In an attempt to deal with the listed shortcomings in previous studies and depict precisely the case of Vietnam, this study will capture not only the impacts of conventional elements on firm and industry characteristics, but also innovation climate factors which are highly likely to be obstacles for firms' innovative activities in the three mentioned aspects. Our study takes on various problems of this issue, and hence represents a precise analysis as well as implying proper suggestions to related actors.

3. Methodology and data

3.1. Empirical strategy

This study uses quantitative techniques to examine the World Bank Enterprise Survey (2015) for Vietnam using the Stata software. The empirical estimation employs probit model with marginal effect in order to analyze the factors that may influence firms' engagement in innovative activities with the assumption on the normal distribution of error terms.

The dependent variable for innovation is binary, equal to 1 if firms innovate and 0 otherwise. As mentioned in Section 2, innovation is considered from three perspectives in respective models: new or significantly improved product or service (Model 1), new or significantly improved method of manufacturing products or offering services (Model 2), and new or significantly improved organizational structures or management practices (Model 3). Precisely, in Model 1 for the aspect of innovation in products/services, the dependent variable for innovation is equal to 1 if firms have new or significantly improved products or services in the last three years and equal to 0 otherwise. Similarly, in Model 2 which considers innovation as improvement in method or process, the dependent variable is equal to 1 if firms have new or significantly improved method of manufacturing or offering of services in the last three years. Finally, in examining innovation in terms of changes in organization or management in Model 3, the dependent value for firms having new or significantly improved organizational structures or management practices is equal to 1 and 0 otherwise.

Explanatory variables are divided into three groups: firm characteristics, industry features, and business climate of country, equivalent to three estimation steps for each measurement of technological and non-technological innovation. The propensity of innovation in the three aspects is explained by independent variables indicating firm characteristics in the first step, supplementary industry features in the

second, and business climate in the third.

Following the findings from previous papers on the relation of openness and innovative activity, this study considers the difference in the innovation pattern between firms engaging in direct export and their counterparts, which are firms selling products domestically or exporting indirectly. The variable of openness is equal to 1 if firm exports directly and 0 otherwise. The results will be checked on the common expectation that the firm exporting directly is more likely to be engaged in innovative activity than the other.

Firm age, presented by the number of year firms operated up to 2015, is deemed to be an element affecting innovation since the operating time may influence them in many ways such as competence of employees, managerial skills of managers, or relation with government officials. Firms existing longer may have better conditions for innovation, but it could be another way around if new entrants tend to be more creative to penetrate their market.

Another element is firm size which is added to see the different pattern in innovation of small, medium, and large firms. Those having less than 20 employees are classified as small firms while medium firms are those having from 20 to 99 employees and firms with 100 employees or more are seen as large ones. The number of workers can reflect human resource of firms and potentially cause specific patterns in organization or management of firms. Small and large firms may have no difference in technological innovative activities, but the difference in the number of employees

requires different patterns in non-technological innovation.

Additionally, this study formulates three models aiming to consider firms' foreign ownership since the involvement of oversea investors is more likely to cause certain advantages in technology and availability of physical capital, compared to domestic firms. More precisely, the former tends to have financial source and up-to-date technology from outside border, which is favorable for innovative performance in comparison with the later. In the survey firms reported the percentage of capital owned by foreign privates, organizations, or companies, and concrete values would be used to show the difference in propensity of innovation for each percent increase of foreign capital.

In addition, government ownership is also adopted in the model for the reason that state-owned companies in Vietnam may have more privileges in finance or legal procedures than private ones. Like foreign ownership, firms were asked the percentage of capital owned by state organization, and concrete values of state owned capital are employed to see the discrepancy in innovation probability in company with one percent change of government-owned physical capital.

The final element of firm characteristics which should be taken into account is the role of internet in firms' innovative activity. Normally, firms employing internet in their operation are more likely to be active and innovative than others that do not. To highlight the effect of internet on innovative activity, the model will compare the

innovative pattern of firms using email and the counterparts. Similarly, internet users are expected to be engaged in innovative activity more than non-users. The variable for email using is represented by dummy variable, equaling 1 if firms utilize email and 0 otherwise. The coefficient is expected to be positive, implying advantages of internet to innovative activity.

In the second step, independent variables of industry characteristics are added to the model together with firm characteristics, represented by dummy variables for group of industries in which firms are operating since different industries have different features in technology and innovation. For example, low technology sectors such as food or textiles are less likely to innovate than high-technology ones such as machinery because the later has more sophisticated products and needs continuous improvement to compete in the market. Nevertheless, the opposite tendency can be true that low technology industries are more likely to innovate since their unsophisticated products such as flavor of foods or design of textile products may be easier to improve. The answer for the difference of industries will be investigated among three groups of sectors, namely low technology sectors, medium technology sectors, and services which are classified based on R&D intensities of OECD Directorate for Science, Technology and Industry (2011). Accordingly, low technology sector include firms operating in the industries of food, textiles and garments, and wood and furniture. Medium technology sector includes firms belonging to those of

machinery and chemicals, metal, and some of wood and furniture. Service sectors are the remaining industries, including those of construction, sales, hospitality, transport, etc.

Moreover, when considering industry characteristics, this study intends to investigate the role of market competition in boosting innovation of firms with the hypothesis that firms will have more incentives to innovate when they have to compete with others. Due to the lack of data for measuring the degree of competition, this study employs available information from a survey in which firms were asked whether they competed against unregistered or informal firms. The variable value is 1 for “yes” answers, and 0 for “no”. The positive value of the estimator implies the advantageous role of competition in innovation.

In the third step, to find out the impact of business climate on innovation the variable relating to governance is added to the model. In fact, weak governance, especially bureaucratic system and legal regulations, causes many obstacles for Vietnam enterprises. Corruption can be used as a measurement for this weakness due to the fact that when governance is inefficient, firms are more likely to be forced to pay bribe to get things done. In the survey firms were required to evaluate subjectively how many obstacles caused by corruption they have, using scales from 0 to 4, equivalent respectively to no obstacle, minor obstacle, moderate obstacle, major obstacle, and very severe obstacle. In order to compare the difference in innovation of firms facing

obstacles in bribery and those without, a dummy variable for corruption will be used in the model, equaling 1 if firms have any obstacle from minor to very severe scales and 0 if firms report no obstacle. It is expected that the firm revealing certain obstacles with corruption is likely to have less innovative activity, i.e. the variable for corruption is anticipated to be negative and statistically significant.

In short, the equation used in the empirical study for firm i in sector j is depicted as:

Step 1:

$$Innov_{ij} = X_{ij}'\beta + \varepsilon_{ij}$$

where:

$Innov_{ij}$ is a dummy variable to measure innovation of firms in three aspects equivalent to three models: new or significantly improved product or services (Model 1), new or significantly improved method of manufacturing or offering services (Model 2), and new or significantly improved organizational structure or management practices (Model 3).

X' is the vector of independent variables representing firm characteristics, including export, foreign factor, state ownership factor, firm age, firm size, and the use of email.

ε_{ij} is the error term assumed to be distributed normally with mean zero and constant variance.

Step 2:

$$Innov_{ij} = X_{ij}'\beta + I_j' + \varepsilon_{ij}$$

where I_j' is the vector of variables representing industry characteristics, namely industry dummy variable and competition dummy variable.

Step 3:

$$Innov_{ij} = X_{ij}'\beta + I_j' + I_c' + \varepsilon_{ij}$$

where I_c' is the vector of elements relating to innovation climate of the country, and to be specific, corruption.

3.2. Data

The study uses the data of Vietnam obtained from the World Bank's Enterprise Survey (2015). The World Bank's Enterprise Surveys (ES) have collected data from key manufacturing and service sectors in every region of the world for many years. The Surveys use standardized survey instruments and a uniform sampling methodology to minimize measurement error and to yield data that are comparable across the world's economies. The questionnaire was divided into two parts: (i) seven sections covering firm characteristics in business and investment climates such as sales and supplies, infrastructure and services, degree of competition, business government relations, and investment climate constraints; and (ii) three sections dealing with facts and figures regarding finance, labor, and productivity. Additionally, information on capacity such as use of production capacity and hours of operation was surveyed in manufacturing enterprises.

Table 1
Variables and summary statistic description

Variable	Obs.	Mean	Std. Dev.	Min	Max
Newproduct	988	0.3076923	0.4617722	0	1
Newmethod	989	0.322548	0.4676879	0	1
Newmanagement	991	0.308779	0.462223	0	1
Directexport	989	12.0546	28.55432	0	100
Medium	996	0.3453815	0.4757314	0	1
Large	996	0.2640562	0.4410508	0	1
Foreign	994	7.10664	24.8409	0	100
Government	995	1.532663	8.878211	0	99
Age	993	12.75629	9.676159	1	113
Email	991	0.9323915	0.2511996	0	1
Medium-technology	996	0.3624498	0.4809493	0	1
Service	996	0.2720884	0.4452587	0	1
Competition	962	0.4656965	0.4990813	0	1
Corruption	996	0.62751	0.4837108	0	1
Poweroutage	986	0.321501	0.4672896	0	1

The 2015 data are the most up-to-date collection attracting participation of 996 enterprises from various industries in Vietnam. The survey was implemented between November 2014 and April 2016 with a more improved questionnaire than the ones used in 2009 and 2011. The number of observations of some variables used in this study may be less than the total sample due to insufficient data for some enterprises (Table 1).

The numbers of firms by key background characteristics are generated for qualitative analysis in an attempt to draw insights into the interaction between different characteristics (Table 2). Table 2 shows that among the firms reporting on innovation from the three aspects, there are 304 firms that changed their products/services (equivalent to approximately 30.8% of the total number of firms), 319 that improved their method of manufacturing or offering

services (equal to 32.3%), and 306 that innovated in terms of organizational structures or management practices (equal to 30.9%).

Each aspect of innovation is classified by different characteristics. For direct export, the number of non-exporters overwhelms the counterparts that are exporters. Among exporting firms, around 40% are innovative for each innovation aspects, while innovative firms in the non-export group accounts for only about 28%. This preliminary descriptive finding may imply the positive relationship between direct export and probability of innovation. Table 2, nevertheless, does not show any significant difference in distribution of firms by size, including small, medium, and large firms.

The analysis of firms by foreign ownership and state ownership reveals that foreign and state firms outnumber domestic

and private ones. In addition, among the studied foreign companies, the percentage of innovative firms is less than that of firms without innovation (26%). Meanwhile, the proportion of innovative firms fluctuates in different aspects of state-owned companies, accounting for around 59% in technology innovation and about 40% given the two remaining facets.

In addition, our analysis emphasizes the impact of internet on innovation by comparing the innovation patterns between email-users and non-users. The data show that email has become a popular means as employed by Vietnamese firms, over 90% of which use email for their operation. However, there is no clear relation between innovation and email use in simple descriptive analysis. This link will be analyzed in the later parts of this empirical study.

Table 2
Numbers of firms by background characteristics

Variable	Newproduct		Newmethod		Newmanagement	
	No	Yes	No	Yes	No	Yes
Direct exporters						
No	560	219	546	235	549	233
Yes	121	83	121	83	133	72
Firm size						
Small	287	98	278	105	285	102
Medium	232	110	227	116	237	105
Large	165	96	165	96	163	99
Foreign ownership						

Variable	Newproduct		Newmethod		Newmanagement	
	No	Yes	No	Yes	No	Yes
No	619	278	602	296	617	283
Yes	63	26	66	23	66	23
Government ownership						
No	668	282	646	305	662	291
Yes	15	22	23	14	22	15
Email use						
No	56	10	53	13	57	9
Yes	626	292	615	304	626	295
Sector						
Low - technology	253	107	240	121	256	106
Medium – technology	226	131	229	129	236	122
Services	205	66	201	69	193	78
Competition						
No obstacles	383	128	383	129	379	134
Have obstacles	286	160	273	174	288	160
Corruption						
No obstacles	256	110	259	110	261	109
Have obstacles	428	194	411	209	424	197
Number of firms	684	304	670	319	685	306

The preliminary examination on the firm-level data by sector reveals that the firms under investigation are distributed quite evenly among the sectors of low technology, medium technology, and services. Low technology and medium technology sectors constitute the same average percentage of firms (36% for each) and service sector has the lowest share (28%). It could be an advantage of the

sample in analyzing the impact of the sector element on firm innovation.

Further analysis of industry characteristics in terms of competition indicates that the proportion of firms reporting facing no obstacles in competition is slightly higher than their counterparts (those reportedly encountering the pertinent hindrance from minor to severe levels). The former accounts for approximately 51% of

the total number of firms, while the latter contributes around 45% and the remaining proportion is for missing values.

Finally, Table 2 shows the summary data on corruption employed as an element of firms' business climate. On average, firms facing obstacles on corruption accounts for a bigger proportion (about 62%), compared to the counterparts that have no obstacles with bribery.

4. Findings and discussion

This part will analyze the findings in detail, considering each facet of innovation.

4.1. Innovation in products/services (Model 1)

To take into account "technology innovation" of firms, defined as the diffusion of new products and services, three regressions are run for three models with firm related elements for the first, firm and industry related elements for the second, and business climate factors added to the third.

Table 3 shows the results of three regressions. As expected, export status of the firm significantly influences the propensity of innovation among Vietnamese firms, with statistically significant coefficients at 1% in all three models. The

results of the third model indicate that being a direct exporter, compared to counterparts that are non-exporters or indirect exporters, increases the probability of innovation by approximately 12.7% points. This can be attributed to the nature of activities that in order to compete in international market exporters are likely to be encouraged to improve their products. It can also be true that by joining global market exporters have better environment for learning and adopting new features of products/services from foreign providers to improve theirs.

The analysis reveals that firm size has a bearing on the probability of "technology innovation." Medium firms, i.e. from 20 to 99 employees, are around 7.43% points and more likely to have new or significantly improved products/services. This difference is quite consistent when the coefficients are statistically significant in all three models. Additionally, being a large firm, compared to counterparts that are small firms, increases the propensity of innovation in products/services by around 7.07%. However, this pattern is statistically significant at 10% in two out of three models. This can be explained by the fact that overall, larger firms may have more capacity for innovation in both physical capital and human resource.

Table 3

Factors influencing firm technology innovation (marginal effect after probit analysis)

Variable	Step 1	Step 2	Step 3
Directexport	0.1092662 (0.005)***	0.126749 (0.001)***	0.1273317 (0.001)***
Medium	0.06148 (0.082)*	0.0734082 (0.042)**	0.0743482 (0.039)**
Large	0.0690973 (0.098)*	0.0697348 (0.103)	0.0707528 (0.098)*
Foreign	-0.0017522 (0.009)***	-0.001755 (0.010)**	-0.0017778 (0.010)***
Gorvernment	0.0041062 (0.025)**	0.0038928 (0.036)**	0.0038623 (0.037)**
Age	0.0022676 (0.175)	0.0023828 (0.160)	0.002432 (0.152)
Email	0.1584235 (0.021)**	0.1661197 (0.019)**	0.1645206 (0.020)**
Medium - technology		0.0747668 (0.034)**	0.0748288 (0.034)**
Service		-0.03072 (0.444)	-0.0325479 (0.419)
Competition		0.1211857 (0.000)***	0.1197513 (0.000)***
Corruption			0.0180874 (0.569)
<i>N</i>	975	947	947

Notes: p-value in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Interestingly, foreign ownership of the firms is revealed to significantly influence the probability of a firm's innovation, but this relationship is negative in all three models. The third model shows that an

increase in a firm's foreign ownership by 1% reduces the probability of innovation in products/services by 0.18% points, contrary to common norms and expectation about advantages of foreign shareholders to

innovation. While this result may appear counterintuitive, there is convincing explanation that can be denied logically. Firms owned partly or wholly by foreign partners tend to work under supervision of the headquarters abroad. Therefore, products or services produced in Vietnam mostly meet the standards developed outside the borders, yet these firms in Vietnam are not allowed, or do not have incentives, to innovate, which leads to less capabilities of fostering innovation compared with domestic firms.

Opposite to prejudices against state ownership, a positive and significant relation is articulated between state-owned firms and innovation, which is quite robust through three models and implies that an increase by around 0.4% points in probability of innovation for each 1% increase in state-owned capital. This finding clearly indicates that state-owned companies in Vietnam seem to be more innovative in production, compared to their private counterparts. It can be argued that the former has advantages in financial and human resources as well as legal procedures favorable for innovative activities over the latter.

Table 3 does not show any significant difference in innovation pattern of firms with different operating age. With regard to email use, on average, firms employing email (16.5% points) are more likely to innovate than non-users, and this relationship is significant at 5% in all three models.

Further analysis of industry characteristics in terms of sectors indicates

that being in medium and high-technology industries increases firms' probability of innovation by approximately 7.5%, compared to the counterparts that are in low-technology industries. Meanwhile, firms in service and low-technology sectors show no significant difference in innovative probability. This result adheres to normal convention, but implies important suggestions for the government to adopt suitable policies for each industry.

Furthermore, the finding reveals the importance of competition in influencing innovative activities. It shows a positive and significant linkage between competition and probability of firm innovation at 1% in both models 2 and 3. It indicates that the proportion of firms reporting facing competition is around 12%, and they are more likely to innovate in products/services, compared to the counterparts with no competition reported. This can be attributed to the fact that to survive in a competitive market firms have more incentives to create new products/services or improve their existing ones.

Finally, the study analyzes the impact of weak governance represented by the issue of corruption on technology innovation. The result indicates that firms reported having obstacles with corruption has no difference in probability of innovation in comparison with the counterparts without obstacles.

4.2. Innovation in manufacturing and offering services (Model 2)

Similar to the analysis of "technology innovation," innovation as improvement in

the methods of manufacturing or offering services is estimated in three models and with the same explanatory variables. The results of the three regressions are shown in Table 4.

Table 4

Factors influencing innovation in terms of manufacturing or offering services (marginal effect after probit analysis)

Variable	Step 1	Step 2	Step 3
Directexport	0.1033393 (0.009)***	0.1248935 (0.002)***	0.1255882 (0.002)***
Medium	0.0533685 (0.135)	0.0625595 (0.087)*	0.0640901 (0.080)*
Large	0.0753257 (0.072)*	0.0877603 (0.042)**	0.0892539 (0.039)**
Foreign	-0.0022601 (0.001)***	-0.0021713 (0.002)***	-0.0022034 (0.002)***
Gorvernment	0.0000272 (0.988)	-0.0006292 (0.726)	-0.000668 (0.710)
Age	0.0008815 (0.595)	0.0009908 (0.555)	0.0010742 (0.524)
Email	0.121619 (0.065)*	0.1278447 (0.059)*	0.1263967 (0.063)*
Medium - technology		0.0277809 (0.436)	0.0275873 (0.439)
Service		-0.071363 (0.078)*	-0.0744453 (0.067)*
Competition		0.1598211 (0.000)***	0.1578438 (0.000)***
Corruption			0.0282972 (0.378)
<i>N</i>	977	949	949

Notes: p-value in parentheses; *** p<0.01, ** p<0.05, * p<0.1

The findings clearly articulate the fact that innovation in terms of changes in manner of manufacturing and offering services is beneficial to direct export. Firms exporting directly and making up about 12.56% are more likely to have improvement in method, compared to non-exporters. This relation is strongly statistically significant at 1% and the absolute value is quite similar to the influence on the studied technology innovation.

The results indicate a positive link between firm size and innovation in method. In comparison with regression on technology innovation, the magnitude is quite similar, implying that medium firms (from 20 to 99 employees) which are approximately 6.4% more innovative than the small ones, and the results are significant at 10% in Models 2 and 3. Large firms (100 employees and over) are around 8.9% more innovative than small firms. This linkage is significant at 5%.

In the same line with the argument over the role of foreign ownership in fostering innovation, the analysis reveals a negative relationship between these two, which implies that 1% increase in foreign contribution is associated with about 0.22% decrease in the method of innovation, and this link is strongly significant at 1%.

Unlike state ownership in its association with technology innovation, Table 4 shows no difference between state firms and private ones. Firm age and corruption show no influence on innovation in method. Meanwhile, the results indicate that firms using email reaches are approximately

12.6% more innovative than non-users, and this relationship is significant at 10%.

In regard to industry related elements, innovation in method shows no difference between low and medium technology industries. However, firms in service sectors amounting to around 7.4% are more likely to have improvement in method of offering services, compared to the counterparts that are low technology firms.

In addition, competition is revealed to have a strong positive influence on innovation in method. It can be interpreted that firms facing competition (around 15.8%) are considered more innovative than others that enter no competition.

Innovation in management (Model 3)

In this model, regression is run to examine the determinants of innovation in management with the same variables as previous analysis. Table 5 shows the estimation results in three steps.

As opposed to technology innovation and innovation in method, the findings reveal no influence of direct export on innovation in management in three models. In other words, exporters see no different pattern in improvement of management, compared to non-exporters.

When it comes to firm size, medium and small firms are not different in management innovation, while large firms are revealed to be significantly different from small ones in management innovation. The result implies that large firms are approximately 13% more innovative in management than small firms. This finding is attributed to the nature of firms that firms with large number of

workers need to have continuous work effectively, while small and medium improvement in management or firms take less notice of this issue. organization to make sure the whole system

Table 5
Factors influencing innovation of management

Variable	newmanagement	newmanagement	newmanagement
Directexport	0.0420788 (0.283)	0.0608054 (0.132)	0.0611456 (0.129)
Medium	0.0390887 (0.268)	0.0523744 (0.147)	0.0533153 (0.140)
Large	0.1188309 (0.004)***	0.1289264 (0.002)***	0.1299024 (0.002)***
Foreign	-0.0024583 (0.000)***	-0.0022638 (0.002)***	-0.0022829 (0.001)***
Gorvernment	0.0006613 (0.701)	0.0002977 (0.864)	0.0002741 (0.874)
Age	0.0003303 (0.841)	0.0004064 (0.808)	0.00046 (0.784)
Email	0.2009742 (0.004)***	0.215838 0.003)***	0.2138618 (0.003)***
Medi		0.0440612 (0.215)	0.0440187 (0.216)
Service		0.0044855 (0.910)	0.0024049 (0.952)
competition		0.1060889 (0.001)***	0.1046557 (0.001)***
Corruption			0.0185462 (0.557)
<i>N</i>	979	951	951

Notes: p-value in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Foreign ownership shows the same pattern as in previous regressions. It indicates that 1% increase in foreign ownership leads to around 0.22% increase in

probability of innovation in management. This finding suggests that foreign investment does not have any positive impact on innovation from all the considered aspects.

In line with previous regressions run for innovation in method, the findings show no difference in managerial innovation between state and private firms. Similarly, firm age does not have any impact on management of firms.

The usage of email, once again, shows a strongly positive impact on management of firms. This finding implies that firms having emails are approximately 21.3% more innovative in management, compared to the counterparts that use no email for operation.

Concerning industry characteristics, the findings show that the matter of which industry firms belong to makes no difference in management among firms when the variables reflect no significant relations in Models 2 and 3. Meanwhile, competition still plays a major role in boosting managerial improvement of firms. The findings show that firms operating in a competitive market are around 10.5% more innovative in management than the counterparts that are firms facing no competition.

Like innovation in two previous aspects, innovation in management is not influenced by corruption, indicating no significant relation in the estimated results.

5. Conclusion and policy implications

In general, each aspect of innovation is

influenced by different characteristics of firms, industry and business climate at different levels. Empirically found to have consistent impacts on all three aspects are foreign ownership, email usage, competition and firm size. Meanwhile, firm age and corruption show no effects on innovation given all regressions. The impacts of remaining elements fluctuate among regressions.

The strong positive relationship between direct export and technology innovation—innovation in products/services as well as innovation in method and process—implies the important role of export in boosting firm innovation. Hence, the policies on support given to Vietnamese firms in joining international market are necessary by aiding in legal frameworks as well as launching initiatives in particularly popularizing national trademarks.

A worthy implication from the strongly negative link between foreign ownership and innovation in all aspects should be considered by government that foreign investment should be controlled strictly because they do not always exert positive impacts on innovation as we expected. The policy on attracting as much as possible foreign money flow may be not efficient in the long run if the focus is shifted on cheap labor and low technology industry. It may also imply that it is critical for government to create an environment, especially legal framework to encourage innovation for domestic firms.

The findings on the positive impact of email use on innovation in all three facets indicate that internet use as the whole and

email in particular should be popularized among firms. Therefore, it is necessary to provide high quality infrastructure for internet connection, and firms should take advantage of internet for effective operation.

The significant difference between low technology and medium technology sectors in technology innovation implies the advantages of medium technology industry in innovation. In the long run Vietnam should prioritize the development of medium and high technology industries instead of relying on cheap labor and natural resources in the low technology sector.

The positive impact of competition found across all three models indicates that competition could be the motivation for firms' being engaged in innovative activities. These findings might imply that it is crucial for government to create a competitive market, which can be implemented by an opening market for more competition. This policy seems to have been effective so far when Vietnam has been lessening the number of state-controlled

companies which are monopolies in many sectors. Moreover, the nation has been joining more and more free trade areas as well as being part of pivotal trade agreements. By doing that, Vietnam firms will have to face fiercer competition which potentially creates incentive for innovation.

In conclusion, this paper accumulates substantial evidences on the role of various factors on firm innovation and implies suggestions to boost innovation, which is a crucial element for sustainable development of the country. A reliable data set retrieved from World Bank and carefully chosen methodologies are employed in an attempt to depict the picture accurately. However, there can be many remaining problems which could not be solved in the paper. Hence, it is imperative to have more studies on firm innovation in Vietnam from different aspects and with different statistical techniques adopted for accurate analysis, which, in turn, will provide conclusive scientific evidence for suitable policy suggestions■

References

- Aghion, P., Bloom, N., Blundell, R., Griffith, R., & Howitt, P. (2005). Competition and innovation: An inverted-u relationship. *Quarterly Journal of Economics*, 120(2), 701–728. doi: 10.1093/qje/120.2.701
- Almeida, R., & Fernandes, A. (2008). Openness and technological innovations in developing countries: Evidence from firm-level surveys. *Journal of Development Studies*, 44(5), 701–727.
- Aubert, J. (2004). *Promoting innovation in developing countries: A conceptual framework*. Retrieved August 4, 2016 from <http://info.worldbank.org/etools/docs/library/137729/0-3097AubertPaper%5B1%5D.pdf>
- Bhattacharya, M., & Bloch, H. (2004). Determinants of innovation. *Small Business Economics*, 22(2), 155–162. doi: 10.1023/B:SBEJ.0000014453.94445.de
- Cameron, A., & Trivedi, P. (2009). *Microeconometrics using Stata*. College Station, Stata Press.

- Cornell University, INSEAD, & WIPO. (2015). *The global innovation index 2015: Effective innovation policies for development*. Fontainebleau, Ithaca, and Geneva.
- Cuerva, M. C., Triguera-Cano, A., & Córcoles, D. (2014). Drivers of green and non-green innovation: Empirical evidence in low-tech SMEs. *Journal of Cleaner Production*, 68, 104–113.
- Francis, J., & Smith, A. (1995). Agency costs and innovation some empirical evidence. *Journal of Accounting and Economics*, 19(2–3), 383–409.
- General Statistics Office of Vietnam. (2010). *Enterprises in Vietnam during the first nine years of 21st*. Statistical Publishing House, Hanoi.
- Hansen, J. (1992). Innovation, firm size, and firm age. *Small Business Economics*, 4(1), 37–44. Retrieved August 4, 2016 from <http://www.jstor.org/stable/40228766>
- Khachoo, Q., & Sharma, R. (2016). FDI and innovation: An investigation into intra- and inter-industry effects. *Global Economic Review*, 45(4), 311–330.
- Lee, C. (2004). The determinants of innovation in the Malaysian manufacturing sector: An econometric analysis at the firm level. *Asean Economic Bulletin*, 21(3), 319–329.
- Nguyen, N. A., Doan, Q. H., Nguyen, N. M., & Tran, B. N. (2016). The impact of petty corruption on firm innovation in Vietnam. *Crime, Law and Social Change*, 65(4), 377–394. doi: 10.1007/s10611-016-9610-1
- Nguyen, N. A., Doan, Q. H., & Nguyen, P. M. (2013). The Vietnam national innovation system. *Asia-Pacific Tech Monitor*, 30(2), 42–51.
- Nguyen, N. A., Pham, N. Q., Nguyen, C. D., & Nguyen, N. D. (2008). Innovation and exports in Vietnam's SME sector. *The European Journal of Development Research*, 20(2), 262–280.
- OECD. (2011). *ISIC REV.3 technology intensity definition*. OECD Publishing.
- OECD. (2014). *Science, technology and innovation in Vietnam*. OECD Reviews of Innovation Policy. Retrieved August 4, 2016 from <http://www.oecd.org/sti/science-technology-and-innovation-in-viet-nam-9789264213500-en.htm>
- Schumpeter, J. (1976). *Capitalism, socialism, and democracy* (5th Ed.). Allen & Unwin, London.
- Symeonidis, G. (1996). *Innovation, firm size and market structure: Schumpeterian hypotheses and some new themes*. Retrieved August 4, 2016 from <https://www.oecd.org/eco/outlook/1863348.pdf>
- Veracierto, M. (2008). *Corruption and innovation*. *Economic Perspectives*, 32(1).
- Wan, D., Ong, C., & Lee, F. (2005). Determinants of firm innovation in Singapore. *Technovation*, 25(3), 261–268.
- World Bank. (2017). *A review of science, technology and innovation in Vietnam*. Retrieved Jun 1, 2017 from <http://www.worldbank.org/en/country/vietnam/publication/a-review-of-science-technology-and-innovation-in-vietnam>