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Title in English: **Essays on Innovation and Productivity: Evidence from Vietnamese Manufacturing Firms**

Title in Japanese: イノベーションと生産性との関係に関する実証研究：ベトナムの製造業企業を事例に

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ACRONYMS AND ABBREVIATIONS

ASEAN	The Association of South East Asian Nations
CDM	Crepon, Duguet, and Mairesse econometric model
CIEM	The Central Institute for Economic Management
CIS	Community Innovation Survey
CSR	Corporate social responsibility
DERG	The Development Economics Research Group
DOST	Departments for Science and Technology
EBRD	European Bank for Reconstruction and Development
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GII	The Global Innovation Index
GNI	Gross National Income
GSO	General Statistics Office of Vietnam
HHI	The Herfindahl- Hirschman Index
ICT	Information and communication technology
INSEAD	The European Institute of Business and Administration
IPR	Intellectual Property Rights

MNEs	Multinational Enterprises
MOET	Ministry of Education and Training
MOF	Ministry of Finance
MOST	Ministry of Science and Technology
MPI	Ministry of Planning and Investment
NA	National Assembly
NAFOSTED	the National Foundation for Science and Technology Development
NATIF	the National Technology Innovation Fund
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Square
R&D	Research and Development
SATI	State Agency for Technology Innovation
SMEs	Small and Medium-sized Enterprises
SOEs	State-owned Enterprises
S&T	Science and Technology
TCS	The Vietnam Technology and Competitiveness Survey
TPF	Total productivity factor
USD	United State Dollar

VAST	Vietnam Academy of Science and Technology
VES	The Vietnam Enterprise Survey
VND	Vietnamese Dong
VSIC	Vietnam Standard Industrial Classification
WB	The World Bank
WTO	World Trade Organization

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ABSTRACT

This thesis aims to investigate empirically the relationship between innovation and productivity in Vietnam's manufacturing sector. The main objective is to provide a comprehensive analysis of the innovation phenomenon in firm level in the context of developing countries. The analysis uses the panel dataset from the annual Vietnam Technology and Competitiveness Survey for the period 2010-2013.

This thesis consists of three essays. The first essay (Chapter 3) investigates the determinants that affect innovation decision of firm, in three levels of analysis: firm, industry and province. The analysis results suggest that firm size, export activities, human resources, and technological intensity of the sector are among important determinants of innovation decision. Notably, the study found a negative effect of the wholly foreign owned firms on the propensity of innovation.

The second one (Chapter 4) explores the relationship between innovation and firm productivity, employing a three-stage model proposed by Crepon, Duguet and Mairesse (1998), namely CDM model. The first stage refers to innovation investment of firm, measured by the level of expenditure on innovation. The second stage describes the transformation process of innovation efforts into innovation outputs. The third stage investigates the impact of innovation outputs on labor productivity. The results imply that the probability of producing innovation outputs (measured by the innovation new to the market and new to the firm) is higher with the increase of innovation expenditure. Furthermore, the results also suggest that the introduction of innovation outputs is driven by qualified workforce, R&D collaboration partnership, licensing agreement and public subsidies. However, this study was not able to find a significant impact of innovation outputs on labor productivity.

The third essay (Chapter 5) further examines the innovative behavior of foreign owned firms, in comparison with domestic private firms. Findings from the analysis indicate that although foreign owned firms are shown to be more productive than domestic private firms, however they seem to be less intensive in innovation investment, and less active in introducing innovation outputs.

CHAPTER 1. INTRODUCTION

1. Research Background

Innovation is considered as one of the main driving forces of productivity and economic growth of nations. The role of innovation has attracted the interest of economists, at least since Adam Smith (1776), who recognized that economic growth was not only driven by the productivity gains from the labor division, but also by technological improvements. After Adam Smith, Joseph A. Schumpeter, one of the most influential innovation theorists, made a more explicit analysis on the role of innovation in his famous books named *The Theory of Economic Development* (1934) and *Capitalism, Socialism and Democracy* (1942). Schumpeter viewed economic growth as a "creative destruction process" which is brought about by technological innovation. In his definition, technological innovation can take the form of new products, new production methods, new markets, new sources of raw materials, or new changes in the organizational structure[1]. Innovation stems from scientific and technological activities and is adopted and diffused by entrepreneurs into the market. The successful commercialization of innovation creates added value for the economy or pushes the economy up, thus contributing to economic growth (Kaya, 2015).

Although Schumpeter laid the basic ground for literature on innovation, empirical studies only increased substantially after the introduction of the endogenous growth model, which was developed by Solow (1957). In this model, Solow (1957) included technological change as an endogenous factor of production growth models in addition to labor and capital. The argument of Solow (1957) is based on the assumption that, in the short run, economic growth is driven by the accumulation of labor and physical capital, but in the long-run, it is determined by the technological progress beside these two traditional factors. Since then, a vast majority of research has attempted to investigate the impact of technological change on countries' or regions' economic growth, as well as on firms' performance. However, the main obstacle faced by researchers at that time was related to the measurement of innovation, which was still considered as a residual factor in Solow's model (Cassoni & Ramada, 2010). Until the 1980s, most studies used research and development (R&D) expenditure and the number of patents as

[1] More specifically, according to Schumpeter, innovation can take the following forms: (i) the introduction of a new good that is new to customers, or a new quality of a good; (ii) the implementation of a new production method which has not been applied in the given sector but is not necessarily based on a new scientific discovery; (iii) opening a new market; (iv) development of new sources of supply for raw materials; (v) carrying out of a new change in organization (Schumpeter, 1934).

a proxy of innovation (Griliches, 1986; Goto & Suzuki, 1989; Lichtenberg & Siegel, 1991). These indicators, as pointed out by Kemp et al (2003), are not informative about the actual process of innovation. Moreover, measures of R&D expenditure do not encompass all the innovative efforts of firms such as learning by doing or the knowledge embodied in investment in new machinery and its human capital (OECD, 1997, cited from Hashi & Stojcic [2013]). Therefore, the innovation process was frequently questioned and remained a "black box" (Kemp et al, 2003).

In the early 1990s, the Organization for Economic Co-operation and Development (OECD), and in particular the European Commission, introduced the Community Innovation Survey (CIS), which brought major changes to innovation research[2]. The CIS provides the basic definition of innovation, the possible indicators related to various kinds of innovation outputs, as well as the way a firm implements innovation, which enables researchers to conduct this kind of research on a broader perspective (e.g. innovation process and innovation systems). The CIS surveys are now conducted in a majority of countries throughout the world, not only in OECD countries but also in developing and transition countries (Mairesse & Mohnen, 2010). With the richness of data on firm-level innovation surveys in recent years, there is a growing interest in studies exploring the determinants of innovation and its relationship with firm performance.

Against this background, this thesis concentrates on exploring three main issues: (i) the determinants of a firm's innovation decision, (ii) the relationship between innovation and productivity, and (iii) of ownership performance in the innovation-productivity relationship in the context of developing countries. In the next sections, after the introduction of research questions and hypotheses, theoretical framework and data sets, the gaps of research surrounding these issues and the contributions of this thesis to fill these gaps will be identified.

2. Research Questions and Hypotheses

This thesis is concerned with investigating the determinants of innovation and the relationship between innovation and productivity of manufacturing firms in Vietnam. The main questions for the study are addressed below.

[2] OECD has introduced the first version of CIS in 1992, aiming to help efficiently collect and interpret innovation survey data from firms and develop policies that support firm's innovation appropriately.

1. *What are the key determinants in firm-industry-province level affecting the innovation decision made by Vietnamese firms?*
2. *What is the relationship between innovation and productivity?*
3. *Does foreign ownership matter for innovation activities of Vietnamese manufacturing firms?*

Based on these questions, the research hypotheses are formulated as follows:

Hypothesis 1.1 The larger firm size, the higher the propensity of innovation.

Hypothesis 1.2 Firms with higher qualified human resources have higher innovation propensity.

Hypothesis 1.3 Firms with foreign ownership have higher innovation propensity.

Hypothesis 1.4 Firms that participate in exporting have higher innovation propensity.

Hypothesis 1.5 Industrial competition has a positive relationship with innovation propensity.

Hypothesis 1.6 Firms in the higher technological industry are more likely to innovate.

Hypothesis 1.7 There is a positive relationship between a local government's innovation support and innovation propensity.

Hypothesis 2 Innovation investment is positively associated with the successful introduction of innovation output (new to the market and new to that firm), which in turn contributes to a greater level of productivity.

Hypothesis 3 Private firms are more innovative than foreign owned firms, because they have more extensive resources of internal and external knowledge.

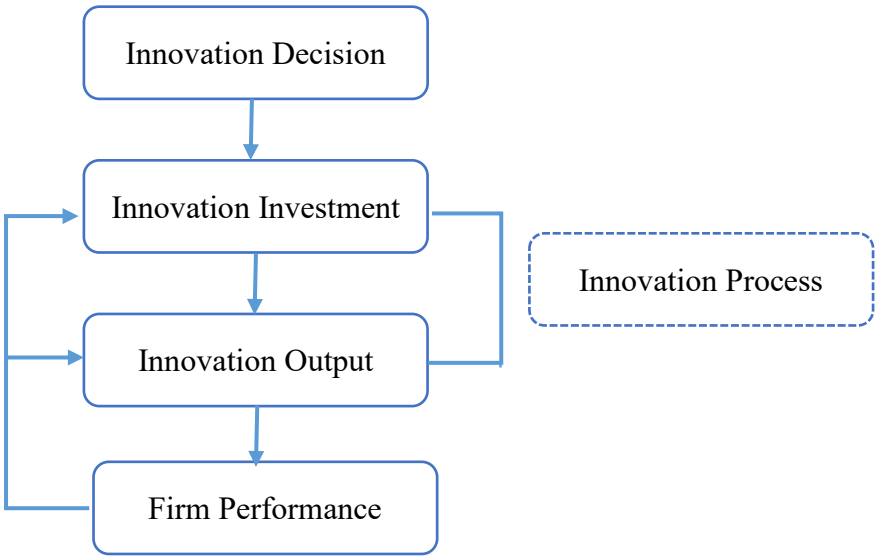
3. Theoretical Framework and Dataset

3.1 Theoretical Framework

In order to answer the above questions and hypotheses, this thesis uses the model introduced by Crepon, Duguet & Mairesse (1998) (hereafter CDM model) as the theoretical foundation for the empirical study. The CDM model summarizes the relationship between innovation process with firm performance in four linkages. The first link (*Innovation decision*) describes the firm's decision on whether or not to engage in innovation. The second link (*Innovation Investment*) refers to innovation effort of firms, assuming that there is the decision to innovate, they will decide how much to invest in innovation. The third link (*Innovation Output*) describes the transformation process of innovation efforts into innovation outputs.

Finally, the fourth link (*Firm Performance*) investigates the impact of innovation output on firm performance (commonly measured by labor productivity), based on the Cobb-Douglas production function. These four linkages are presented in Figure 1.1 below.

Figure 1. 1 Theoretical Framework (the CDM Model)



Source: Kemp et al (2003, p.10)

The CDM model is employed for three main reasons. First, the CDM model is a substantial improvement in the methodology in comparison with the previous models on the innovation-productivity relationship, as it comprehensively analyses the innovation process and productivity. Second, the CDM model address two methodological problems: (i) selectivity issue, which is associated with the fact that only a small number of firms report on innovation investment; (ii) endogeneity problem between innovation and productivity, which means that the factors which affect innovation would also affect productivity and vice versa. Third, the CDM model seems to be reliable and fit the data well as it has been widely used in different countries, both developed and developing countries.

3.2 Dataset

This thesis uses three sources of data in accordance with three levels of analysis: firm-industry-province level, respectively. First, for the firm level information, this study uses a panel data set which drawn from the Vietnam Technology and Competitiveness Survey (TCS) in the period 2010-2013. The surveys are based on a survey module incorporated into the Vietnam Enterprise Survey (VES), which conducted yearly by General Statistics Office (GSO)

of Vietnam[3]. The survey was designed by the Central Institute for Economic Management (CIEM), and the Development Economics Research Group (DERG) of the University of Copenhagen, with a focus on collecting data relating to competitiveness and technology issues of Vietnamese manufacturing firms. The panel data comprises 25,848 observations, covering 23 manufacturing sectors in 63 province and cities of Vietnam[4].

Second, to collect the industry information (such as industrial competition, a proxy of competition in the domestic market) and to test whether the sample of this research is representative for Vietnamese manufacturing firms or not, this study uses the VES in the same period, and constructs a panel data set of 213,301 observations.

Third, for the purpose of provincial-level analysis, this thesis also uses the Vietnam Province Statistical Yearbook for 63 provinces and cities from the home page of the Ministry of Finance of Vietnam. These Yearbooks provide the information of provincial expenditure on scientific and technological activities.

4. Research Gaps and Contributions of Three Essays

This thesis is a comprehensive study on innovation, which comprises three essays examining: (i) the determinants of innovation decisions, (ii) the relationship between innovation and productivity, and (iii) the ownership performance in innovation-productivity relationship, using the panel dataset from the TCS during the period 2010-2013. The main thread binding these essays is the investigation of the innovation process and its impact on a firm's productivity. Theoretically, the analysis of these essays is based on the CDM model. More specifically, the first essay explores the determinants that affect the firm's decision to engage in innovation (the first linkage), while the second one investigates the relationship between innovation process and a firm's productivity (the last three linkages), and the final one conducts a deeper analysis on the ownership performance on this relationship. Thus, although each essay is presented in separate chapters, all these essays are connected by the same framework and the combination of them provides an integrated and comprehensive analysis on the innovation phenomenon of Vietnamese firms. The overview, the gaps in the literature and the contributions of each essay are outlined below.

[3] The VES is a census survey of Vietnam's enterprises in all economic sectors that are formally registered with provincial authorities, and it has been conducted yearly by GSO since 2000. The TCS series have been start since 2009, as an additional module of the VES.

[4] In this survey, the Vietnamese manufacturing industries are categorized based on the Vietnam Standard Industrial Classification (VSIC)at the four-digit industry level.

4.1 Essay 1: Determinants of Innovation: A Panel Analysis of Vietnamese Manufacturing Firms, 2010-2013

The first essay is presented in Chapter 3, which aims to investigate the different contextual factors influencing Vietnamese manufacturing firms' innovation decision. Unlike with the traditional stream of literature which is concerned with the 'technology push' and 'demand pull' effects, this study focuses on the contextual factors on the firm-industry-province level with regard to their influence on the firms' innovation propensity. This essay is motivated by the several identified gaps in the research where: (i) the existing studies of Vietnamese firms merely focused on a limited set of factors (e.g. firm size, firm age) and have paid little attention to the factors in industry and province level, (ii) most of the studies mainly focused on small and medium enterprises (SMEs) which underestimates the innovative efforts of Vietnamese firms because of the fact that SMEs' innovation tends to be low and informal.

Based on the literature review and identified research gaps, a research model is developed in order to explore which factors in three analysis levels (firm, industry, province) drive the innovation decision of Vietnamese manufacturing firms. The analysis results confirm the general view from the literature on the positive effects of firm size, export activities, human resources, and technological intensity of the industrial sector. Furthermore, in contrast to the other Asian countries' studies, this study found a negative effect of the wholly foreign owned firms on innovation propensity. In addition, the provincial government's support does not show significant role on promoting innovation.

With the above comprehensive model of factors, this essay extends the existing studies which focused mainly on firm characteristics and provides an overall picture of firm-level innovation propensity. Moreover, by using an extensive panel dataset from the TCS which consists of over 8,000 manufacturing firms per year (25,848 observations in total for the period 2010-2013) in 63 provinces, the results from this essay can be generalized to the whole manufacturing sector, not being limited to any particular sector or limited regional coverage.

The findings from this essay have been revised from two published academic papers written by me entitled 「ベトナム製造企業における研究開発活動の決定因」（2017）(In English: Research development and its determinant factors: The case of Vietnamese manufacturing firms), and "Determinants of innovative propensity in Vietnamese small and medium-sized enterprises" (2017). In addition, another version of this essay entitled "The determinants of innovation in Vietnamese manufacturing firms: An empirical analysis using a

technology-organization-environment framework" has been also revised and resubmitted to the *Eurasian Economic Review* for possible publication.

4.2 Essay 2: Innovation and Productivity: Evidence from Vietnamese Manufacturing Firms

The essay presented in Chapter 4 is focused on the main topic of this thesis. The aim of this essay is to investigate the relationship between innovation process and productivity by employing the CDM model. As an extension of the first essay in Chapter 3, this essay focuses on the latter three stages of innovation and productivity. The review of the literature shows that in contrast to the consensus that innovation has a positive effect on improving productivity found in the empirical studies in the cases of developed countries, the evidence from developing and transition economies is mixed and inconclusive. In the case of Vietnam, to the best of my knowledge, there is no research along this line that has yet been done, which motivates this thesis to address this topic.

The main findings of this essay are that, (i) innovation investment (measured by the total expenditure on innovation activities) is an important determinant of developing innovation outputs (proxied by innovation new to the market and new to that firm), and (ii) there is no significant impact of innovation output on a firm's labor productivity, which suggests a 'longitudinal effect' of innovation in a longer period.

This essay contributes to the existing literature in three ways. First, on the theoretical side, this essay develops a conceptual framework which combines three stages of the CDM model and the various contextual factors that have been predicted in Chapter 3. Second, on the empirical side, this essay extends the existing CDM studies by accounting for non-traditional indicators for innovation, such as the degree of novelty of innovation and acquisition of external technology. Third, on the practical side, this thesis is the first study using the TCS dataset to apply the CDM model to investigate the innovation-productivity linkage in Vietnamese manufacturing firms.

4.3 Essay 3: Innovation and Productivity- A Comparative Study on Ownership Structure

This third essay conducts a deeper analysis on the relationship between innovation and firm performance, by making a comparative study on the differences between foreign-owned and domestic private firms. The purpose of this essay is to examine whether the foreign owned firms matter in promoting innovation in Vietnam and what are the differences in innovation

performance in comparison with those of private firms. This topic is important in the context of developing countries and transition economies, like Vietnam, because the literature suggests a gap in technology and productivity between these two types of firms, which leads to the differences in innovation performance.

The review of empirical studies reveals mixed evidence in both developed and developing countries, for example there is a higher propensity of foreign firms to get involved in R&D activities in developed countries (Castellani & Zanfei, 2003; Criscuolo et al, 2010) and a weak effect in developing countries as shown in Almeida & Fernandes (2008) and Masso et al (2012). This complexity requires more empirical studies, particularly from the context of developing countries.

The findings reveal that: (i) foreign firms in Vietnam are likely to be less intensive in innovation than private firms, (ii) while foreign firms seem to be less active in introducing innovation outputs, (iii) their labor productivity is higher than that of private firms, and (iv) the higher innovation performance of private firms is explained mainly by the collaboration partnership in R&D projects.

The contributions of this essay are twofold. First, this study seems to be the first one to investigate the innovative behavior of foreign owned firms, taking a comparative perspective with the performance of domestic private firms in Vietnam. Second, this study extends the existing empirical studies on this topic by considering production function, rather than focusing only on knowledge production function.

5. Definition of Terms

This section summarizes some important definition of terms used in this thesis. Firstly, it presents the definition of terms relating to innovation. Secondly, it provides the definition of terms relating to the determinants of innovation and productivity.

5.1 Definitions of Terms relating to Innovation

Innovation: "the implementation of a new or significantly improved product (goods or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (OECD & Eurostat, 2005, p.46).

Product innovation: "the introduction of a new product or a significant improvement in an existing one with respect to its characteristics or intended uses. This includes significant

improvements in the technical specification, components and materials, incorporated software, user-friendliness or other functional characteristics" (OECD & Eurostat, 2005, p.48). Product innovation refers to the development of totally new or improved goods or service and it is assumed to have a positive effect on the growth of revenue (Fagerberg, 2009).

Process innovation: "the implementation of a new or a significantly improved production process or delivery method. This includes significant changes in technique, equipment, and/or software" (OECD& Eurostat, 2005, p.49). Process innovation is the improvements in the method of production of goods or services, which may provide the means for improving quality and saving the cost (Kotler & Armstrong, 2001)[5].

Innovation activities include the following activities:

- R&D activities: creative work undertaken on a systematic basis within the enterprise in order to increase the stock of knowledge (OECD, 2015, p.44). R&D activities can be categorized into two types, based on the source of expenditure: (i) intramural R&D and (ii) extramural R&D. Intramural R&D is all R&D activities conducted by the enterprise, and extramural R&D is the acquisition of R&D services from the external partners (OECD, 2015, p.97).
- Non-R&D activities: the modification of product or process, retraining personnel for new technology or the use of new machines and any experimental production which has not been included in R&D (OECD & Eurostat, 1997, p.41).

Innovative firm: is one that has implemented R&D activities (including both of intramural and extramural R&D activities) and non-R&D activities (modification of the existing production process), during the survey period.

Innovation investment: the expenditure on all innovation-related activities (intramural and extramural R&D expenditure, modification of the existing technology/product, purchase of new machinery, equipment for innovation activities).

Innovation new to the firm: "the innovation may have already implemented by other firms, but it is new to the firm" (OECD& Eurostat, 2005, p.57). This type of innovation is the lowest degree of novelty.

[5] Beside product and process innovation, OECD & Eurostat (2005) also defines marketing and organizational innovation. However, in this study, two types of innovation, product and process innovation, are chosen to serve the purpose of analysis.

Innovation new to the market: "the firm is the first to introduce the innovation into the market" (OECD& Eurostat, 2005, p.58). It is worth noting that, if an innovation is new to the firm, it is not necessarily new to the market, however an innovation new to the market is always new to the firm which introduced it (Nanja Strecker, 2009).

Innovation new to the world: "the firm is the first to introduce the innovation for all domestic and/or international markets and industries" (OECD& Eurostat, 2005, p.58). This type of innovation implies the greatest degree of novelty.

5.2 Definition of Terms relating to the Determinants of Innovation and Productivity:

Firm size: the number of employees, which is in compliance with Decree 56/2009/ND-CP on assistance for development of SMEs[6]. In this research, firm size is classified into three groups: (i) small firm (less than 200 employees), (ii) medium firm (201-300 employees), (iii) large firm (more than 301 employees).

Foreign owned firms: the enterprises with capital directly invested by foreigners, not separated by percent of capital share. There are two types of foreign owned firms: (i) Wholly foreign owned firms with 100% of capital invested by foreigners, and (ii) Joint venture firms between domestic investor and foreigners[7].

Private (domestic) firms includes the following types: (i) Private firms, (ii) Cooperative companies, (iii) Private limited companies, (iv) Joint stock company without capital of State, (v) Joint stock companies with 50% or less than of charter capital shared by the government.

State owned enterprises (SOEs) include the following types: (i) Enterprises with 100% of state capital operating under the control of central or local government agencies, (ii) Limited companies under management of central or local government, (iii) Joint stock companies with domestic capital, of which the government's share is more than 50% charter capital.

Qualified workforce: professionally trained and educated workforce.

Export: Goods and services produced by the firms purchased by the foreign partners.

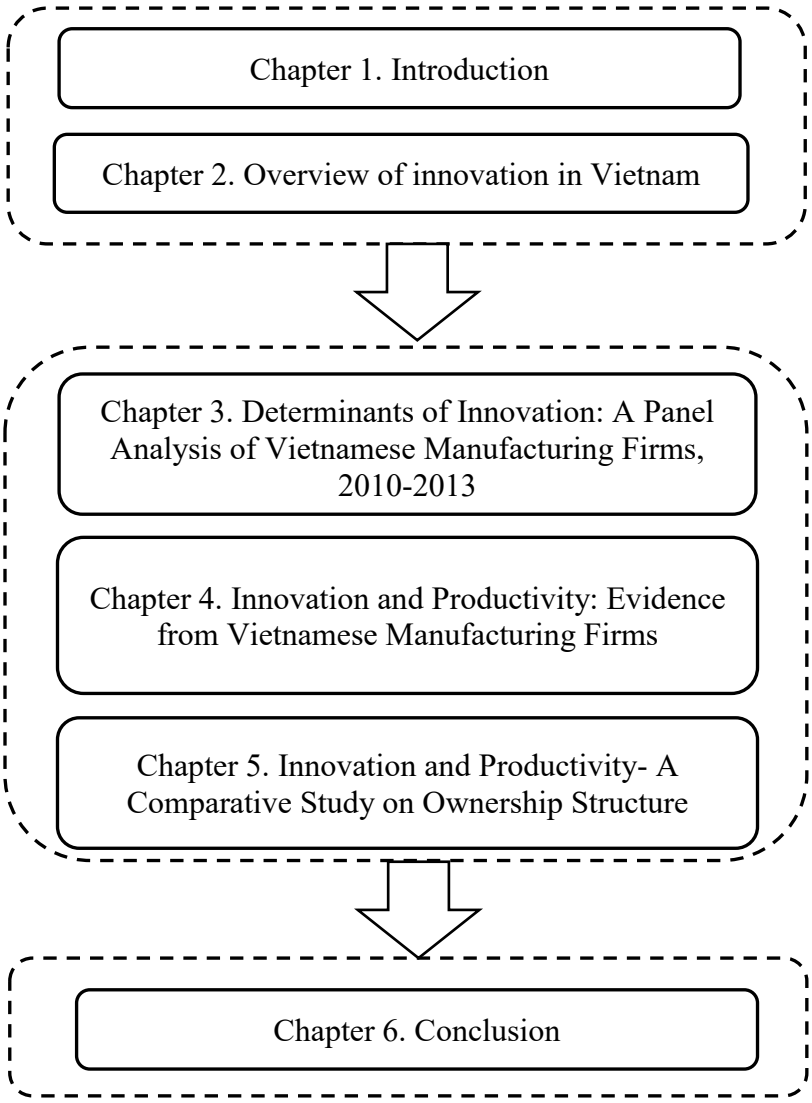
Physical capital: total physical assets of the firm, which contains the value of land, building, factory, equipment/machinery, transport equipment.

[6] Retrieved from https://thuvienphapluat.vn/van-ban/Doanh-nghiep/Decree-No-56-2009-ND-CP-of-June-30-2009-on-assistance-to-the-development-of-small-and-medium-sized-enterprises-93371.aspx
[7] The definition relating to the ownership is based on the GSO Statistical Yearbook 2014.

6. Structure of the Thesis

As introduced above, this thesis examines three topics relating to innovation activities in Vietnamese manufacturing firms: (i) the determinants of innovation decision, (ii) the relationship between innovation and the firm's productivity, and (iii) the differences in innovative behavior between foreign firms and domestic private firms. Each topic constitutes an independent empirical study and presented in three chapters. In addition to these three chapters, there is one chapter introducing the context of Vietnam (Chapter 2). This information is necessary and helpful for understanding the empirical analysis in the subsequent chapters. Finally, Chapter 6 provides a summary of the main findings, as well as addressing the limitations of the present study and future research directions. The overall structure of this thesis is shown in Figure 1.2.

Figure 1. 2 Structure of the thesis



CHAPTER 2. OVERVIEW OF INNOVATION IN VIETNAM

1. Introduction

In this thesis, Vietnam has been chosen as the context for the study. Therefore, this chapter aims to provide an overview of the country context of Vietnam, the evolution and performance of Vietnam's innovation system. Firstly, I introduce the country context, by presenting the economic reform, its outcomes regarding to the changes in economic sector and ownership structure, and the concerns for a sustained growth. Secondly, I describe the evolution in innovation system and the structure of government organization related to science and technology. Finally, I present the innovation performance of Vietnam.

2. Overview of Vietnam's Economy

2.1 Economic transition and its performance

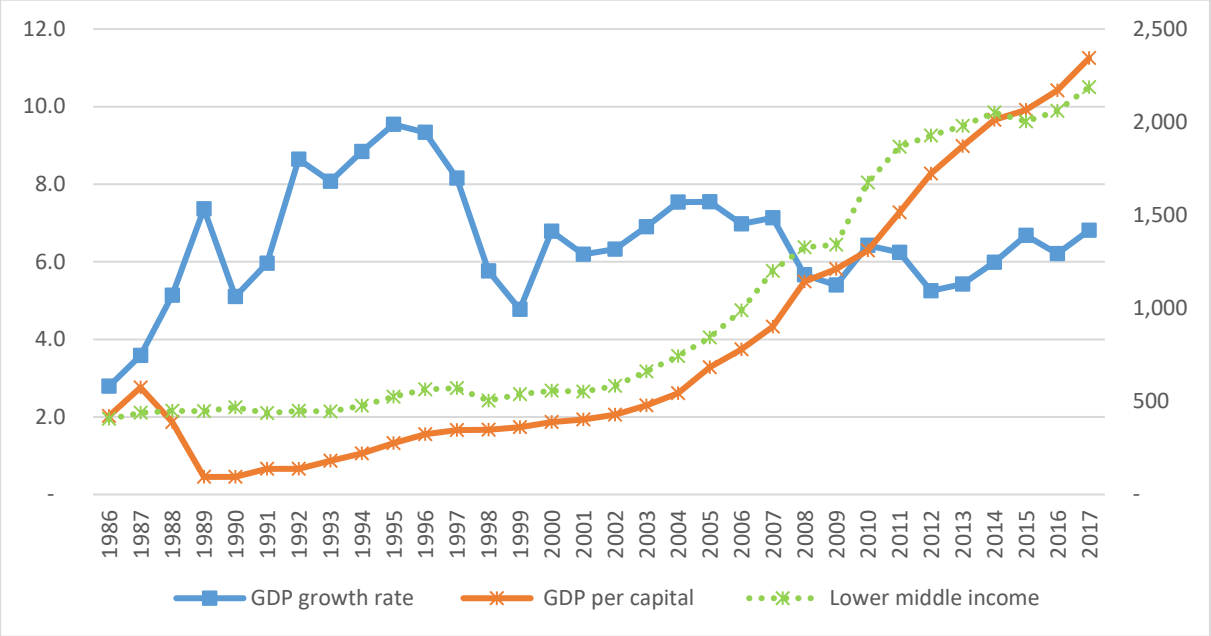
In 1986, Vietnam government launched the economic renovation program with the goal of creating a socialist-oriented market economy. Two central parts of this program were: (i) developing the economy with multi-ownership, and (ii) opening up the economy by integrating into regional and global economies. There was a range of comprehensive reform package implemented, in which Vietnam has made efforts to promote the development of non-state sector and attract foreign direct investment (FDI). Besides, Vietnam has actively engaged in international economic integration by signing to various bilateral and multilateral trade agreements[8].

Since then, Vietnam has achieved remarkable economic performance in gross domestic product (GDP) growth, macroeconomic stabilization, export expansion and poverty reduction. During 1990-2010, with the annual growth rate averaged 7.5%, Vietnam became one of the most rapidly growing economies among Southeast Asian countries. Along with high GDP growth rate, the GDP per capita increased from USD100 in 1986 to USD 2,000 in 2014 (Dinh, 2016). This greatly contributes to the upgrading of Vietnam from a low-income to a lower-middle income country. According to the World Bank (WB) classification, Vietnam is now a

[8] After being a member of the Association of South East Asian Nations (ASEAN) in 1995, and the World Trade Organization (WTO) in 2007, Vietnam has actively joined in bilateral and multilateral trade agreements. By 2016, Vietnam has signed 90 bilateral trade agreements, nearly 60 agreements on investment incentives and protection, and developing trade relations with over 230 countries and territories (Dinh, 2016).

lower-middle income country with an average per capita income of USD 2,343 in 2017[9]. Figure 2.1 shows the economic performance of Vietnam in the period of 1986-2017 in terms of GDP growth rate, and GDP per capital in current USD. The dotted line is the lower-middle income category set by the World Bank which varies year by year. As this figure demonstrates, Vietnam grew steadily from 1989 and joined the lower-middle income category from 2008[10].

Figure 2. 1 Vietnam's economic performance, 1986-2017



Source: Author's compilation based on World Development Indicators online data.

During the transition process to a market economy, Vietnam's economy has experienced gradual changes in terms of *economic sectors* and *ownership structure*. First, the economic structure has shifted in the direction towards a declining of the agriculture sector, but increasing of the industry[11] and service sector. As shown in Figure 2.2, the proportion of agriculture, forestry, fisheries in GDP sharply declined from 38.06% in 1986 to 20.58% in 2010, and 18.12% in 2015. At the same time, the share of manufacturing and construction in GDP increased from 28.88% in 1986 to 41.1% in 2010, and 38.5% in 2015. As a result, the industry

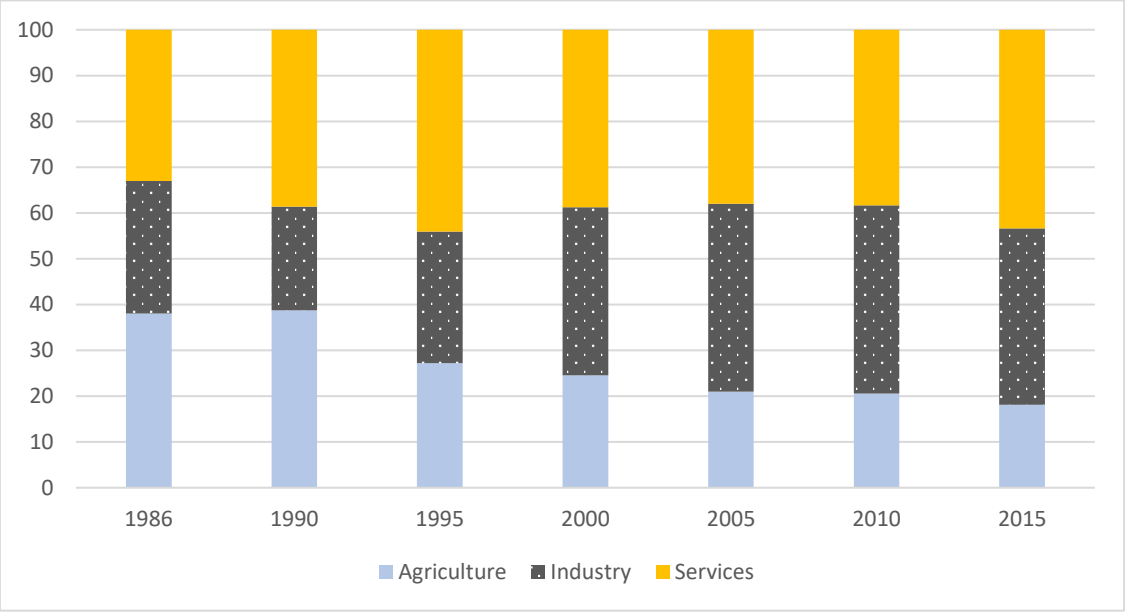
[9] World Bank's country classification is based on income level and revised annually. The classification in 2017 is as follows: low income countries (USD1,005 or less); lower-middle income countries (USD 1,006- USD 3,955), upper-middle income countries (USD 3,956- USD 12,235); high-income countries (USD 12,235 or more).

[10] In 2008, the current classification for lower-middle income country was USD 976-USD 3,855.

[11] Due to the statistical aggregation by GSO, "industry" refers to manufacturing, mining and construction.

sector became the biggest sector, accounting for 41.1% of total GDP in 2010. This pattern reflects the significant change in economic structure toward industrialization.

Figure 2. 2 Sector Structure, 1986-2015 (Unit: %)



Source: Constructed from Statistical Yearbook of Vietnam 2016 (GSO, 2016).

Second, another dramatic change in the economic structure was also observed in firm ownership. While the share of SOEs in the total number of enterprise decreased, the share of private firms has raised, especially after the implementation of the Enterprise Law in 2000. In the period 2000-2015, the share of the state owned sector has sharply decreased from 15.50% to 0.64%, whereas the private sector has raised from 88.58% to 96.66%. Along with the changes in the number of enterprise, there has also been a total shift in the structure of employment, with the share of employment within the state-owned sector reducing from 61.71% to 10.67% in the same period. Private and foreign invested sector have become the majority sources of employment with the share of 59.99% and 29.34%, respectively.

In terms of the share in GDP, Table 2.1 shows that the structural changes in GDP are also associated with the changes in number of firms and share in employment. From 2000 to 2015, the output share of SOEs reduced from 38.52% to 28.69%, while that of FDI increased from 13.27% to 18.07%. For private sector, although their share remains the largest value among the output of total ownership structure in the period, it exhibited a slight decrease with 48.21% in 2000 and 43.33% in 2015.

Table 2. 1 Sector Structure, 2000-2015 (Unit: %)

	2000	2005	2010	2015
Total number of enterprises	36,069	106,616	279,360	442,485
SOEs *	15.50	3.83	1.17	0.64
Private firms**	88.58	92.70	96.23	96.66
Foreign-invested firms***	4.24	3.47	2.59	2.70
Share of total employment				
SOEs	61.71	33.53	17.21	10.67
Private firms	26.13	46.39	60.86	59.99
Foreign-invested firms	12.15	20.08	21.93	29.34
Share in GDP**				
SOEs	38.52	37.62	29.34	28.69
Private firms	48.21	47.22	42.96	43.33
Foreign-invested firms	13.27	15.16	15.15	18.07

Source: Constructed from GSO (2017).

Note: *State sector includes central state-owned and local state-owned enterprises
**Non-state sector includes the ownership of sole proprietors, limited liability, joint stock.
***Foreign-invested sector includes 100% percent foreign invested companies and joint ventures.
****The value is calculated at the current prices. There is also the share of products taxes less subsidies on production in GDP, but for analysis, it is excluded.

2.2 The possibility of the middle-income trap and the needs of innovation

However, despite the above impressive growth, there are some concerns with the stagnation in the growth rate, the low technological capabilities of manufacturing sector, for Vietnam's sustained growth.

First, in recent years, the Vietnamese economy has been slowing down. As observed in Figure 2.1 in Section 2.2, since 2008, the GDP growth rate has been slackened, with the average rate of nearly 6% per year. According to Tran (2013b), besides several historical events that account for this problem, this slowdown is partly due to the slow upgrading of industrial structure[12]. As described in Appendix 2 cited from Tran (2013b), the share of industrial products in total export values has risen to 64.5% in 2010, among which labor-intensive manufactures

[12] Tran (2013b) pointed out that there are three events that affecting this slackened down of Vietnam's economy. First, after the WTO accession in 2007, the sudden inflows of foreign capital brought about an expansion of the money supply, which led to a high inflation rate. Second, the establishment of state economic groups from 2006 has affected the direction of economic policies and distort the allocation of resources. Third, since Deputy Prime Minister Nguyen Tan Dung was promoted to prime minister in 2006, many pro-SOEs policies have been adopted which resulted in a high investment rate and a large debt.

such apparel, textiles accounted for 43.5%, while that of machinery was only 16.4%[13]. This share was much lower than that of the other Asian countries, for example, 70.5% for Philippines, 57.5% for Thailand, and 49.5% for China, in the same year, indicating a low value-added structure of industrial sector.

The concern of the researchers about this slowdown of economic growth in Vietnam has been spreading for the last decade, along with the concept of the middle income trap. The definition of the middle income trap was first introduced by Gill & Kharas (2007), which refers to the countries that have experienced rapid growth and reached the middle income level, but have not been able to develop further to become higher-income countries, based on the World Bank's classification on income level. Since then, this concept has attracted the attention of researchers on investigating the growth performance of emerging market economies, especially East Asian countries.

One of the most notable studies on explaining this phenomenon in East Asian countries is the study of Ohno (2009). Ohno (2009) defined the industrial catching up progress for a country to achieve economic growth as a five-stage model, and described the middle income trap in the East Asian countries as a "glass ceiling" between the second and the third stage[14]. Moreover, he argued that none of the ASEAN4 (Malaysia, Thailand, Indonesia, Philippines) has broken this invisible glass ceiling to move up the higher-level of economic growth, and suggested that the key requirements for this issue are the development of industrial human resources, supporting industries and logistics.

Kohli et al (2011) argued that the "failed industrial upgrading" is the major cause of the middle income trap, and defined the middle income trap as "a situation in which middle-income countries are unable to compete with low-income, low-wage economies in manufacturing exports and unable to compete with advanced economies in high skill innovation". In line with this view, in a study on the electronic sector in Penang, Malaysia, Yusuf & Nabeshima (2009)

[13] In his definition, "machinery" products include electric and electronic, automobiles, computers and other office machines, precision machines, and construction machinery.

[14] According to Ohno (2009), a country starts from stage 0 where the economic structure still fragile due to a war, political turmoil, and so on. In the stage 1, after such economic mismanagement is removed, the industrialization starts by the simple production of FDI firms such as manufacturing of garment, footwear, food processing and assembly of electronic parts. In the stage 2, the domestic supporting industries begins to develop, but still highly dependent on foreign technology and management. In the stage 3, the foreign dependency reduces and locals replace FDI in all areas of production. The country becomes an exporter of high-technological products. In stage 4, the country can create new products and lead the global markets through innovation.

concluded that weak industrial linkages and an insufficient innovation capacity may prevent the local government from upgrading and diversifying the economy. Supporting this view, Tran (2013a) analyzed the middle income trap for four ASEAN countries, comparing them against Korea, and recommended the enhancement of R&D capacity and productivity for advanced ASEAN member to avoid this issue.

In the context of Vietnam, this issue has consistently been made by Ohno (2009) and Tran (2013a, 2013b). They warned that although Vietnam is entering the lower-middle income category, however, if Vietnam fail to catch up with the higher level economies, the possibility of the middle income trap may become true. They pointed out that, there were several signs of this possibility. First is the stagnation of the economic growth as stated above. Second is the declining trend in the productivity growth since the middle of 1990s. From the calculation of Ohno (2009), from 1997, the contribution of total factor productivity to growth declined while the contribution of capital accumulation increased significantly. This trend indicates that the growth of Vietnam's economy has been increasingly input-driven with the limited contribution of technical improvement (Tran, 2013b).

Second, it is frequently stated that the technological capacity of Vietnam's manufacturing sector is in low level. In Vietnam, manufacturing sector plays an important role. Its role has been recognized in various aspects, such as contributing to output, employment. According to the report of GSO (2017), the number of manufacturing firms increased rapidly from 9,318 firms in 2000 to 67,490 firms in 2015, accounting for 15.25% of total firms in the economy. Moreover, manufacturing sector created 6.2 million jobs in 2015 (or 48.49% of total employment population). The gross output of the manufacturing sector increased from VND 243,809 billion (or 30.46% of total GDP) in 2000 to VND 5,838,045 billion (or 38,30% of GDP) in 2015.

However, in terms of technological capacities, manufacturing sector is characterized as small in size and low in technological level. Table 2.2 shows the number of manufacturing firms by firm size and technological level. The table shown that the majority of Vietnamese manufacturing firms are small firms (92.59% in 2015). Moreover, low-tech industries account the largest share of manufacturing sector, with 65.37% in 2000, and having a slight tendency of reduction with the share of 56.80% in 2015. This reflects the comparative advantage of Vietnam is in low tech industries, which are mainly labor-intensive, light manufacturing.

Medium and high-tech industries accounted only 30.52% and 12.68%, however, in comparison with 2000, there was an increase in the number of these two sectors.

Table 2. 2 Performance of manufacturing firms, 2000-2015

	2000	2005	2010	2015
Total number of firms	36,069	106,616	279,360	442,485
Numbers of manufacturing firms	9,318 (25.83%)	20,843 (19.55%)	45,472 (16.28%)	67,490 (15.25%)
By firm size				
Small (<200 employees)	81.56	85.95	91.01	92.59
Medium (200-299 employees)	5.28	3.91	2.70	2.19
Large (>300 employees)	13.16	10.14	6.28	5.22
By technological intensity				
Low-tech	65.37	59.24	8.65	56.80
Medium tech	21.47	26.81	29.22	30.52
High-tech	13.16	13.95	2.13	12.68

Source: Constructed from GSO (2017).

In short, in order to avoid the middle income trap and strengthen the competitive advantage, the building up for innovation capabilities and upgrading the technological capabilities are essential for Vietnamese manufacturing firms.

3. Overview of Vietnam's Innovation System

3.1 Evolution of Vietnam's Innovation System

In line with the economic transition, the innovation system has also undergone many changes as well. According to OECD (2014), the evolution of Vietnam's science, technology and innovation policy can be divided into five phases as below.

3.1.1 Pre-reform phase (1979-1986)

This period is the pre-economic reform phase. In this period, science and technology (S&T) was characterized by a strict top-down system of control and allocation of resources with a separation of R&D, production and educational activities. The most notable policy in this period was Decision 175/CP in 1981 which allowed the signing of contracts between R&D organizations with their partners. This decree was the first legal recognition of Vietnamese government on S&T activities, and it has laid the ground for the establishment of the innovation system in the latter phases (Irene et al, 1995).

3.1.2 Early "Doi Moi (Renovation)" phase (1987-1995)

In this early period of economic reform, the S&T policy framework of the Vietnamese government has been dramatically changed. The main reform of this phase is the decentralization of the state monopoly on S&T activities, which allowed the involvement of private R&D organizations on R&D contracts. This phase began on 31st August 1987 when the Ministers Council issued Decision 134/HDBT encouraging private R&D organizations to make R&D contracts with individuals and non-public organizations. After that, this process has been strengthened by the promulgation of the Decree and Law on Foreign Investment in Vietnam in 1987, which included the provisions on intellectual property rights, and encouraging the interests of foreign investors in technology transfer in Vietnam. Despite of these changes, the S&T system continued to emphasize on the governmental S&T organizations, with relatively strict administrative procedures unchanged (Irene et al., 1995).

3.1.3 Restructuring phase (1996-2002)

Several reforms on restructuring the governmental research organizations have been witnessed in this period. For example, Decision 782/TTg dated 24 October 1996 encouraged the development of private research institutions, by providing the regulations to turn research institutes to enterprises or other incentives for enterprises to set up their own universities and research institutes. It aimed to enhance the linkage between research-production-commercialization. As a consequence of this reform, in this period, the relations between research-production has begun to take shape and new innovation infrastructure were initiated (for example, the Hoa Lac high-technology park and later the Saigon high-technology park) (OECD, 2014). One of the most important policies that has been gained in this period is the first Law on Science and Technology was issued in 2000 which served as backbone for the innovation in the country. This law opened a new phase of the science and technology policy in the next period.

3.1.4 Integration phase (2003-2010)

After the introduction of Law on Science and Technology in 2000, in the following years, the government provided new legislation and regulations, new financing instruments, and new institutional arrangements and infrastructures, with the below two objectives.

First, to integrate the country's innovation system into the global system. It improved the Law on Intellectual Property Rights (IPR) in 2005, and again in 2009. Furthermore, it passed

the Law on Technology Transfer in 2006, defining the areas in which technology transfers are allowed and even encouraged. In the same year, the Law on Standards and Technical Regulation aligned relevant national norms with international standards. In 2010, Decree 80/2010/ND-CP was adopted, which aimed to facilitate foreign investors, firms and research institutes' investment in setting up R&D unit and subsidiaries in Vietnam.

Second, the improvement of public management and financing for science and technology was emphasized. Decree 115 in 2005 changed profoundly the funding mechanism of public R&D organizations. In 2006, the updated Law on Technology Transfer was approved by the National Assembly on November 29, 2006. The Law enables firms to extract a part of their pre-tax profit for establishing scientific and technological development fund and for supporting technology transfer. Together with this law, in 2008, National Assembly approved the Law on High Technology, which has set the legal framework for the involvement of foreign investors and high-technologies activities, ranging from manufacturing and production to education and training. In addition, series of laws have been enacted and have laid the essential foundations for the policy framework of Vietnam, such as Law on Product and Goods Quality in 2007, Law on Nuclear Energy in 2008.

3.1.5 Development phase (2011-present)

The most important reform in this period is the formulation of the Strategy for Science and Technology Development (2011-2020), in correspondence to the Socio-Economic Development Strategy (2011-2020). The general goals of this Strategy are to become a modern industrialized country by 2020 and stabilize the political community, improve people's lives, and achieve an advance status in the global market. This Strategy has raised some numeric goals such as, the ratio of high-tech products in the total GDP raises to 45%, the government' expenditure on S&T account for 2% in total budget in 2020[15].

Besides the reforms in the national innovation system, the government has attempted to increase financial incentives for firms' investment in innovation. These financial incentives include: (i) direct capital support, and (ii) indirect incentives (tax incentives, credit providing).

[15] See Appendix 3 for more details.

First, regarding direct capital support policies, there are a number of incentives embodied in the Law on Science and Technology from 18 June 2013. In accordance with the law, firms conducting innovative projects can receive the following incentives:

- Financial support of up to 30% of total investment if they implement projects which apply scientific and technological results to create new products or to increase productivity, product quality and product competitiveness.
- Support up to 50% of total investment for projects in disadvantage socio-economic regions.
- Support up to 50% of total investment costs for projects that carry out national level science and technology tasks in preferential areas.

In addition, in 2014, the government has established the National Technology Innovation Fund (NATIF) with the charter capital of VND1,000 billion, which aims to support firms in technological innovation and improvement, direct financial support for the scientific and technological research conducted by firms, foreign technology importation and hiring of experts for research. The objectives of the NATIF is to mainly support enterprises, organizations and individuals whose conduct innovation activities such as the applications of new technology, commercialization the results of scientific research and technological development to bring the market new products and services that have high technological content and high added value[16].

The development of Vietnam's innovation system is summarized through major legal documents as listed in Table 2.3.

[16] Cited from website of NATIF. http://natif.vn/en.html

Table 2. 3 Selected innovation policies, laws

Year	Legal documents
1981	• Decision No.175/CP dated 29 April 1981 of the Government Council on the Entering into and Carrying out of Economic Contracts in Scientific Research and Technically-Deploying Activities[17].
1987	• Decision No.134-HDBT dated 31 August 1987 of the Ministers Council on the Measures to Encourage Science and Technology[18]. • Law No. 04-HDNN8 of 29 December 1987, on Foreign Investment in Vietnam[19].
1996	• Decision No.782/TTg dated 24 October 1996 issued by Prime Minister on the Arrangement of S&T Research Institutes[20].
1998	• Decree No.45/1998/ND-CP dated 01 July1998 of the Government Stipulating in Detail the Technology Transfer[21]. • Decision No.54/1998/QD-TTg dated 03 March 1998 issuing the Regulations on Management of Technical-Economic Programs: Informatics Technology, Biological Technology, Materials Technology and Automatic Technology[22]. • Circular No.2345/1998/TT-BKHCNMT dated 4 December 1998 Providing Guidelines for Determination and Recognition of High-tech Industrial Enterprises Operating Under the Law on Foreign Investment in Vietnam[23].
1999	• Decision No.2265/1999/QD-BKHCNMT in December 30, 1999 Promulgating the Regulation on Democracy in the Activities of Scientific and Technological Agencies[24].

[17] Retrieved from website https://thuvienphapluat.vn/van-ban/Thuong-mai/Quyet-dinh-175-CP-ky-ket-thuc-hien-hop-dong-kinh-te-trong-nghien-cuu-khoa-hoc-trien-khai-ky-thuat-42467.aspx.
[18] Retrieved from website https://thuvienphapluat.vn/van-ban/Linh-vuc-khac/Quyet-dinh-134-HDBT-bien-phap-khuyen-khich-cong-tac-khoa-hoc-ky-thuat-37392.aspx.
[19] Retrieved from website https://vanbanphapluat.co/luat-dau-tu-nuoc-ngoai-tai-viet-nam-1987-4-hdnn8.
[20] Retrieved from website https://thuvienphapluat.vn/van-ban/Cong-nghe-thong-tin/Quyet-dinh-782-TTg-sap-xep-co-quan-nghien-cuu-Trien-khai-khoa-hoc-cong-nghe-40117.aspx.
[21] Retrieved from website https://thuvienphapluat.vn/van-ban/Thuong-mai/Nghi-dinh-45-1998-ND-CP-huong-dan-chuyen-giao-cong-nghe-41823.aspx.
[22] Retrieved from website https://thuvienphapluat.vn/van-ban/Cong-nghe-thong-tin/Quyet-dinh-54-1998-QD-TTg-Quy-che-Quan-ly-dieu-hanh-cac-Chuong-trinh-Ky-thuat-Kinh-te-Cong-nghe-thong-tin-sinh-hoc-vat-lieu-tu-dong-hoa-41524.aspx.
[23] Retrieved from website https://thuvienphapluat.vn/van-ban/Doanh-nghiep/Thong-tu-2345-1998-TT-BKHCNMT-huong-dan-xac-dinh-cong-nhan-doanh-nghiep-cong-nghiep-ky-thuat-cao-hoat-dong-luat-dau-tu-nuoc-ngoai-tai-Viet-Nam-44885.aspx.
[24] Retrieved from website https://thuvienphapluat.vn/van-ban/Bo-may-hanh-chinh/Quyet-dinh-2265-1999-QD-BKHCNMT-quy-che-dan-chu-hoat-dong-co-quan-khoa-hoc-va-cong-nghe-46088.aspx.

2000
- Law No.21/2000/QH10 of 9 June 2000, on Science and Technology[25].
- Decree No.06/2000/ND-CP dated 03 March 2000 of the Government on the Investment Cooperation with Foreign Countries in the domains of Medical Examination and Treatment, Education and Training, Scientific Research[26].
- Resolution No.07/2000/NQ-CP dated 05 June 2000 of the Government on the Building and Development of Software Industry in the period 2000-2005[27].

2003
- Decision No.272/2003/QD-TTg dated 31December 2003 of the Prime Minister on Strategic Development of Science and Technology Vietnam in 2010[28].

2005
- Decree No.115/2005/ND-CP dated 05 September 2005 of the Government Stipulating Mechanism of Autonomy, Self-responsibility of Public S&T Organizations[29].
- Law No.50/2005/QH11 of 29 November 2005 on Intellectual Property[30].

2006
- Law No.68/2006/QH11 of 29 June 2006 on Standards and Technical Regulations[31]
- Law No.80/2006/QH11 of 29 November 2006 on Technology Transfer[32].

2007
- Decision No.36/2007/QD-BTC dated 16 May 2007 of the Minister of Finance Promulgating the Regulation on Organization and Operation of Scientific and Technological Development Funds of Organizations, Individuals and Enterprises[33].
- Decree No.80/2007/ND-CP dated 19 May 2007 of the Government on Science and Technology Enterprises[34].

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[25] Retrieved from website https://vanbanphapluat.co/luat-khoa-hoc-va-cong-nghe-2000-21-2000-qh10.
[26] Retrieved from website https://thuvienphapluat.vn/van-ban/Dau-tu/Nghi-dinh-06-2000-ND-CP-hop-tac-dau-tu-voi-nuoc-ngoai-trong-linh-vuc-kham-chua-benh-giao-duc-dao-tao-nghien-cuu-khoa-hoc-46192.aspx.
[27] Retrieved from website https://thuvienphapluat.vn/van-ban/Cong-nghe-thong-tin/Nghi-quyet-07-2000-NQ-CP-xay-dung-va-phat-trien-cong-nghe-phan-mem-giai-doan-2000-2005-46428.aspx.
[28] Retrieved from website https://thuvienphapluat.vn/van-ban/Cong-nghe-thong-tin/Quyet-dinh-272-2003-QD-TTg-Chien-luoc-phat-trien-khoa-hoc-va-cong-nghe-Viet-Nam-den-nam-2010-52433.aspx.
[29] Retrieved from website https://luatvietnam.vn/khoa-hoc/nghi-dinh-115-2005-nd-cp-chinh-phu-17714-d1.html#noidung.
[30] Retrieved from website https://thuvienphapluat.vn/van-ban/So-huu-tri-tue/Luat-So-huu-tri-tue-2005-50-2005-QH11-7022.aspx.
[31] Retrieved from website https://thuvienphapluat.vn/van-ban/Linh-vuc-khac/Luat-Tieu-chuan-va-quy-chuan-ky-thuat-2006-68-2006-QH11-12979.aspx.
[32] Retrieved from website of National Office of Intellectual Property of Vietnam, MOST. http://www.noip.gov.vn/noip/resource.nsf/vwSelectImageResourceUrl/EBA50893159FE8D94725767C002105D7/$FILE/Luat%20Chuyengiao%20Congnghe%202006.pdf.
[33] Retrieved from website https://luatvietnam.vn/khoa-hoc/quyet-dinh-36-2007-qd-btc-bo-tai-chinh-30932-d1.html#noidung.
[34] Retrieved from website https://thuvienphapluat.vn/van-ban/Doanh-nghiep/Nghi-dinh-80-2007-ND-CP-doanh-nghiep-khoa-hoc-cong-nghe-20237.aspx.

	• Law No.05/2007/QH12 of 21 November 2007, on Product and Goods Quality[35]
2008	• Law No.18/2008/QH12 of 03 June 2008, on Nuclear Energy[36].
	• Law No.21/2008/QH12 of 13 November 2008, on High Technologies[37].
2010	• Decree No.80/2010/ND-CP dated 14 July 2010 of the Government Providing for Foreign Cooperation and Investment in Science and Technology[38].
2011	• Decision No.677/QD-TTg dated 10 May 2011 of the Prime Minister Approving the National Technology Innovation Program until 2020[39].
2012	• Decision No.418/QD-TTg dated 11 April 2012 of the Prime Minister Approving the Strategy for Science and Technology Development for the 2011-2020 period[40].
2013	• Law No.29/2013/QH13 of 18 June 2013 on Science and Technology[41].
2014	• Decision No.1069/QD-TTg dated 04 July 2014 of the Prime Minister Promulgating the Establishment of the International Technology Search and Transfer Program[42].
	• Inter-Ministerial Circular No.120/2014/TTLT-BTC-BKHCN dated 25 August 2014 of the Ministry of Finance and the Ministry of Science and Technology Promulgating the Establishment of the National Technology Innovation Fund[43].

Source: OECD (2014) and other sources.

[35] Retrieved from website https://thuvienphapluat.vn/van-ban/Thuong-mai/Luat-chat-luong-san-pham-hang-hoa-2007-05-2007-QH12-59776.aspx.
[36] Retrieved from website https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Luat-nang-luong-nguyen-tu-2008-18-2008-QH12-67115.aspx.
[37] Retrieved from website of MOST. https://www.most.gov.vn/vn/Pages/ChiTietVanBan.aspx?vID=28480&TypeVB=1.
[38] Retrieved from website https://luatvietnam.vn/dau-tu/nghi-dinh-80-2010-nd-cp-chinh-phu-53917-d1.html#noidung.
[39] Retrieved from website https://luatvietnam.vn/khoa-hoc/quyet-dinh-677-qd-ttg-thu-tuong-chinh-phu-61537-d1.html#noidung.
[40] Retrieved from website http://www.vusta.vn/vi/news/Dang-Nha-nuoc-va-TC-khac/Quyet-dinh-so-418-QD-TTg-ngay-11-4-2012-cua-Thu-tuong-Chinh-phu-ve-phe-duyet-chien-luoc-phat-trien-khoa-hoc-va-cong-nghe-giai-doan-2011-2020-44090.html.
[41] Retrieved from website of Vietnam government. http://vanban.chinhphu.vn/portal/page/portal/chinhphu/hethongvanban?class_id=1&mode=detail&document_id=169383.
[42] Retrieved from website https://thuvienphapluat.vn/van-ban/Dau-tu/Quyet-dinh-1069-QD-TTg-2014-tim-kiem-chuyen-giao-cong-nghe-nuoc-ngoai-den-2020-238303.aspx.
[43] Retrieved from website of MOST. https://www.most.gov.vn/vn/Pages/ChiTietVanBan.aspx?vID=28260&TypeVB=1.

3.2 Administrative Structure

In order to implement the above legal framework, Vietnam has a system of government bodies in charge of innovation activities, from the central level to the provincial level. There are three major governance layers: central level (headed by the State and the Government); the ministries and affiliated agencies level (headed by the ministries); provincial level (headed by provincial people's committees and specialized bodies).

The top level is the State and the Government (National Assembly (NA), Communist Party), which are in charge of approving national strategies and legislation for science and technology development and innovation. Under these two organizations, the Committee of Science, Technology and Environment (under NA) and Department of Education, Science, Technology and Environment (under the Government) are in charge of assisting these two organizations to make major decision on innovation issues in Vietnam. In addition, there are a few independent bodies of the Government, which can report directly to the Prime Minister, such as Vietnam Academy of Science and Technology (VAST).

Second level is the ministries and affiliated agencies, with the leading ministries are Ministry of Science and Technology (MOST), Ministry of Education and Training (MOET), Ministry of Planning and Investment (MPI) and Ministry of Finance (MOF). Among these ministries, MOST is the key actor which is mandated to conduct the general management of science and technology activities; to formulate the science and technology policies and incentive programs, and to monitor the implementation of science and technology strategy plans. Other actors include MPI and MOF which are responsible for formulating policies and incentives for promoting innovation in Vietnam, MOET is in charge of universities and colleges.

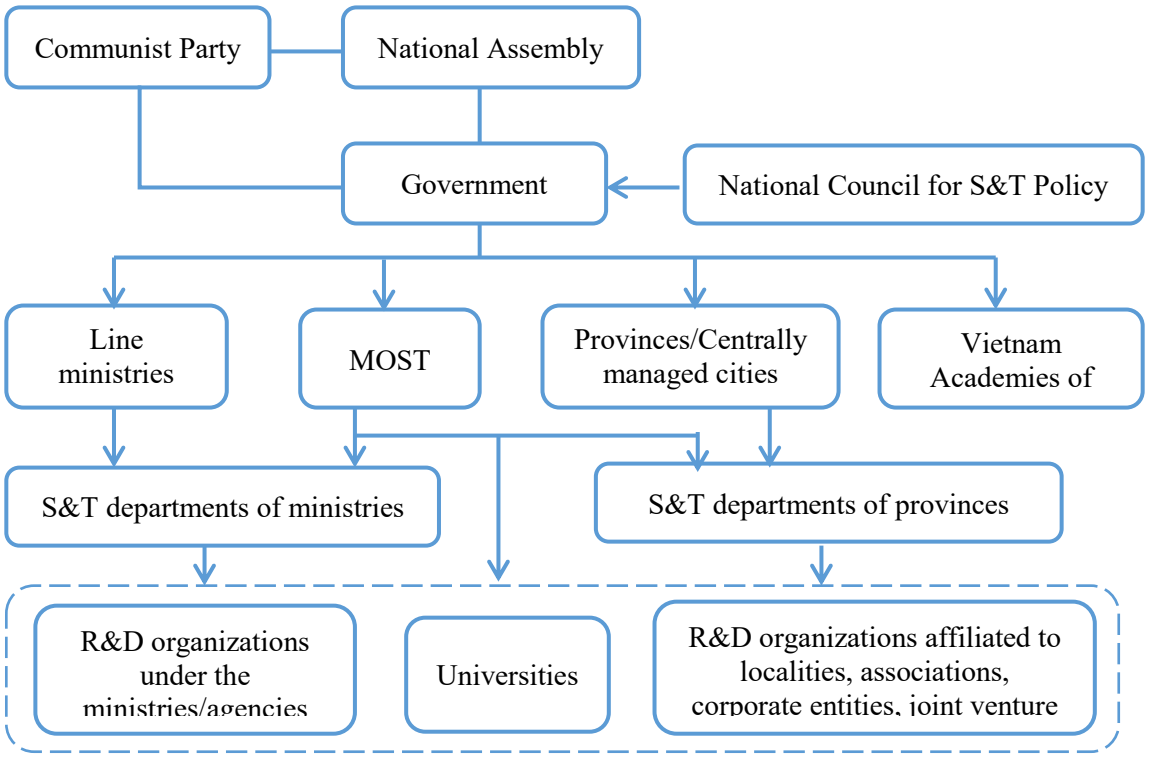
At the provincial level, Departments for Science and Technology (DOST) are in charge of overseeing their respective regional and local science and technology, innovation activities, under the direct supervision of MOST and Science and Technology offices within people's committee. These departments receive their budget allocation from MOST, except for the DOST in Ho Chi Minh city, which gets a local budget from the City Government.

Besides these administrative agencies, there is also a number of other agencies that support innovation and R&D activities. These agencies are the National Fund for Science and Technology Development, National Programs for Science and Technology Development, the State Agency for Technology Innovation (SATI), the National Foundation for Science and

Technology Development (NAFOSTED). These agencies are mostly publicly funded bodies and have administrative and policy implementation functions and support policy making.

The above management system can be visualized as presented in Figure 2.3.

Figure 2. 3. Institutional profile of Vietnam's S&T system



Source: OECD (2014).

4. Innovation Performance of Vietnam

There are a number of available indexes to assess a country's innovation performance. The most frequently used indexes in the literature are the Global Competitiveness Index (developed by the World Economic Forum), and Global Innovation Index (developed by the European Institute of Business and Administration [INSEAD]). Below I use the Global Innovation Index to assess Vietnam's innovation performance.

The Global Innovation Index (GII) has been published by the INSEAD since 2007. The index aims to capture a country's innovation capacities by providing the evaluation based on 79 indicators grouped into: (i) innovation input sub-index (including institutions, human capital and research, infrastructure, market and business sophistication), and (ii) innovation output sub-index (including scientific outputs and creative outputs). These indicators are assessed by different quantitative measures. For example, human capital and research are measured by

education and R&D related indices, business sophistication is measured by the innovation linkages and external knowledge acquisition during the implementation of innovation (intellectual property payment, high tech imports, FDI inflow, research talent).

To assess the innovation performance of Vietnam, I employ the latest report of GII published in 2018. Table 2.4 shows the GII rankings of Vietnam in 2018, in comparison with the other four Asian countries (Philippines, Thailand, Indonesia, Malaysia and China). According to the GII 2018, among these four countries, Philippines and Indonesia are classified as lower-middle income countries in the same group of Vietnam, while Thailand, Malaysia and China are in the group of upper-middle countries. Although in the GII report, there are seven groups of sub-indexes, however, for the purpose of analysis, this study focuses on the following sub-indexes: (i) input indicators (including human capital, R&D expenditure), (ii) firm activities (including R&D investment by firms, innovation linkages, external knowledge acquisition), and (iii) output indicators (patent application, knowledge impact).

Table 2. 4 Global Innovation Index Rankings in 2018 among five Asian countries

Indicators	Vietnam	Philippines	Indonesia	China	Malaysia	Thailand
GII rank 2018	**45**	**73**	**85**	**17**	**35**	**44**
Input Indicators						
Human capital	66	94	86	23	31	57
R&D expenditure	66 (0.4%)	97 (0.1%)	107 (0.1%)	14 (2.1%)	23 (1.3%)	53 (0.6%)
Firm activities						
Firms' investment in R&D	13 (58.1%)	46 (36.9%)	na	2 (76.1%)	23	6 (66.2%)
Linkage	88	93	44	58	47	86
Knowledge acquisition	25	32	50	12	19	28
Output Indicators						
Patent application	67	84	85	1	59	65
Knowledge impact	19	57	66	2	25	31

Source: Author's compilation from Global Innovation Index 2018 (Cornell University et al., 2018).

As shown in Table 2.4, of five countries, in the total 126 countries, the top ranked country with 17th position is China, followed by Malaysia (35th) and Thailand (44th). Vietnam ranked at 45th position, followed by Philippines (73th) and Indonesia (85th). The difference between the highest ranked country (China) and the lowest ranked country (Indonesia) in the group is large, namely 56. These results reveal the wide gaps in innovation performance between these countries.

For the case of Vietnam, 45th position is the highest ranking in the last ten years (65th in 2008)[44]. The results of sub-indexes show that Vietnam performed well in: (i) the investment of firms in R&D (measured by the gross expenditure on R&D financed by firms as a percentage of total gross domestic expenditure on R&D), and (ii) knowledge acquisition (intellectual property payments, high-tech imports, information and communication technology [ICT] services imports, FDI inflow and research talent in business enterprises). On the other hand, the results also suggest a low ranking of Vietnam in the sub-indexes of: (i) human capital (knowledge-intensive workforce), total expenditure in R&D, (ii) the linkages in innovation (the collaboration with university and research institutions, state of cluster development, foreign financing in R&D), and (iii) patent application. The report reflects the low level of government's budget on R&D, the lack of skilled workforce and linkage in innovation, which may constraint the improvement of innovation capabilities of Vietnam.

5. Conclusion

Vietnam offers an interesting case in the study of innovation in several aspects. The first aspect relates to the socio-economic features. Although Vietnam is still considered as lower-middle income country by the classification of WB, Vietnam's economy has achieved the most rapidly growth rate among the Southeast Asian countries with the average growth rate of 7.5% during the period 1990-2010. However, in the context of the declining trend in the growth rate and the low contribution of productivity, the building up for innovation capacities and upgrading the technological capabilities become increasingly important for Vietnamese manufacturing firms to avoid the middle income trap.

The second aspect relates to the innovation performance of Vietnam. In 2018, Vietnam is ranked at 45th position and performs well in the investment of firms in R&D and the external knowledge acquisition for innovation activities. However, despite these above positive features, Vietnam's performance on a number of global indices indicates that Vietnam's performance is still generally regarded as a poor performance. This performance relates to the low level of government's budget on R&D, the lack of skilled workforce and linkage in innovation. These problems indicate the constraints that Vietnamese firms are facing in implementing innovation.

[44] Vietnam's rankings in the last few years were 76th in 2012, 71st in 2014, 52nd in 2015, 59th in 2016, 47th in 2017.

Despite these constraints, the report also reveals that Vietnamese firms are attempting to conduct innovation.

In the following chapters, I investigate the determinants which affecting the innovation process as well as the relationship between innovation and productivity of Vietnamese manufacturing firms.

CHAPTER 3. DETERMINANTS OF INNOVATION: A PANEL ANALYSIS OF VIETNAMESE MANUFACTURING FIRMS, 2010-2013

1. Introduction

Since the economic reform known as "Doi Moi" (renovation) was introduced three decades ago, Vietnam has experienced an impressive economic performance. With the average annual growth rate of 7.5% in 1990-2010, Vietnam became one of the most rapidly growing economies among Southeast Asian countries. According to World Bank classification, Vietnam is now a lower-middle income country with an average per capita income of 2,170 USD in 2016. This economic growth has decreased poverty from 58% in 1993 to 5.8% in 2016 (Pimhidzai, 2018). However, to ensure the sustainable growth in the forthcoming years, further reforms are required, and Vietnam is now at its crossroads. As argued in Chapter 2, in the past ten years, the economic growth of Vietnam has slackened. Tran (2013b) pointed out that this slowdown is partly because of the inefficiency of investment and the slow upgrading of industrial structure. Against this context, concerns have been voiced that the Vietnamese economy may fail to catch up with the leading world economies, and may get stuck in the middle-income trap (Ohno, 2009; Tran, 2013b). This trend is a future possibility for Vietnam, but it is already a reality in some other Asian countries, such as Malaysia and Thailand (Ohno, 2009). In that context, the requirement of innovation becomes increasingly important to avoid this phenomenon and catch up with global technological frontiers.

Vietnamese government has been fully aware of the critical role of innovation. A broad range of policies have been promulgated with the aim of promoting technology and innovation of business enterprises[45]. Despite the importance of business enterprises building their national innovation capability, information about the Vietnamese firms' innovation activities is still scarce. Several empirical studies have investigated the patterns and determinants of innovation activities of Vietnamese firms (Nguyen et al, 2008; Phan, 2014; Nham, 2012; Vu & Doan, 2015). Generally, most studies tended to focus mainly on SMEs by using micro data from the

[45] In 2013, the Law on Science and Technology stipulates the financial support for technological innovation of firms in which firms can receive the financial support of up to 30% of total investment if they implement projects with the results to create new products, or to increase product quality, productivity. More recently, in 2014, the National Technology Innovation Fund was established which has a charter capital of VND 1 trillion from the state budget, with the goal of enhancing the innovation among Vietnamese firms (National Assembly, 2014).

Vietnam SMEs survey to depict firms' innovative activities. The results from this survey might be informative for the case of SMEs, however, since SMEs' innovation efforts are low and tends to be informal (Phan, 2014), it may underestimate the innovative behavior among Vietnamese manufacturing firms. Moreover, these studies merely focus on a limited set of factors, including firm size, firm age, without paying proper attention to the factors in industry and province level. Industry and province level factors, such as local innovation support policies are also important determinants that can provide the full picture of innovation activities in Vietnam (Tran, 2017).

In this study, I aim to address such gaps in the literature by examining the determinant factors of innovation propensity of Vietnamese firms. I then develop a model of firm innovation which combines firm, industry, and provincial characteristics to predict the key drivers of innovation in Vietnam and to give the implications for determining which policies are most likely to promote innovation for Vietnamese manufacturing firms. In oder to examine these factors, I combine the firm-level data of Vietnamese manufacturing firms for the period 2010-2013 and the province level data on the local government budget for firms' innovation in this period. The firm-level data consists of 25,848 firms which were drawn from the TCS. The survey contains measures of R&D activities and non-R&D activities (that is modification of existing technology), allowing me to consider two types of input in innovation. The survey also collected detailed information on export activities, industrial sector, and location of the firm, which enabled me to examine the role of the firm's characteristics as well as the role that technological intensity and region play in innovation.

The empirical results of this study can be summarized as follows. I found out that larger firms are more likely to innovate than smaller firms, which is consistent with the Schumpeter hypothesis. The similar results were also found in the exporting firms, the firms that having a higher proportion of qualified employees, activating in medium-high tech and high-tech industrial sectors, locating in urban location (Hanoi).

Interestingly, the study found a mixed effect of foreign ownership on innovation propensity. While the influence of wholly foreign owned firms is negative, the propensity to innovate is positively correlated with the joint venture ownership. This result contrasts with the findings observed in the other Asian countries, which supported the positive effect of wholly foreign owned firms. It indicates that Vietnamese foreign owned firms are less active in innovation

activities than the domestic private firms and confirm the role of joint venture firms in promoting innovation in Vietnam.

This study contributes to the empirical literature in a number of respects. Firstly, this study extends the existing studies which focus mainly on firm characteristics, by taking into consideration the industry and province level factors which are more likely to capture the nature of a firm's innovation effort in a developing country like Vietnam. Secondly, the data set includes a larger number of manufacturing firms enabling this study to generalize the findings to the whole manufacturing sector, and not limit it to any particular sector and/or limited regional coverage, which is often the case with the existing studies of determinants of innovation in developing countries.

This chapter is organized as follows: Section 2 is devoted to reviewing the theoretical background related to determinant factors of innovation and to propose a conceptual model that is applicable for predicting the innovative behavior of Vietnamese firms. Section 3 explains the data set and econometric model applied in this study. Section 4 introduces the methodology and estimated model while section 5 represents the empirical results. Finally, section 6 summarizes the main findings as well as suggestions for future research.

2. Literature Review on Determinants of Innovation and Hypotheses

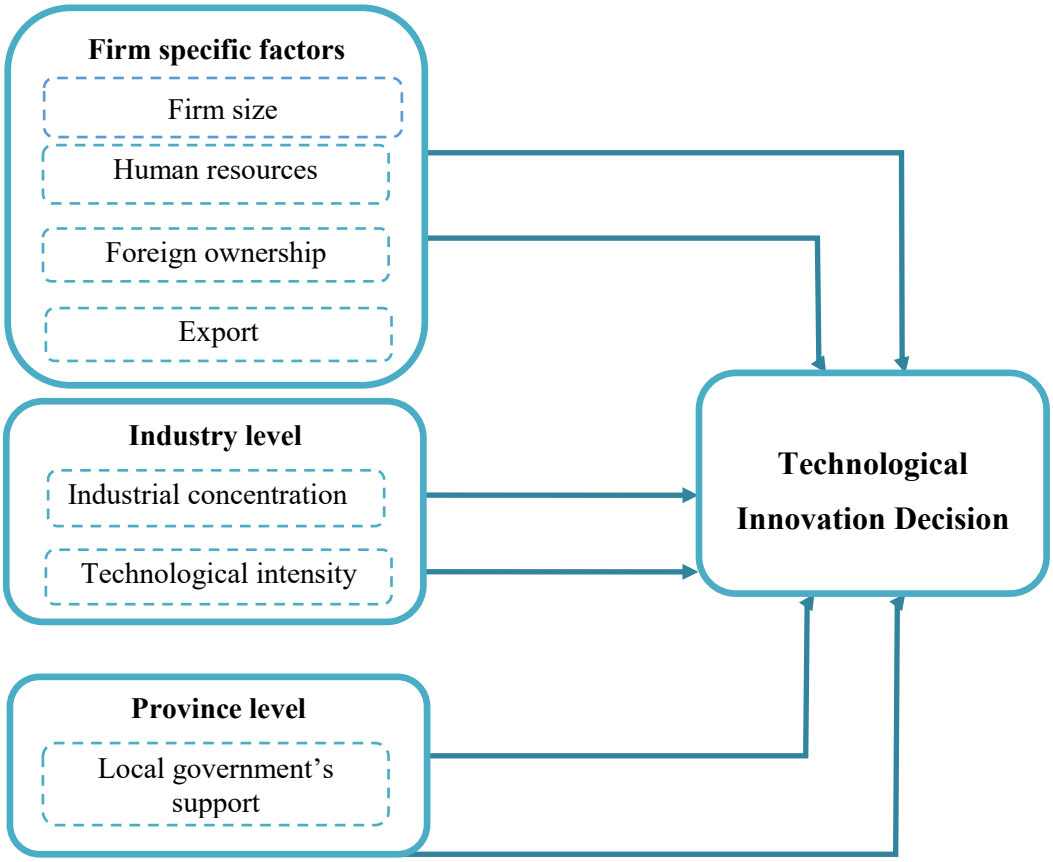
There are two streams of literature that address the determinants of innovation propensity at the firm level. The first stream is concerned with the 'technology push' effect, which emphasizes the key role of scientific and technological activities that the scientists play in developing innovation (Herstatt & Lettl, 2004). In the 'demand pull' model of innovation, contrary to the 'technology push' model, scholars distinguish between the sources of innovation in the technology domain and the innovation driven by the market demand (Burgelman & Sayles, 1986). These two models were applied in major studies from the 1960s through the 1980s with the purpose of explaining the technological change process of manufacturing firms in order to adapt with a turbulent economic environment in the period after the Second World War (Rothwell, 1994). However, the results of these studies are inconclusive and differ with regard to research objectives and construct definitions (Chidamber & Kon, 1994; Howells, 1997). Moreover, the applicability of these relatively old results to today's situation is questionable, because circumstances were different at the time (Nanja Strecker, 2009). As pointed out by Chidamber & Kon (1994, p.111) "The 1950s and 1960s […] were a period of

heavy investment in R&D, so innovation activity in the 1970s may have been skewed towards market-orientation incremental innovation" (as cited by Nanja Strecker, 2009).

The second stream of literature investigates the various contextual factors driving innovation propensity. Three groups of contextual factors are commonly distinguished: firm specific factors, industry-level, province level factors. This stream of literature is more recent with conceptual research and empirical studies starting in the early 1990s and is still under development (Nanja Strecker, 2009). This study follows this stream of research, with the aims to investigate the above three groups of innovation drivers: firm specific factors, industry level, and province level factors.

Based on this stream of literature, a model for technological innovation in Vietnamese manufacturing firms, using three levels of contextual factors: firm-industry-province framework was developed. The model proposes that three contextual factors affect technological innovation decisions made by Vietnamese firms. This model is depicted in Figure 3.1.

Figure 3. 1 Research model for the drivers of innovation in Vietnamese firms



Source: Author

In this model, the innovation decision is the dependent variable, and the independent variables are examined in the three contexts, which have been explained as below.

2.1 Firm specific factors

This group of factors includes: (i) size of firm, (ii) human resources, (iii) foreign ownership, (iv) exporting activity. In the literature, there are two traditional theories on the relationship between *firm size* and the probability of innovation. On the one hand, Schumpeterian theory (Schumpeter, 1942) claims that in the market structure where perfect competition between all the firms is more or less equally competitive, large firms have competitive advantages in undertaking innovation in comparison with small firms. These advantages are: First, innovation activities require large fixed costs that can be recovered only with a large volume of sales. Large firms with the advantage of size, higher technological capacities and profitability, have better access to internal financing as well as external financing to secure the expenditures for innovation. Second, larger firms tend to have established reputations and marketing channels, which enable these firms to take advantage of innovation through production and sales. Finally, larger firms can pay higher wages, therefore they can hire qualified workers more easily than smaller firms (Pamukcu, 2003).

On the other hand, this view of Schumpeter was contradicted by Acs & Audretsch (1988) who suggested that innovation is associated with large firms in a monopolistic market and concentrated industries with high barriers of entry, while small firms are more innovative in a competitive market. Supporting this view, Edmiston(2007) explained that small firms are thought to be more innovative than larger firms for three reasons: the lack of entrenched bureaucracy, more competitive markets and stronger incentives. The entrenched bureaucracy that characterizes large firms may cause subsequent communication inefficiency and inflexibility. To some extent, small firms operate in more competitive markets which stimulate them to innovate. Finally, as the ownership and management at the small firms is intertwined, personal rewards for potential innovators are higher than those at large firms (cited from Tran, 2017).

Similar to the contradictory nature of the theoretical arguments, empirical studies do not reach conclusive results regarding significance, even negative sign of this relationship. Majority of empirical studies show a positive relationship between R&D intensity and the firm's size (Scherer, 1990). However, there are studies which have found a negative (Acs & Audretsch, 1988) or an inverted U-shaped relationship (Aghion, et al, 2005; Zemplinerova, 2010).

The second component of firm specific factors is *human resources*, which are also frequently studied as an important factor determining innovation decisions. The effect of human resources on innovation is commonly explained by the resource-based view, which is developed by the path-breaking paper of Wernerfelt (1984). Resources based view implies that there exist differences that originated from the inherent resources of firms which determine their competitive advantage and performance (Wernerfelt, 1984; Barney, 1991; Peteraf, 1993). These resources are defined as those tangible and intangible assets, including physical resources (machinery, equipment, material), financial resources (cash balances, debts) and human resources (total workforce employed, skills of labors) (Barney, 1991). Of all these types of resources, human resources are perhaps the most important for adapting to the changing environment, access to new knowledge and continuous learning (Senge, 1990). In line with this view, Rothwell (1992) emphasized that success in innovation is people dependent rather than resource dependent, and it is the nature and quality of human resources that determines whether a firm can innovate or not. The high percentage of qualified employees facilitates the acquisition of new knowledge and skills (Cohen & Levinthal, 1990).

A third firm-level factor-*foreign ownership*- has attracted the attention from both researchers and policy makers, especially in developing countries. In principle, the firms that belong to an international group will have easier access to financial and human resources and information on marketing (Kumar & Aggarwal, 2005; Amara et al, 2008), thus they are expected to invest more in innovation, compared with the domestic firms. Furthermore, foreign invested firms are expected to be an effective channel to transfer technology from multinationals to local firms and to implement innovation due the former's superior technologies and management skills. Innovation may take place in these firms in order to adapt product specifications to local needs and to modify production technologies in order to take advantage of the relatively low cost of labor. Pack (1982) explained that innovation activities occur in foreign owned firms more frequently than in pure local firms because the local branch of foreign firms can get the information about new technologies from the headquarters of their foreign partners with a relatively low cost. This positive effect can be probable if the local partners have the motivation and the ability to learn from the technological competence of the foreign partner as argued by Dahlman et al (1987). However, if the local partner has weak technological capabilities and if the main motivation of the foreign firm is to gain access to the domestic market, joint ventures might not result in any innovation activity.

This effect has been found in the previous studies relating to the developing countries. In a study of 43 developing countries, Almeida & Fernandes (2008) reported that the foreign owned firms, which are categorized into majority and minority foreign-owned firms, tended to be more likely to adopt a new technology. Moreover, it was found that majority foreign-owned firms tended to be more innovative than minority foreign-owned firms and domestic firms.

European Bank for Reconstruction and Development (EBRD, 2014) reported that in transition economies, foreign-owned firms (defined as the firms where foreign investors hold a stake of 25% or more) are likely to have a higher level of spending on in-house R&D. They also reported that the percentage of foreign-owned firms that have introduced new products is significantly higher than the percentage of locally owned firms that have done so.

Finally, the fourth component - *exporting activity*-has attracted much attention from researchers. The impact of exporting on innovation is explained by the competition in the international market and learning-by exporting effect. It is believed that participation in exporting will push firms to innovate in order to gain market shares or remain competitive in the international market (Becheikh et al, 2006). Indeed, competition in the international market is fiercer than that in the domestic market, forcing the firms engaging in exporting to invest in innovation activities (Janz, et al 2004)..

Moreover, by exporting, firms can learn about new technologies or products through their interaction with foreign partners (Almeida & Fernandes, 2008). This effect has been reported in several studies. For instance, Bernard & Jensen (1997), Baldwin & Gu, (2004), and Iacovone & Javorcik (2012), who found evidence from micro data sets that exporting is correlated with firm investment in R&D or adoption of new technology that can also affect productivity. Braga & Willmore (1991) and Alvarez & Robertson, (2004) reported that, for Brazilian and Chilean firms, exporting firms invest more in R&D.

Overall, I propose the following hypotheses:

Hypothesis 1.1: *The larger the firm size, the higher the propensity of innovation.*

Hypothesis 1.2: *Firms with higher proportion of qualified human resources have higher innovation propensity*

Hypothesis 1.3: *Firms with foreign ownership have higher innovation propensity.*

Hypothesis 1.4: *Firms that participate in exporting have higher innovation propensity.*

2.2 Industry-level factors

In the literature, the industry level factors that have been frequently analyzed by scholars are the industrial competition and technological intensity of the sector (Kraft, 1989; Van Dijk et al, 1997). There are two opposite point of views on the effect of industrial competition on innovation propensity. The first view is based on the Schumpeter hypothesis which postulates the positive effect of competition on firm innovation. Schumpeter (1942) argued that in a concentrated industry, large firms have more incentive and advantages for innovation (R&D). According to Schumpeter (1942), industrial competition motivates innovation by restricting competitive initiative and enhancing profitability, which in turn provides the incentives for large firms in investing R&D. Supporting the view of Schumpeter, Aghion et al (2005) demonstrated that, there are two advantages for large firms in concentrated industry to invest in R&D. First, the development of innovation allows a firm to differentiate its products and achieve lower production costs, which can reduce the level of competition and the reduction of production costs can stimulate the firm to increase its output, causing competitors to react and lower their output (Anna, 2017). Second, large firms in concentrated industry may be able to preserve their market power by innovating to deter the entry of competitors.

In contrary to the Schumpeter's view, Arrow (1962) argued that firms operating in a competitive market have greater incentive to invest in R&D and innovation than a monopolist firm, as "the pre-invention monopoly power acts as a strong disincentive to further innovation" (Arrow, 1962). Therefore, under the view of Arrow (1962), the larger monopolist firms are, the less incentive they have to innovate. In line with his view, Blundell et al (1999) found that in developed countries, as the degree of industrial competition increase, the rate of innovation decrease.

Technological intensity of the industrial sector is also important factor of innovation. Brouwer & Kleinknecht (1996) found that high-tech manufacturing firms tend to have a higher propensity to innovate than firms in other sectors. Arundel & Kabla (1998) argued that the low-tech sector, such as food, tobacco, petroleum refining, and the basic metal industries, mostly conduct informal R&D. On the other hand, Huergo & Jaumandreu (2004) proved that the firms that produce metal products or motor vehicles with medium technological intensity have a distinctly above-average propensity to introduce products and process innovation.

Based on the above literature, I present the following hypotheses:

Hypothesis 1.5 *Industrial competition has a positive relationship with innovation propensity.*

Hypothesis 1.6 *Firms in higher technological industries are more likely to innovate.*

2.3 Province level factors

The findings from the literature suggest that, in most cases, a firm's innovation could depend on external resources, not only internal financial or human resources as stated above (Fagerberg et al, 2006). Previous studies generally include the region dummies to control for heterogeneity of location in determining a firm's innovative behavior, in order to capture the regional differences in detail (Shi & Wu, 2017). The urban hierarchy hypothesis asserts that firms located in urban areas may have a higher performance, productivity, and innovation than their rural counterparts (Roper, 2001). This stresses the informational and resource advantages of urban location for innovation. As the main advantages of urban or metropolitan locations are industrial concentration (measured by the percentage of the employees in manufacturing), agglomeration (measured by population density per km^2), and labor quality (measured by the percentage in technical and professional occupations), the firms located in these areas are predicted to assimilate knowledge and information more easily than the firms in rural areas (Roper, 2001), as cited in (Tran, 2017).

In addition, the role of local government is considered as one of the key actors in a regional innovation system (Kang & Park, 2012; Lundvall, 2010). The regional innovation system approach allows government intervention in the form of industry policies such that resources are effectively allocated to foster innovation (Shi & Wu, 2017). In the empirical studies, the local government's subsidies on R&D projects, R&D tax policies have been widely discussed (Mansfield, 1986; González & Pazó, 2008; Carboni, 2011; Czarnitzki et al., 2011). The findings from these studies reveal that the attitude of local governments probably play an important role in a firm's innovative behavior.

In sum, I propose the hypothesis for province level factors as follows:

Hypothesis 1.7 *There is a positive relationship between local government's innovation support and innovation propensity.*

3. Data and Econometric Model

3.1 Data source

This study uses a panel data set which is drawn from the TCS in the period 2010-2013[46]. The surveys are based on a survey module incorporated into the VES[47], and they have been conducted yearly since 2009. The survey was designed by the CIEM, and the DERG of the University of Copenhagen, with a focus on collecting data relating to competitiveness and technology issues of Vietnamese manufacturing firms. Particularly, the TCS questionnaires include the following information:

- General information on firms: tax code, name, location (63 provinces and cities), industrial sector, type of ownership, total number of employees, major products/services, total assets, revenue.
- Characteristics of currently used technology/production machinery and equipment
- Relationship with suppliers and customers
- Innovation activities
- Competitors
- Corporate social responsibility (CSR)

As an additional module of the GSO's national enterprise survey, the TCS series adopts the sampling approach for the registered firms with at least 10 employees (except for Hanoi and Ho Chi Minh City, the minimum cut-off is 30), with the focus on non-state owned manufacturing firms. There are three types of firms in terms of ownership in the survey, namely (i) SOEs, (ii) private firms, and (iii) foreign firms. According to the definition of GSO, SOEs are defined as the firms in which the state owns more than 50% of charter capital (either at central or provincial level). Private firms may be owned cooperatively or privately by one owner or shared with an individual group or shared with the government when the capital proportion is equal to or less than 50% of registered capital (Vu, 2014). Foreign firms have

[46] The latest survey was conducted in 2014, however, we use data for only the period 2010-2013 due to the lack of information on the main variables of interest in this year, e.g the intensity of R&D and non-R&D related innovation activities, competition etc.

[47] The VES is a census survey of Vietnam's enterprises in all economic sectors that are formally registered with provincial authorities, and it has been conducted yearly by the GSO of Vietnam since 2000.

capital directly invested by foreign investors, regardless of any percentage share of capital, which includes wholly foreign owned firms and joint venture firms (Vu,2014). In this study, I mainly focus on private and foreign firms because of the low number of state firms in the dataset.

In addition, the survey contains the information of the number of employees, which enables this study to take into account the effect of firm size. This study adopts the definition of firm size stated by the Vietnam Government in Decree No.59/2009/ND-CP: firms with fewer than 10 employees are defined as micro firms, those with 11-200 are defined as small firms, while those with 201-300 employees are defined as medium-sized firms and more than 301 are seen as large firms. It is important to note that, in this study, micro firms with fewer than 10 employees are also considered small firms, because it is assumed that micro firms, especially in the manufacturing sector, do not engage in significant innovation activities.

Finally, the survey uses the Vietnam Standard Industrial Classification (VSIC) at the four-digit industry level to identify the industrial sector. Based on the most common categorization of technological levels by OECD, this study classifies the sample firms into four groups: (i) low tech, (ii) medium-low tech, (iii) medium high tech, (iv) high tech industrial sectors. Low tech industry includes food products and beverages (VSIC code 10, 11), tobacco products (VSIC code 12), textile (VSIC code 13), wearing apparel (VSIC code 14), leather and related products (VSIC code 15), wood and wood products (VSIC code 16), paper and paper products (VSIC code 17), printing and reproduction of recorded media (VSIC code 18), furniture and other products are not classified elsewhere (VSIC code 31, 32). These sectors are characterized as labor-intensive and use relatively simple technologies, with R&D tend to be low and limited innovation (Vu, 2014).

Medium-low industry includes coke and refined petroleum products and nuclear fuel (VSIC code 19), rubber and plastics products (VSIC code 22), other non-metallic mineral products (VSIC code 23), basic metals (VSIC code 24), fabricated metal products, except machinery and equipment (VSIC code 25). Medium-high industry includes chemicals and chemical products (VSIC code 20), computer, electronic and optical products (VSIC code 26), machinery and equipment (VSIC code 28), motor vehicles and other transport equipment (VSIC code 29, 30). These industries require sophisticated technologies and a highly skilled workforce, especially in the development of new products as well as a long process of learning, innovation and the continuous improvement of technology and production process (Vu, 2014).

High-tech industry includes pharmaceuticals, medicinal chemical and botanical products (VSIC code 21), and electrical equipment (VSIC code 27). These industries require advanced capabilities in technology and innovation and imposes significant risks on investors.

Furthermore, as the survey provides the information about the location of firms, I classify 63 provinces and cities into eight separate regions, which include Red River Delta, North East, North West, North Central, South Central, Central Highlands, South East, Mekong River Delta. In Vietnam, economic activity is concentrated in specific areas of the North and South, especially in the Red River Delta and South East where two big cities, Hanoi and Ho Chi Minh City, are located.

The survey has several inherent advantages for analyzing technological innovation. First, it is a unique dataset about the innovation activities of Vietnam, which can provide the necessary information on whether the firm recently conducted R&D activities, innovation expenditure as well as the business performance. Second, as mentioned above, this survey is a large dataset which includes the sample of all registered manufacturing firms with 10 employees or more, covers all the major manufacturing sectors. Third, most importantly, the survey is implemented in the same cross-section of firms in each survey year, generating a panel dataset that enables this study to investigate the dynamic of innovation activities within individual firms over time. Next, the process of data cleaning and construction of the sample will be presented.

3.2 Sample Selection

In the period 2009-2014, there are 43,516 observations with an average number of 7,252 firms per year in the survey. Ideally, all observations should be used in the empirical analysis. However, the investigation of the data from TCS 2009 and 2014 suggests that there will not be sufficient information to construct the necessary variables for the empirical analysis in this study. Therefore, this study adopts the period 2010-2013, with a total number of 30,774 observations for the analysis.

In order to construct a panel dataset, this study uses tax codes as key information to identify the surveyed firms. In Vietnam, a unique tax code is provided to each firm by the Provincial Department of Finance, therefore, this is useful information to identify firms.

Furthermore, to collect the sample, the dataset was cleaned to exclude those firms with duplicate or missing information. Consequently, I dropped 4,926 observations for: (i) missing

information and/or duplicate tax code (2,414 observations), (ii) missing information in all the available variables (2,512 observations).

After cleaning data, I obtained a comprehensive sample of 25,848 observations covering the period 2010-2013. Besides using this database, for the purpose of analysis, the study also uses the provincial expenditure on scientific and technological activities which was drawn from the Vietnam Province Statistical Yearbook for 63 provinces from the home page of the Ministry of Finance.

3.3 Comparison with the VES Population

The difference between the number of manufacturing firms in my sample and the population of manufacturing firms is negligible. I compared the sampled firms in this study with that in the GSO's national enterprise survey based on numbers of identified information. The comparison of the sampled firms with the VES population is shown in Table 3.1. Based on the population provided in the data, the total number of sample firms is 25,848 firms, representing 16.22% of Vietnam's manufacturing firms in VES (159,352 firms). In the sub-group of firm size, small-sized firms account for 78.70% of the sample as compared to 65.36% of the total population of the VES, followed by large firms (14.96% and 33.03%, respectively). This means that small-sized firms are larger in the sample at 13.34%. This can be explained by the difference in the definition of firm size of this study with that of the VES[48]. According to the VES, small firms are defined as the firms having the workforce at a total number of less than 50 employees.

The sub-group of industrial sector also takes a somewhat similar share in the total in each sector category, with the majority in the low and medium-low tech industry (85.55%, 88.35%, respectively), and a little bit smaller for the medium-high tech industry (1.75% and 9.12%, respectively). In the ownership structure, the proportion of private firms in the sample is smaller than the population (76.39% in the sample and 93.76% in the population), while that of foreign owned firms is larger than the population (23.28% and 3.43%, respectively). These differences might be the result of the data cleaning process and the low number of state-owned firms in the survey.

[48] The VES uses the current definition of World Bank on the size of firm. As this study focuses on Vietnam's manufacturing firms, the definition of Vietnam's government is employed.

Overall, the investigation of data suggests that this sample are different with the total sample of the VES in terms of the larger share of small-sized and private firms. In the next section, I present the specifications on the estimated model and constructs of variables.

Table 3. 1 Comparison of the sample and VES population, 2010-2013

	Sample		VES Population*	
	Number of firms	%	Number of firms	%
Total	**25,848**		**159,352**	
of which:				
Firm size				
Small	20,343	78.70	104,154	65.36
Medium	1,637	6.33	2,568	1.61
Large	3,868	14.96	52,630	33.03
Industry				
Low-tech	13,795	53.37	92,105	57.8
Medium-low	8,317	32.18	48,688	30.55
Medium-high	2,778	1.75	14,529	9.12
High-tech	958	3.71	4,030	2.53
Ownership				
SOE	87	0.33	4,483	2.81
Private	19,744	76.39	149,406	93.76
Foreign	6,017	23.28	5,461	3.43

* VES Population= Number of manufacturing firms in the Vietnam Enterprise Survey
Source: Author's computations based on the VES and TCS survey in 2010-2013.

4. Empirical Methodology and Estimated Model

4.1 Methodology and Econometric Model

The methodology of this chapter had two stages: first, I tried to identify the actual situation of innovation in Vietnamese manufacturing firms in the survey period; second, I analyzed the determinant factors that affect the innovation propensity of Vietnamese manufacturing firms by conducting regression analysis.

As mentioned above, this study uses three sets of explanatory variables re considered, i.e. firm-industry-province level factors. In order to study if the above factors determine a firm's innovation propensity, I follow the conventional practice of using a Probit model with marginal effect, with the following model:

$$Y_{it}^{*} = \beta_0 + \beta_1(\textit{Firm level factors}) + \beta_3(\textit{Industry level factors}) + \beta_3(\textit{Province level factors}) + \varepsilon_i \quad (1)$$

where

$y_i=1$ if $y_i^*>0$ i.e. firm *i* innovates (2)

$y_i=0$ if $y_i^* \leqslant 0$ otherwise (firm did not innovate)

Here, y_i^* is a latent dependent variable for innovation decision, which is equal to 1 if the firms engage in innovation activities, or equal to 0 if the firm does not. Three groups of independent variables reflect firm-industry-regional context respectively. Table 3.2 lists all of these variables used. According to this table, I postulate that the probability of innovation is influenced by the following factors:

a. **Firm specific factors** include: firm size, human resources, ownership, and exporting. Firm size is measured by the dummy variable of small (SMALL), medium (MEDIUM) and large firms (LARGE), where small firms acts as the reference category. Human resources (LABORSKILL) is measured by the share of the labor force with higher education background. Ownership structure is measured by the dummies to represent private owned firms (PRIVATE), wholly foreign-owned firms (FOREIGN) and joint venture (JOINTVENT), where private firms are used as the reference category[49]. In addition, this study considers the difference in innovation pattern between firms participating in exporting and their counterparts, which are selling products domestically or exporting indirectly. The participation in exporting (EXPORT) is measured by a dummy variable taking on the value of 1 when a firm exports, and of zero when it does not.

b. **Industry level factors** include industrial competition, technological intensity. Industrial competition (at the 2-digit VSIC level) is measured by the standard Herfindahl-Hirschman Index (HHI), based on the sample of 213,313 manufacturing firms from the Vietnam Enterprise Survey conducted by GSO. This index can be calculated as follows:

$$\text{HHI} = \sum_{i=1}^{m} \left(\frac{Domestic\ sales\ of\ firm}{Total\ sales\ of\ industry} \right)^2$$

[49] As explained in section 4.1 and 4.2, in this survey, the number of SOEs engaged in innovation is only 0.3%, therefore the variable representing the SOEs has been excluded.

This index takes value between 0 (perfect competition) and 1 (monopolistic industrial concentration). It means that the higher the value of this measure, the more concentrated the industry sector.

Technological levels of industry which is based on the OECD classification. They are dummies to represent low technology (LOW), medium-low technology (MEDIUMLOW), medium-high technology (MEDIUMHIGH), and high technology (HIGH), where low and medium-low technology levels acts as the reference category.

c. **Province level factors** include local government support (PRO_SUP), defined as the ratio of the province's expenditure on science and technology over the general budget spending of local finance, which is drawn from the website of Vietnam's Ministry of Finance.

d. **Control variables**: location dummies of Hanoi (HANOI) and Ho Chi Minh City (Hochiminh) are included to control for the potential heterogeneity.

Table 3. 2. Description of variables

Dependent variables	Description
INNO	Dummy for R&D innovation and non-R&D innovation
Independent variables	
Firm level factors	
MEDIUM	Dummy for medium firms (201-300 employees)
LARGE	Dummy for large firms (more than 301 employees)
FOREIGN	Dummy for wholly foreign owned firms
JOINTVENT	Dummy for joint venture firms
EXPORT	Dummy for export activities
LABORSKILL	The percentage of qualified workforce
Industry level factors	
HHI	Herfindahl-Hirschman Index for industrial competition
MEDIUMHIGH	Dummy for medium high technological industry
HIGHTECH	Dummy for high technological industry
Province level factors	
PRO_SUP	Percentage of the province's expenditure on science and technology over the general budget spending of local finance
Controlled variables	
HANOI	Dummy for firm's location in Hanoi
HOCHIMINH	Dummy for firm's location in Ho Chi Minh City

4.2 Descriptive Statistics

The summary of the statistics for the sample and correlation matrix of the variables are presented in Table 3.3. As shown in the table, about 12.4% of the surveyed firms are involved in innovation activities, and around 36% of the firms are exporters. Regarding the correlation matrix, Table 3.3 shows that most of the correlations are statistically significant. Basically, these descriptive statistics are consistent with what has been found for firms' innovation in the literature.

Table 3. 3. Summary of statistics

	Obs	Mean	Std. Dev.	Min	Max	inno	medium	large	laborskill	Dexport	FDI	jointvent	HHI	medium high	hightech	pro_sup	Hanoi	Hochiminh
Dependent variable																		
inno	25848	0.124	0.330	0	1	1												
Independent variables																		
Firm-level factors																		
medium	25848	0.063	0.244	0	1	0.048	1											
large	25848	0.150	0.357	0	1	0.070	-0.109	1										
laborskill	25848	38.19	29.63	0	100	0.059	0.002	0.008	1									
FDI	25848	0.233	0.423	0	1	0.005	0.097	0.316	-0.017	1								
jointvent	25848	0.023	0.149	0	1	0.045	0.058	0.047	0.047	0.277	1							
DExport	25848	0.364	0.481	0	1	0.041	0.145	0.402	-0.047	0.494	0.085	1						
Industry-level factors																		
HHI	25848	0.135	0.134	0	1	0.008	0.014	0.037	0.018	0.043	0.009	0.040	1					
mediumhigh	25848	0.107	0.310	0	1	0.047	0.004	-0.014	0.074	0.133	0.036	0.003	0.179	1				
hightech	25848	0.037	0.189	0	1	0.067	0.041	0.022	0.063	0.059	0.028	0.027	0.205	-0.068	1			
Region-level factors																		
pro_sup	25848	0.307	0.106	0.1	0.9	0.009	0.019	0.053	0.030	0.057	0.035	0.062	0.006	0.034	0.026	1		
Control variables																		
Hanoi	25848	0.117	0.321	0	1	0.054	-0.008	-0.071	0.126	-0.094	0.011	-0.116	-0.012	0.056	0.074	-0.031	1	
Hochiminh	25848	0.155	0.361	0	1	-0.006	0.016	0.020	0.043	0.015	0.047	0.114	0.012	0.012	0.051	0.257	-0.156	1

Regarding the share of innovative firms, table 3.4 shows that the firms engaging in innovation activities was 12.43%, among which, there were 5.23% of the total number of firms that engaged in intramural R&D, 0.8% that collaborated with the other institutes or firms to conduct extramural R&D, and 5.85% that innovated in terms of modification of an existing technology. This percentage is at quite a low level in developing countries. For example, in a study of innovative behavior of 43 developing countries, Almeida & Fernandes (2008) reported that 56% of firms engaged in technological innovation and 48% of firms having conducted R&D activities.

This low value may be explained by the weakness of Vietnamese firms' internal technological capabilities and other factors that constrain innovation activities of Vietnamese firms, such as the inadequacy of financial incentive schemes for R&D activities or the lack of linkage between science and business sectors, as pointed out by (OECD, 2014; Phan, 2014; Tran, 2017).

Regarding ownership, Table 3.4 also shows that the most innovative firms in Vietnam are privately owned firms at 9.38% and being the most engaged in R&D activities (6.7%). The rate of firms with foreign ownership that engage in innovation was 2.96%. As expected, SOEs do not engage in innovation activities (0.11%). This figure indicates that privately owned firms are the most innovative sector in Vietnam, while the expected effect of foreign invested firms as a major channel for innovation may be overestimated. For SOE, this number can be explained by their monopolistic nature, which led to weak or even absence of competition, which in turn discourages innovation (Tran, 2017).

For the number of innovative firms by industrial sector and technological intensity in this survey, the firms in low and medium-low technological sectors, with the majority in the total number of firms, are more likely to innovate compared with medium-high and high technological industries. This tendency can be true in the case of Vietnam because low technological industries, with their unsophisticated products such as food or garments may be easier to innovate (Vu et al, 2017).

Table 3. 4. Innovative behavior of Vietnamese manufacturing firms

	Observations	% of firms	Innovative firms (%)	R&D-based innovation				Non R&D
				Intramural R&D	Extramural R&D	Both of R&D	Subtotal	Modification
	25,848	**100**	**12.43**	**5.23**	**0.80**	**2.71**	**8.80**	**5.85**
Firm size								
Small	12,307	47.61	4.25	1.77	0.26	0.75	2.82	2.10
Medium	9,673	37.42	5.50	2.28	0.40	1.29	3.98	2.52
Large	3,868	14.96	2.68	1.18	0.14	0.67	2.00	1.23
Ownership								
SOE	87	0.34	0.11	0.05	0	0.03	0.09	0.06
Private	19,744	76.39	9.38	3.98	0.6	2.09	6.7	4.42
FDI	6,017	23.28	2.96	1.21	0.2	0.6	2.01	1.37
Industry								
Low tech	13,795	53.37	5.72	2.11	0.36	1.22	3.7	2.98
Medium-low	8,317	32.18	4.03	1.7	0.26	0.94	2.91	1.89
Medium-high	2,778	10.75	1.82	0.94	0.09	0.4	1.44	0.68
High tech	958	3.71	0.88	0.49	0.09	0.16	0.74	0.3
Region								
Red River Delta	8,499	32.88	4.35	1.97	0.29	1.09	3.37	1.81
Northeast	1,018	3.94	0.65	0.31	0.05	0.1	0.45	0.34
Northwest	108	0.42	0.05	0.02	-	0.02	0.04	0.03
North Central	1,596	6.17	0.82	0.27	0.02	0.18	0.47	0.51
South Central Coast	1,488	5.76	0.61	0.21	0.05	0.09	0.35	0.37
Central Highlands	124	0.48	0.05	0.01	-	0	0.02	0.04
Southeast	10,153	39.28	4.46	1.84	0.29	0.97	3.11	2.05
Mekong River Delta	2,862	11.07	1.47	0.62	0.09	0.28	0.99	0.71

Source: Constructed from the TCS in 2010-2013.

5. Empirical Results

Based on above-mentioned research model, the estimation results using the described sample are reported in Table 3.5. Overall, the results from the data analysis are in line with what were found in the literature that the innovation decision is subject to the different contextual factors in firm-, industry-, and province-level. The results of each model will be presented below.

Table 3. 5. Empirical results

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3
medium	0.065***	0.063***	0.0629***
	(0.007)	(0.007)	(0.007)
large	0.065***	0.066***	0.066***
	(0.006)	(0.006)	(0.006)
laborskill	0.000***	0.000***	0.000***
	(6.77e-05)	(6.76e-05)	(6.76e-05)
FDI	-0.034***	-0.043***	-0.043***
	(0.005)	(0.006)	(0.006)
jointvent	0.080***	0.081***	0.081***
	(0.012)	(0.012)	(0.012)
DExport	0.020***	0.023***	0.023***
	(0.005)	(0.005)	(0.005)
HHI		-0.008	-0.008
		(0.060)	(0.060)
mediumhigh		0.045***	0.045***
		(0.007)	(0.007)
hightech		0.083***	0.083***
		(0.009)	(0.009)
pro_sup			0.018
			(0.019)
Hanoi	0.045***	0.037***	0.037***
	(0.006)	(0.006)	(0.006)
Hochiminh	-0.009	-0.014**	-0.015**
	(0.005)	(0.005)	(0.005)
2011.year	-0.023***	-0.022***	-0.022***
	(0.006)	(0.006)	(0.006)
2012.year	-0.072***	-0.071***	-0.071***
	(0.005)	(0.005)	(0.005)
2013.year	-0.068***	-0.067***	-0.067***
	(0.005)	(0.005)	(0.005)
Observations	25,848	25,848	25,848

Source: Author's calculations using data from the TCS.

Note: The dependent variable is technological innovation. The table reports the marginal effects (at mean values) on the firm's propensity to innovate from Probit regressions. *, **, *** indicate significance at 10%, 5% and 1% confidence levels, respectively.

Group 1: Firm specific factors

Firm size

The coefficients for MEDIUM and LARGE were positive and statistically significant at 1%, suggesting that compared to small firms, medium-sized and large firms are more likely to innovate. The marginal effects revealed that for the medium and large sized firms, the predicted probability of innovation increases by 6.5%[50], holding other factors at their mean values. This result strongly supports the Schumpeter hypothesis that large firms are more innovative than small ones. Thus, the hypothesis "*The larger firm size, the higher the propensity of innovation"* was verified.

Labor skill

The coefficient for the labor skill variable was positive and statistically significant at the 1% level, indicating that firms with a higher qualified workforce[51] are more likely to innovate. Although the impact was quite small (below 1%), but in some extents this result suggests that the probability of innovation increases for firms with a higher percentage of highly qualified workforce, holding other factors at their mean values. This result supports the hypothesis that "*human resources have a positive relationship with the propensity of innovation*".

Foreign ownership

Regarding the firms with foreign ownership, there is an interesting difference between the two forms of ownership, the wholly foreign owned firms (FOREIGN) and joint venture (JOINTVENT). The coefficient was both statistically significant at 1%, but while JOINTVENT was positive, FOREIGN was negative. This indicates that, relative to privately owned firms, joint venture firms are associated with more innovation, while wholly foreign-owned firms are less likely to innovate. Thus, the hypothesis "*Foreign ownership has a positive relationship with innovation propensity"* was supported in the case of joint venture firms but not for wholly foreign-owned firms.

Export

In addition, the results also show a positive correlation between exporting and innovation propensity. EXPORT is statistically significant at 1%, and the marginal effects shows that the

[50] This effect is similar with the other developing countries: 8% for Panama, 10% for Argentina, Chile, Columbia and Costa Rica, 17% for Uruguay (Crespi and Zaniga, 2010).
[51] As presented in Chapter 1, the term of "qualified workforce" indicates the labor with professionally trained and educated background.

probability of innovation increases by 2% for the firms engaging in exporting compared to the firms that produce for the domestic market only. Thus, the hypothesis "*Export has positive relationship with the innovation propensity of firms"* was supported.

Group 2: Industry level factors

Industrial Competition

The results of the degree of industrial competition is insignificant, suggesting there is no effect of industrial concentration on innovation.

Thus, the hypothesis "*Industrial competition has a positive relationship with firm's innovation propensity*" was not supported.

Technological intensity

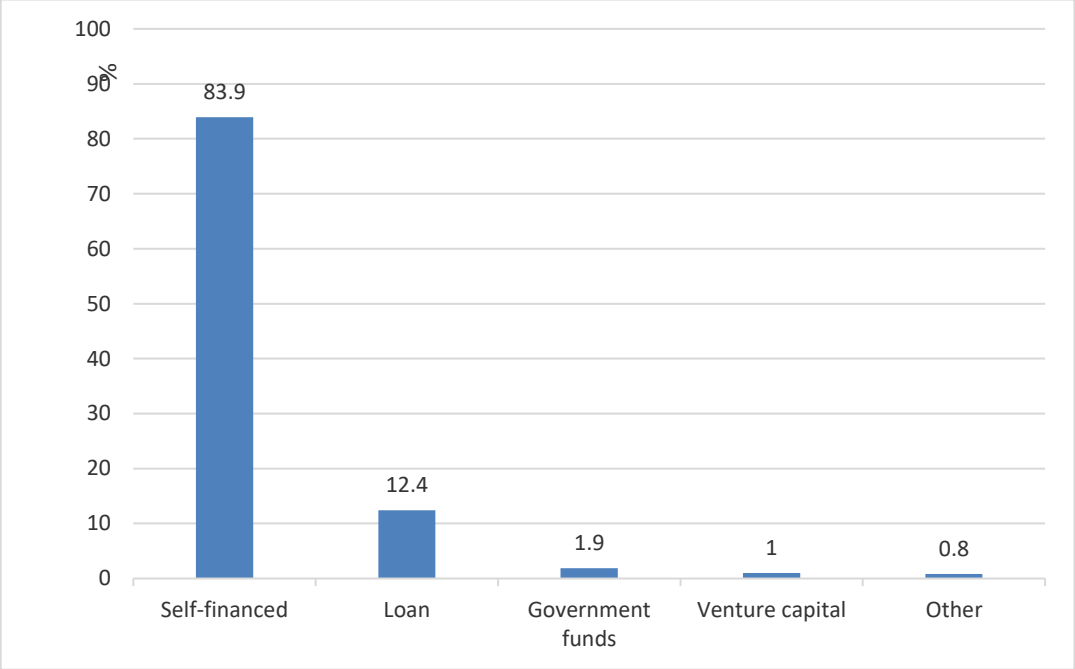
The positive coefficients for type of industry indicates that firms in high and medium technology industries are more likely to innovate, compared to firms in low and medium-low technology sectors. Further, these coefficients are higher for medium high and high technological industries as compared to the medium low technological ones. In this case, the hypothesis *"the firms in higher technological intensity are more likely to innovate"* was supported.

Group 3: Region level factors

Local government support

Unlike with the literature**,** there is no statistically significant connection that could be found between the local government's financial support and the firm's innovation probability. This result can be observed by the low participation of firms in this type of instruments to promote innovation. As shown in Figure 3.1, the majority of the sampled firms still carry out innovation with their own resources (83.9% of 2,268 firms reporting their financing resources), and just only 1.9% of firms (42 firms) reported getting assistance from the government for research into new technologies. This finding indicates that the financial incentives of Vietnam's local government do not play a significant role in enhancing innovation in the surveyed firms. This result has been reported in other developing countries such as Mexico and Argentina (Raffo et al, 2008). This result did not support the hypothesis *"Local government support has a positive relationship with firm's innovation propensity*".

Figure 3. 1 Finance sources for innovation in Vietnamese firms



Source: Constructed from the TCS in 2010-2013.

[Control variables]

The estimated coefficients of location dummy variables represented by Hanoi and Ho Chi Minh City show that firms located in Hanoi are more likely to engage in innovation activities, while firms in Ho Chi Minh have a significant negative relationship with innovation behavior. This result is in line with Pham & Ho (2017) who found that although the firms located in Hanoi and Ho Chi Minh City are more productivity than other cities, their innovation intensity seems to be lower due to the constraints in greater operational expenditure.

6. Conclusions

This study has examined the determinants of innovation decision by Vietnamese manufacturing firms. The estimation model consists of seven constructs and purports those three contextual factors: (1) Firm specific factors (firm size, labor skill, foreign ownership, export), (2) Industry level factors (competition, technological intensity), (3) Province level factors (local government support). The results suggest some important findings as follows.

First, I confirmed the general view in the literature that both large firms and export activity are important drivers of innovation activities. These results support the Schumpeter hypothesis on the role of large firms, and the assumption that global integration facilitates the diffusion of

knowledge. This could be interpreted to mean that large firms have a greater capacity to innovate, due to access to more substantial resources.

Second, I found that the firms with a higher proportion of qualified employees seem to be more positive in innovation activities. This result is in line with the idea that a more qualified workforce improves the firm's absorptive capacity and reduces the costs of adopting or creating new technologies (Cohen & Levinthal, 1990; Harris & Trainor, 2011).

Surprisingly, the study found a mixed effect of foreign ownership on the propensity of innovation. While the influence of the wholly foreign-owned firms is negative, the propensity to innovate is positively correlated with joint venture ownership compared to privately owned firms. The results from this study of Vietnamese manufacturing firms reveal how it is different from the findings observed in other Asian countries. In a study about the role of FDI on innovation and R&D investment in 10 developing Asian countries, Erdal & Göçer (2015) showed that firms with foreign ownership increased in innovation activities[52]. This can be explained by the following differences in the propensity to innovate of wholly foreign owned firms with joint venture and privately owned firms. First, as noted in previous studies, in technologically lagging countries, multinational firms rarely invest in innovation or RD activities if the market size is not sufficiently large to justify fixed costs for R&D, or if there is no specific national academic attractiveness (Raffo et al, 2008)[53]. Second, it could also be the case that multinational firms do not innovate in Vietnam because their activity is more focused on the exploitation of Vietnam's comparative advantage of, for instance, natural resources, human resources, cheap labor cost, or they use the technological assets from headquarters, which is observed in Chile by Alvarez et al. (2011). If they conduct some kind of technological activity, they focus more frequently on adaption and tailoring the products to local markets (with a low level of newness).

This suggests that the collaboration with foreigners in the form of joint ventures, rather than fully owned subsidiaries is apparently a more efficient channel for promoting technology adoption in Vietnam. Furthermore, it also implicates one way to boost innovation activity is to concentrate more on encouraging domestic privately-owned firms to innovate, rather than

[52] Erdal and Gocer (2015) estimate the FDI effects (measured by capital stock by FDI) on R&D and innovation by using the data of R&D expenditures and numbers of total patent application. They concludes that "one point increase in the amount of FDI inflow is associated with 0.83% increase in R&D expenditure, 0.42% increase in patent applications" in these countries for 1996-2013 period.
[53] Recently, some exemptions are China, India, where technology hub are emerging and increasingly attracting the R&D activities by foreign firms.

focus policy resources on inward investment by foreign-owned firms (unless these firms are willing to commit to undertake more local R&D and other related innovation activities in their host plants).

Regarding the effect of industry level factors, the competition in industry showed insignificant relationship with innovation propensity, while the significant effect of medium-high tech and high-tech sectors in innovation are observed, indicating the advantage of these sectors in innovation. In the long run, Vietnam should prioritize the development of these sectors instead of relying on cheap labor or natural resources in the low-tech industry.

In terms of province level factors, local government support does not show to have a significant role on promoting innovation. These results reveal that although Vietnam has implemented a series of support systems for firms to undertake R&D and engage in innovation (such as providing financial support for firms' scientific and technological projects ect., as reviewed in Chapter 2), there is still a gap between the policies and reality, which constraints Vietnamese firms in accessing the government's financial support. This result has been reported in other developing countries such as Mexico, Argentina (Raffo et al, 2008), and China (Zhu et al, 2012). This may be due to the shortage of effective intermediaries and transparent service information connecting these supporting policies to the needs of the firms (Zhu et al, 2012).

My study offered several contributions. First, I developed a framework combining firm-industry-province level factors for identifying the drivers of a technological innovation decision, instead of a limited set of factors. Second, my empirical analysis identified seven significant innovation decision predictors in the context of Vietnamese manufacturing firms. These results might be useful to serve as a reference for other studies on developing countries.

The results from this study indicate that policies could be designed more efficiently. In particular, the support schemes for investment in technology and innovation activities proved insufficient, because as shown in the results, support provided by the local government proved inefficient, suggesting a need for a more in-depth assessment and possible policy change.

Furthermore, the study also has managerial implications as well. First, it is important for firms to build up their technological competence to conduct innovation, including both the qualified human resources and the complexity of technological development. Second, managers need to re-evaluate the benefits and costs of innovation adoption as the environment changes.

A number of issues addressed in this study deserve further research. First, considering the importance of the service sector in the Vietnamese economy, there is a need to pay attention to this sector to provide a full picture of the innovation activities in Vietnam. A second limitation is concerned with the taxonomy of determinant factors. In a study on 448 manufacturing firms (SMEs) in Croatia, Radas & Božić, (2009) categorized those factors into facilitating factors and obstacle factors to the innovativeness of the firms. It could be interesting to see which obstacle factors pose the biggest challenge to the innovation of Vietnamese manufacturing firms.

CHAPTER 4. INNOVATION AND PRODUCTIVITY- THE EVIDENCE FROM VIETNAMESE MANUFACTURING FIRMS-

1. Introduction

This chapter aims to study, at the firm level, the relationship between innovation investment, innovation output, and firm performance measured by labor productivity, using a panel dataset from the TCS in the period of 2010-2013. I extend the model studied in Chapter 3 by using a three-stage model which depicts the relationship between the innovation process and productivity. Similar to Crepon et al., (1998)'s argument that a firm's productivity is driven by innovation output but not directly driven by innovation input, such as R&D investment, and based on the results from the previous CDM studies, I argue that a higher investment in innovation activities generates a higher probability of introducing innovation outputs, which subsequently improves a firm's productivity.

The findings partially support my hypothesis that "*Innovation investment is positively associated with the successful introduction of innovation output (innovation new to the market and new to the firm), which in turn contributes to a greater level of productivity".* In line with the literature, I found evidence that the contribution to innovative efforts generates new knowledge for innovation. However, contrary to expectation, I could not find a significant relationship between two indicators of innovation output and labor productivity. These results are consistent with the evidence from other developing countries such as Chile in Benavente's (2006) study in the period 1995-1998.

Regarding the determinants of innovation investment, the results indicate that cooperation in R&D, exporting and belonging to high-tech industry sectors encourage firms' innovation investment. The acquisition of external technology via licensing, importing equipment or acquiring from suppliers or customers, foreign ownership, industry concentration and local government's support in innovation activities have no impact on innovation investment. These results are in line with Crespi & Zuniga (2012) in their study of six Latin American countries.

The contributions of this chapter are three-fold. On the theoretical side, I consider three aspects of innovation process in a theoretical framework. Specifically, I use a three-stage model of innovation process, taking into account various contextual factors. This model was introduced by Crepon et al., (1998). On the empirical side, this study extends CDM studies by accounting for non-traditional proxies for innovation, including the degree of novelty of the

innovation and external technology acquisition. On the practical side, to the best of my knowledge, this study is the first attempt to employ the CDM model to comprehensively investigate the innovation- productivity relationship of Vietnam's manufacturing sectors.

This chapter is organized as follows. First, in section 2, I present the review of literature on innovation and productivity. Based on the reviewed literature, I develop the conceptual framework, which leads to the relevant research hypothesis in section 3. The specification of estimated model, methodology and descriptive statistics are also presented in this section. Section 4 provides main empirical results, various robustness tests and analyzes the main findings in comparison with the literature review. Section 5 concludes the chapter.

2. Literature Review on Innovation- Productivity Relationship

2.1 Definition and Measure of Productivity

Productivity is defined as "a ratio of a volume measure of output to a volume measure of input use" (OECD, 2001), or "the quantity of goods and services that can be produced from each hour of a worker's time" (Mankiw, 2004), or "using the minimum necessary level of input to produce a certain level of output in a sense of efficiency, using its technological knowledge, its organization, its size and the operation environment" (Hall, 2011). Increasing productivity implies more output is produced with the same amount of inputs or a specific amount of output is produced requiring less input (Rogers, 1998). According to the OECD (2001), output measures are represented by gross output and value added, while inputs of productivity are labor, capital and intermediate inputs.

Based on these measures, productivity can be categorized into two dimensions, namely: (i) single factor productivity and (ii) multifactor productivity (OECD, 2001). The former category refers to a ratio between output and a specific input factor (e.g, labor productivity, capital productivity), while the latter category relates to a ratio of output produced and several input indicators.

In the literature on innovation at the firm level, the most common measure of productivity is labor productivity, measured by the value added per employee or per working hour. The literature suggests that labor productivity is a useful measure for several aspects: (i) it is considered as a proxy for firm performance (Belderbos et al, 2004), (ii) it "relates to the most important factor of production (human capital) and easy to measure", and (iii) it is "the key determinant of living standards, which is significant for policy relevance" (OECD, 2001).

For these reasons, this study uses labor productivity as the measurement of firm performance and investigates the relationship between innovation and productivity.

2.2 The relationship between innovation and productivity

In economic research throughout the decades, the relationship between innovation and productivity has been a major area of study (Solow, 1957; Griliches, 1979; Pakes & Griliches, 1984; Crepon et al.,1998). Tracing back the history, this research trend starts from the growth theory developed by (Solow, 1957). Solow (1957) suggested that technological change is one of the key factors explaining productivity and economic growth of the United State during the 20th century. Inspired by his argument, much research has focused on the factors which underlie the productivity residual, that part of productivity growth not explained by the growth in capital and labor (Hall, 2011; O'Mahony & Vecchi, 2014). These studies argue that this residual part was ascribed to a technical change and they attempted to find a measure for this part (such as improvement in capital and labor quality, R&D activities) in order to measure the growth in productivity (Griliches, 1998; Griliches, 1995; Hall, 2011).

In the early period, the studies on innovation and productivity were mostly based on the classical Cobb-Douglas production function (Cobb & Douglas, 1928), which describes the ratios between output production and input factors (e.g. Griliches 1998; Griliches & Mairesse 1991; Kline & Rosenberg 1986). In 1979, Griliches (1979) added an indicator for innovation measured by the stock of R&D capital in the traditional production function, as a proxy of technical change, and named this model as the "knowledge production function". In this model, Griliches (1979) divides the inputs of economic outcomes into three categories: (i) conventional factors such as capital and labor, (ii) technological knowledge, and (iii) other unmeasured determinants of outputs. He assumes that the production of new knowledge depends on the investment in knowledge (e.g. R&D investment) and on other factors such as knowledge sources from outside the firm.

After that, Pakes & Griliches (1984) developed a model by combining both the knowledge production function and the traditional production function in order to handle the neglected link between inputs and outputs of the innovation process. The model of Pakes & Griliches (1984) described the relationship between R&D, innovation and productivity, which consists of three equations: (i) innovation input equation, measured by the investment in innovation; (ii) knowledge production function, representing the generation of economically valuable knowledge, measured by the number of patents resulting from the past R&D activities; (iii)

firm performance equation, based on the classical production function from Cobb-Douglas explaining the output using input factors, such as physical capital, human capital, material, and R&D investment. The studies using this model showed that in general, R&D expenditure has a positive effect on firm production. However, as Griliches (1979) points out, because this model takes into account only R&D, it ignores imitation and other sources of quality changes that are not a direct product of R&D activity. Moreover, as argued by Kemp et al., (2003), this model explores only the effect of innovation input on firm performance, while neglecting the black box of the innovation process in which a firm's efforts are converted into innovation output.

In 1998, Crepon et al., (1998) introduced an alternative model, which Lööf & Heshmati (2002) labeled as "the CDM model"[54], assumed an indirect link between R&D investment and productivity. They demonstrate that firm productivity is driven by innovation output, such as patents and innovation sales, and not directly driven by innovation input, such as R&D investment. As introduced in section 1.3 Chapter 1, the original CDM model portrays the relationship between innovation process and productivity in four equations: (i) Innovation decision, (ii) Innovation investment, (iii) Innovation output, and (iv) Firm performance (productivity). The first equation has been investigated in Chapter 3, therefore, in this chapter, I focus on the latter three equations.

Below I will survey the results of several notable studies that can be referred to in my analysis in the forthcoming section.

Table 4.1 present surveys based on the empirical studies that used CDM models focusing on developed countries. Lööf & Heshmati (2002) used the data from 619 Swedish manufacturing firms in the period 1996-1998 to examine the impact of R&D intensity on innovation output. For innovation indicators, they used the traditional input measure, R&D expenditure for the innovation input, and the percentage of innovative product sales in the total sales for the innovation output. Unlike with the traditional CDM model, they accounted for the feedback effect of productivity on innovation output. They found that the impact of R&D expenditure on innovation output appeared to be positive and statistically significant with an elasticity of around 0.3, similar to Crepon et al., (1998). However, regarding the feedback effect of productivity, the results showed an insignificant relationship.

[54] CDM refers to the initials of three authors of the model, Crepon, Duguet and Mairesse.

Using the same data, Loof & Heshmati (2006) further examine this relationship by conducting a comparative analysis of 3,190 manufacturing and service firms. For innovation input, they used the total innovation expenditures in eight different categories including: (i) R&D based innovation activities, (ii) non-R&D based innovation activities, (iii) purchase of services for innovation activities, (iv) purchase of machinery and equipment related to innovation activities, (v) other non-machinery and equipment-related innovation activities, (vi) industrial design or the other preparations for innovation, (vii) training activities, (viii) marketing activities. For innovation output, they used the level of innovation sales-per-employee, and took into account the degree of novelty of innovation with two categories (i) new or significantly improved to the market, and (ii) new or significantly improved only to the firm. For the firm performance equation, they use different measures, such as labor productivity, profit per employee, growth of sales and employment.

Table 4. 1 Summary of CDM Studies on Innovation-Productivity focused on Developed Countries

Authors	Year	Country	Data, Methodologies	Dependent variables	Independent variables (Innovation input, output)	Main findings
Crepon et al	1998	France	• 5,000 manufacturing firms in 1986-1990 • Four stage estimation (Tobit, Asymptotic Least Squares): Innovation decision, R&D investment, Output, Productivity	Total factor productivity	R&D expenditure Sales of innovative products Number of patents	Firm's productivity correlates positively with a higher innovation output. The research effort and innovation output increases with firm size, market share, diversification, demand pull and technology push forces.
Loof & Heshmati	2002	Sweden	• 3,000 firms in 1996-1998 • Two phases estimation: Input (Decision, Investment), Output (Innovative sales, patent, TFP) • Probit, Tobit, Simultaneous equation for feedback effect from production to innovation	Labor productivity	R&D expenditure Sales of innovative products (new to the firm, new to the market, technologically improved product)	Productivity growth increases largely with knowledge capital. There is no feedback effect between innovation and productivity. A 10% increase in investment in innovation activities per employee increases innovative sales by 3%.
Loof & Heshmati	2006	Sweden	• CIS data of service and manufacturing firms with 3,190 firms for 1998, 2,899 for 1996-1998 • Two phases estimation • OLS, 3stages least squares	Value added per employee, sales and profit per employee	Total innovation expenditure Innovation sales per employee	Positive effect of innovation new to the firms on the level of productivity, sales and profit. Productivity growth increases only with innovation new to the market in the case of manufacturing firms.
Grifith et al	2006	France, Spain, UK, Germany	• 5,000 manufacturing firms in 1998-2000 • Probit, Tobit	Labor productivity	Total innovation expenditure Product and process innovation	Significant effect of process innovation on productivity only for France, insignificant effect of product innovation for Spain, UK, Germany. Greater R&D effort leads to the higher probability of being innovators.
Hashi & Stojcic	2013	16 European countries	• CIS data for 16 European countries in 2002-2004 • Tobit, 3 stage least squares	Labor productivity	Total innovation expenditure Share of sales of innovation new to the market and new to the firm	Productivity increases significantly with innovation output. Insignificant feedback effect of productivity on innovation output. Innovation investment positively influences innovation output.

Source: Author's summary.

They found that innovation output has a positive effect on labor productivity in both sectors, sales growth only for the manufacturing sector, and employment growth only for the service sector. Regarding the effect of innovation novelty, they found that innovations new to the firms had a closer relationship with labor productivity and sales growth, as compared with innovations new to the market. They concluded that the positive relationship between innovation and productivity is independent of the degree of novelty of the innovations.

As another alternative model to the previous CDM model, Griffith et al., (2006) argued that all firms carry out innovation activities in some level but not all firm report this effort if it is below a certain threshold or they want to keep their R&D activities secret. Therefore, they predict R&D expenditure for all firms from the first equation. Furthermore, they distinguished product innovation from process innovation in order to estimate their effect on labor productivity. They use the CIS data for four European countries: France, Germany, Spain and the UK in the period 1998-2000. They found similar results across these countries in the R&D equation that a firms' greater R&D effort per employee makes them more likely to be product or process innovators. However, the effect of two innovation outputs on labor productivity showed mixed results, with a significant effect of process innovation only for France, an insignificant effect of product innovation for Germany, but significant for all other three countries.

In a recent study, Hashi & Stojcic (2013) used the dataset of 16 European countries covering some 90,000 firms, including developed and transition economies. They reported that innovation investment increases the sales of innovation new to the market and new to the firm, which in turn contributed to the better productivity of firms.

Table 4. 2 Summary of CDM Studies on Innovation-Firm Performance focused on Developing Countries

Authors	Year	Country	Data, Methodologies	Dependent Variables (Productivity)	Independent variables (Innovation input and output)	Main findings
Benavente	2006	Chile	• 488 firms in 1995-1998 • Tobit model and asymptotic least squares	Labor productivity	R&D expenditure per employee. Share of innovative sales	No impact of R&D expenditure and share of innovative sales on productivity
Chudnovsky et al.,	2006	Argentina	• 718 firms in 1992-2001 • Panel data fixed effects for innovation investment and productivity, multinomial logit for innovation outcomes on productivity	Labor productivity	Total innovation expenditure, Four groups of innovation outcomes: product, process, combined innovators, non-innovators	Labor productivity is 14.1% higher in innovators than non-innovators. Higher significance is found for both product and process innovators, and only process innovators. Non-significant effect of only product innovators.
Goedhuys	2007b	Brazil	• World Bank data for 1352 firms, 1997-2002 • Partial adjustment and two-stage estimation for endogeneity problem	Total factor productivity Sales growth	R&D expenditure Product and process innovation	No impact of R&D expenditure and innovation output on productivity. Significant impact of R&D on sales growth
Raffo et al.,	2008	Argentina, Brazil, Mexico	• Argentina 1998-2001, Brazil 19998-2000, Mexico 1999-2000 • Two-stage estimation (Tobit, Probit, OLS)	Labor productivity	R&D expenditure per employee, Product, process innovation	Product innovation does not have an impact on labor productivity in Argentina, in contrast to Brazil and Mexico
Cassoni & Ramada	2010	Uruguay	• 494 firms in 2004-2006 • Tobit model and Full Information Maximum Likelihood (FIML) estimation	Labor productivity growth	Total innovation expenditure, The intensity of the degree of novelty, and share of innovative sales	10% increase in the degree of relevance of product innovation would generate an increase in the growth rate of labor productivity of 3%. In case of process innovation, the effect increases to 5%.
Crespi & Zuniga	2012	6 Latin American countries	• Argentina, Chile, Colombia, Costa Rica, Panama, Uruguay • Two-step least squares for endogeneity problem	Labor productivity	Total innovation expenditure, New product/process	Positive and significant effect of innovation intensity, innovation output on productivity. Greater innovation effort leads to a higher probability of having at least one innovation, which increase above 100% in productivity (except for Costa Rica).

Source: Author's summary.

Table 4.2 summarizes the CDM studies in the case of developing countries. While the positive impact of innovation on productivity is widely confirmed in developed countries, the evidence of developing countries is much more mixed than the case of firms in developed countries.

On the one hand, a positive association between R&D, innovation, and productivity has been reported in Argentinean and Uruguayan firms in the studies from Chudnovsky et al., (2006) and Cassoni & Ramada (2010). Chudnovsky et al., (2006) concluded that the innovative firms have a higher productivity than non-innovative ones, and the innovation propensity is positively impacted by the firm size and the R&D expenditure. Cassoni & Ramada (2010) found that the returns on innovation for Uruguayan firms were significantly positive and of a much large size for process innovation than for product innovation. These results suggest that a 10% increase in the degree of relevance of process innovation would generate an increase in the growth rate of labor productivity by 5% and 3% in the case of product innovation.

On the other hand, Benavente (2006) and Goedhuys (2007b) failed to find any significant effect of innovation in a firm's productivity in Chilean or Brazil firms, respectively. In the case of Chilean firms, Benavente (2006) concluded that, for the short term, the spending on R&D and other innovation activities do not have an impact on a firm's productivity. Similarly, Goedhuys (2007b) found that, while innovation had a positive and statistically significant association with sales growth, there was no impact of innovation on productivity.

As explained by Crespi & Zuniga (2012), the lack of significant effect of R&D, innovation on productivity in developing countries might reflect the fact that a firm in developing countries is too far from technological frontier and incentives to invest in innovation are weak or absent. Indeed, in developing countries, firms' innovation activities are characterized with incremental changes in nature with little or no impact on the international market and are mostly based on imitation or acquisition of machinery and equipment from outside (Acemoglu et al, 2006).

Regarding this insignificant effect, Hall & Mairesse (2006) and Alvarez et al., (2010) suggested the need to evaluate the effects over longer periods of time, as it takes some time for innovation to affect firms' productivity.

For the case of Vietnam, there are a limited number of studies investigating the relationship between innovation and firms' productivity. Generally, the studies relating to innovation in Vietnam can be divided into two groups: (i) studies examining the determinants of innovation, or (ii) studies investigating the impact of innovation investment on firm performance.

The first group includes the empirical studies that examined the determinant factors of innovation output in Vietnam. Nguyen et al., (2011) investigated the impact of trade liberalization on innovation activities by SMEs, using the data set from the SME survey in 2005, 2007, and 2009. They identified two channels for the linkage of trade liberalization and innovation: competition effect from FDI and engagement in importing and exporting. They found that the competition and exporting have an important impact on innovation activities.

Vu et al., (2017) further examined the effect of firm characteristics, industry characteristics, and business climate on different types of innovation, including technological and non-technological innovation. Using the data of the World Bank enterprise survey in 2015 with the sample size of 996 firms, they found that firm size, exporting, and competition increased the probability of introducing technological innovation. Meanwhile, they found a negative effect of foreign ownership on both types of innovation, technological and non-technological innovation. Regarding the industry characteristics, they found that medium and high-tech industries have a higher probability of introducing innovation output, compared to low-tech industries.

Luu & Inaba (2013) used the knowledge production function model proposed by Griliches (1979) to investigate the role of external engagements on innovation activities by SMEs. They defined innovation activities by three dummy variables: product innovation, process innovation, and modification of the existing product. For the external sources of knowledge, they analyzed both international engagements (export, import of intermediate goods, supports from foreign donors/NGOs) and domestic engagements (outsourcing, purchasing outside business service, subcontracting, and being a member of a trade association). They confirmed the positive effect of exporting in all three indicators of innovation, while the import of intermediate goods and support from donors showed a significant association with production modification and new process innovation.

Table 4. 3 Summary of Empirical Studies related to Innovation and Productivity on the Case of Vietnam

Authors	Year	Data, Methodologies	Dependent variables	Independent variables	Main findings
Group 1. Studies focus on the determinants of innovation					
Nguyen et al.,	2011	• 2,537 firms in 2007, 2,532 firms in 2009, from SMEs survey • Probit model	Innovation output: new product, new process, product modification innovation	Trade liberalization: sales to FDI firms, import, export, foreign competition.	Competition, sales to FDI firms and export are important factors of innovation output.
Luu & Inaba	2013	• 2,655 firms, data from SME survey in 2009 • Logistic model	Innovation output: new product, product modification, new process	Innovation investment Innovation capabilities Firm characteristics Business environment International activities	Innovation investment has a positive effect on product modification and new process. Positive effect of export in all innovation outputs, while import of intermediated goods has a positive effect on product modification, new process
Vu et al.,	2017	• 996 firms from World Bank's Enterprise Survey • OLS, Probit model	Innovation output: product, process, organization innovation	Firm characteristics, industry features, business climate of country	Export and competition are important motivations for firms to engage in innovation. Foreign ownership is negatively associated with innovation activities.
Group 2. Studies focus on determinants of productivity and the related effect of innovation					
Newman et al	2009	• 29,435 manufacturing firms, data from VES in 2001-2007	Total factor productivity	Innovation investment Technology usage Ownership structure	Investment and technology usage are important determinants of productivity. Foreign and stated owned firms have higher levels of productivity, compared to private firms, driven by the higher levels of investment and technology usage.
Hien & Santarelli	2013	• 11,006 non-agricultural firms from GSO's annual enterprise survey in 2000-2005 • Tobit model, generalized method of moments for endogeneity	Firm performance: Sales growth, profitability, survival propensity	R&D decision R&D investment Innovation output: number of innovative projects completed	R&D and innovation increase firm's profitability, growth of sales and survival propensity. Exporting firms and diversified firms are more likely to be innovative, but the ability to transform the innovative efforts into higher profitability and growth can only be witness among diversified firms.

Newman et al	2014	• Panel data from VES in 2005-2011 and the TCS survey in 2009-2011.	Productivity	Indirect effect of innovation on export-productivity relationship	No effect of technology adoptions and R&D investment on export-productivity relationship. Innovation strategy contributes to the learning effects of export on the productivity growth.
Vu & Doan	2015	• 10,587 SMEs from the SMEs survey in 2005, 2007, 2009, 2011 • 2 stages least squares	Gross profit	Innovation output: product, process innovation	Innovation activities contribute positively to the performance of SMEs
Calza et al	2019	• Panel data of SMEs from the SMEs survey in 2011, 2013, 2015. • OLS and fixed effect estimation, instrumental variables for endogeneity	Labor productivity	Indirect effect of innovation on international management standards certification and productivity relationship	The probability of certificate adoption is higher when firms implement technological innovation. The effect of certification on productivity is strong for firms with technological innovation.
Pham & Ho	2017	• Data of 2,100 SMEs from the SME survey in 2007, 2009. • Fixed effect model	Labor productivity	Investment in technological innovation	Innovative firms are more productive than non-innovative firms by 2.9%.

Source: Author's summary.

The second group of empirical studies is on the impact of innovation on firm performance. Newman et al., (2009) explored the role of technology usage and investment on productivity growth in 29,435 Vietnamese manufacturing firms in the period 2001-2007. They found that investment and technology usage are important determinants of firm productivity levels. More importantly, they observe the differences of this relationship across three forms of ownership, state-, foreign- and private owned firms. Specifically, the foreign and state-owned firms had higher levels of productivity as compared with private-owned firms, and this difference was driven almost entirely by their higher levels of investment and technology use.

In another study, Newman et al., (2017) investigated the indirect effect of innovation on the relationship between exporting and productivity, by using panel data in the period 2005-2011. They collected the data from the 2005-2011 Vietnamese Enterprise Survey for the general information of firms and extracted the innovation information from the 2009-2011 Technology and Competitiveness Survey. Although they did not find a positive effect of technology adaptions and R&D investment on the export-productivity relationship, the results imply that the contribution of innovation strategy (to improve processes and the quality of the products) on the learning effects of exporting on the productivity growth.

Along the same line, Calza et al., (2019) focused on the indirect effect of technological innovation on productivity in Vietnamese SMEs. They found that the possession of an internationally recognized standard certificate leads to an improvement in productivity, and this probability is likely higher when firms implement technological innovation (measured by product and process innovation).

The most recent study is Pham & Ho (2017) which investigated the linkage between innovation investment and labor productivity in SMEs. The study estimated Cobb-Douglas production function to analyze the impact of innovation, proxied by whether the firm has invested in innovation activities or not, on that firm's labor productivity. They concluded that for the firms investing in a new product or new technology or improvements in the existing product, on average, their productivity would be 2.9% higher than non-innovative firms.

In brief, there is a large number of empirical studies that have explored the relationship between innovation and productivity in developed and developing countries, however, the results have been found to be mixed and inclusive. In the case of Vietnam, the above-mentioned studies have not yet addressed the relationship between innovation investment, innovation output, and productivity. This motivates this study to address this relationship in the case of

Vietnam. In the next section, before the introduction of the conceptual framework, I investigate the mechanism of innovation's effect on productivity.

2.3 Impact of Innovation on Productivity

In the previous section, I reviewed the literature and showed that innovation and R&D activities increase productivity through its impact on innovation output. This section aims to answer the question how innovation output affects productivity.

According to Atkinson & Wial (2008), productivity (as a ratio between output and inputs) can be improved in two ways: firstly, by raising the value of output (goods or services, such as shifting production from standardized commodities based on existing technologies to new and higher performance technologies for which consumers are willing to pay a premium and also gain greater economic benefit); secondly, by producing goods and services in a more efficient way. Among these two methods, product innovation is considered to be closely associated with the former one, which is likely to promote the transitions from lower to higher value-added products, while process innovation and organization are considered to improve the latter one.

In terms of product innovation, Mohnen & Hall (2013) suggested that the successful introduction of a new product may create a new demand for the firm's products, potentially giving rise to scale effects in its production or requiring less of inputs than the old products. However, on the other hand, the new product may also cause the '*cannibalizing effect*' to the business and profits made from producing the old products by replacing and driving out the old products from the market. Furthermore, it may also be that at the beginning of selling the new products, productivity might decrease initially and afterwards it may improve due to the learning effects.

These effects of product innovation on productivity have been investigated in many empirical studies. Most of them have revealed a positive effect (Mairesse & Mohnen, 2005; Griffith et al., 2006; Hall et al., 2009; Mairesse & Robin, 2009), while a few studies has shown a negative effect (Duguet, 2006; Raffo et al., 2008).

The importance of product innovation might differentiate by the degree of novelty. As reviewed in Chapter 2, OECD & Eurostat (2005) classified product innovation as either innovation new to the market or new to the firm[55]. The innovations are considered as new to

[55] Besides these two degree of novelty, OECD & Eurostat (2005) also classify the innovation new to the world, when the firm is the first to introduce the innovation for all markets and industries. However, in this study, the limitation of data does not allow me to consider this classification.

the market when the firm is the first to introduce the innovation in the market. An innovation is new to the firm when it may have already been implemented by other firms but it is new to the firm. Innovation new to the firm can be regarded as an '*incremental innovation*', or even '*imitation*', while a innovation new to the market represents a '*really new innovation*' (OECD & Eurostat, 2005; Garcia & Calantone, 2002).

As pointed out by Mohnen & Hall (2013), innovation new to the market have a larger potential in terms of increasing productivity by scaling effects if it can be sold rapidly in a large market and if it corresponds to the customers' needs in that large market. In line with this argument, Barlet et al., (2000) labeled this effect as the '*efficiency effect'*, and further explained that because the innovation new to the market can respond to the market demands and is valued by the market, so it is more productive and profitable than innovation new to the firm. On the other hand, Barlet et al., (2000) also suggested an opposite effect, namely *'inertia'*, which is interpreted as the greater the novelty, the greater the risk is associated with the introduction of innovation. New products are only gradually accepted by the market, therefore, it is expected there is a weaker relationship between innovation new to the market and a firm's performance than in the case of innovation new to the firm.

In terms of process innovation, it is expected to have a positive effect on productivity as the implementation of a new process may lead to more efficiency in production and a reduction in production costs (by saving some of the more costly inputs) (Mohnen & Hall, 2013). This effect was found by several studies, such as Huergo & Moreno (2011) for the case of Spain, Parisi et al., (2006) for Italy, and Peters et al., (2013) for German manufacturing firms. However, some other studies found no relationship between process innovation and firm productivity. For example, Griffith et al., (2006) found no relationship for the case of Spain, the UK and Germany. Koellinger (2008) also found similar results and explained that process innovation may take longer to generate returns than product innovation. Furthermore, product innovation might be independent of other technologies and resources, which were not advanced enough to yield returns.

In the empirical studies of developing countries, labor productivity is most frequently used as the proxy of firm performance because of its importance for developing countries to catch up and reach similar per capital income levels of the higher income industries (Crespi & Zuniga, 2010). Similar with the evidence from the studies on developed countries, related studies also show contradicting results. In a study of six Latin American countries using the CDM model, Crespi & Zuniga (2010) found a strong association between innovation and productivity in all

six countries. They concluded that in these countries, firms that invest in innovation were more able to introduce a new product/process, and those that innovate have higher labor productivity than firms that do not innovate.

In the same way, Cassoni & Ramada (2010) explored the case of Uruguay manufacturing firms. They found a positive and significant effect of product innovation in the growth rate of labor productivity, but a negative effect of process innovation. For the case of Chile, Alvarez et al., (2011) found that process innovation is positively associated with productivity, but there was no similar effect with product innovation. When they used the products data for further analysis on manufacturing firms, they found that, at the sectoral level, there was a positive impact from innovation on productivity for the low-tech industry sectors such as Food, Textile, Wood and Non Metallic Mineral Products.

2.4 Other determinants of innovation and productivity

In the previous two sections, the linkage and impact of innovation on productivity was presented. Besides innovation, the literature has suggested several other determinants affecting labor productivity, and in this section, I address the main determinants that affects this relationship of innovation and productivity in three stages. Besides the input-related factors that I have reviewed in the previous chapter, for the purpose of analysis in this chapter, I include output-related factors which may affect the transformation process of innovation.

2.4.1 Firm size

The size of a firm is one of the main determinants affecting both innovation process and firm's productivity. As discussed in the previous chapter, Schumpeter (1942) argues that large firms have a competitive advantage in undertaking innovation, for the following two reasons. First, innovative activities require a high fixed cost. Large firms with the advantage of size, higher technological capacities and profitability, have better access to financial resources to secure the expenditure for innovation. Second, large firms tend to have an established reputation and marketing channels, which enable these firms to take advantage of innovation through production and sales. In line with this view, Gault (2014) found that SMEs are less likely to conduct R&D and innovation activities than larger firms, and explained that because they have limited resources, making one mistake in their business strategy may mean they go out of business.

The evidence from the previous empirical studies have shown to have contradictory results. On the one hand, Kam et al., (2003) found the number of firms engaging in innovative activities

in Singapore increased with firm size; Hall (2011) found that the development of product and process innovation to the market is much higher for large firms than for SMEs because they are involved in a wider range of innovation activities, so that they could innovate at least one of them. On the other hand, the findings of Zemplinerova & Hromadkova (2012) in a study of Czech firms revealed a negative effect on innovation, which was measured by innovation sales per employee. They concluded that small firms are more efficient in transforming innovation input into innovation output.

With regard to the question whether firm size affects the degree of novelty of innovation, in accordance with the Schumpeter hypothesis, a broadly accepted strand of literature suggests that large firms have more incentive to generate radical innovation compared to smaller firms. In the knowledge production function model of Griliches (1979), innovation activity is the direct result of a firm's investment in knowledge inputs, such as human capital and R&D. A large firm, which has large R&D departments, would be expected to generate more radical innovations than those smaller ones with their size constraining their ability to invest in R&D (Cohen & Klepper, 1992). In contrast with this view, however, several empirical studies revealed findings that larger firms tend to pursue more incremental innovation, while the smaller firms invest more in radical innovation (Cohen, 2010; Henderson, 1993).

In terms of firm size and productivity, the literature has also suggested that large firms may be more efficient because of their greater production differentiation, their ability to access resources, their greater market power, the cost advantages of scale economies, their brand, and their perquisites to attract more competent managers and workers (Jovanovic, 1982; Ahuja & Majumdar, 1998).

However, on the other hand, the other strand of literature has argued that small firms may have higher production efficiency because they have more flexibility to respond to changes in the economic environment and they have lower supervision costs (Chapelle & Plane, 2005; Yang & Chen, 2009). The findings from empirical studies are not consistent. While some studies found a positive relationship between firm size and productivity growth (Johansson & Lööf, 2009; Loof et al, 2001), the others reported a negative relationship (Adamou & Sasidharan, 2008).

2.4.2 Human resources

There are two streams in the literature investigating the link between human resources, innovation and productivity. The first stream studies the impact of human resources on

innovation. The resource-based theory suggests that human resources present the most relevant factor for adapting to the changing environment, access to new knowledge and continuous learning (Senge, 1990). A qualified workforce, which is commonly measured by the percentage of qualified workforce, indicates the quality of human resources. These human resources indicate that integration of skills and knowledge in an organization can have a positive impact on the R&D activities (Coad & Rao, 2010; Fleming, 2001). The firms with a high percentage of qualified human resources, technological sensitivity, and the knowledge spillover effect can promote the absorption of information during the innovation process (Galende Del Canto & Súarez González, 1999). The findings of Fleming (2001) have also suggested that an enterprise's technical staff that have knowledge in technological fields can increase the opportunities for integrating knowledge to create new technologies and develop R&D activities.

The second stream emphasizes the direct contribution of human resource on labor productivity. According to Gambin et al., (2009), the skill of labor raises productivity in several ways: (i) skills enable workers to undertake more complex tasks, to work more effectively and to produce higher value products, (ii) make the investment in innovation become more profitable, (iii) the skilled labors are better at adapting and responding to a changing work environment and at implementing new technology and production processes, (iv) knowledge spillovers from the highly skilled labor to the other workers. Many of the empirical studies found a positive and direct impact of labor skills on labor productivity.

For the case of Vietnam, Vu & Doan (2015) used the same indicator of human capital to examine the effects on innovation and confirmed that the firms (SMEs) having more qualified workers will be more likely to carry out innovation than the other firms. They explained that in many SMEs a foreman or a supervisor, who have a lot of technical knowledge, are responsible for not only technical issues, such as controlling the quality of finished products or repairing machines, but also labor management. In many cases, they are even more knowledgeable than the proprietors of enterprises in managing their daily production activities (Hoang Nam et al., 2009).

2.4.3 Foreign ownership

Foreign ownership is assumed to positively affect innovation investments. In principle, the firms that belong to an international group will have easier access to finance and human resources and information on marketing (Amara et al, 2010; Kumar & Aggarwal, 2005), thus they are expected to invest more in innovation compared with the domestic firms.

EBRD (2014) reported that, in transition economies, foreign-owned firms (defined as the firms where foreign investors hold a stake of 25% or more) are likely to have a higher level of spending on in-house R&D. They also reported that the percentage of foreign-owned firms that have introduced a new product is significantly higher than the percentage of locally owned firms that have done so.

Furthermore, the foreign owned firms are assumed to have a higher probability of introducing innovation output than domestic firms. The empirical studies have given strong evidence that foreign owned firm differ from domestic firms in terms of firm-specific assets, such as specific knowhow on production process, technology, reputation, brands or management capabilities (Dunning, 1973; Caves, 1996). These assets enabled foreign owned firms to create new products and services more easily and yield a higher turnover from these innovations than domestic firms could. This argument is supported by several empirical studies, for example, Frenz & Ietto-Gillies (2004) and Castellani & Zanfei (2003) for Italian and UK firms.

However, not all firms develop the same technological innovation. The output of innovation depends on the strategies of the MNEs, their own evolution of the subsidiaries, the specific localization advantage, and the industry sector's technological opportunities (Birkinshaw & Hood, 1998; Cantwell & Mudambi, 2005). The literature distinguishes foreign owned firms into two types according to their technological responsibilities: (i) competence exploiting firms, and (ii) competence creating firms (Cantwell & Mudambi, 2005; Kuemmerle, 1999). In the former type, innovation activities are generally directed towards adapting products and processes to local markets, while the latter one seeks the creation or acquisition of new or complementary technological competencies that increase the knowledge stock or innovation capacity of the MNEs for both local and global markets. As a result, the innovation activities of the adaptive type are generally in the form of incremental innovation (new to the firm), and the output of the creative type tends to be radical innovations that are new to the market/industry or new to the world.

For developing countries, in Mexico, Brown & Guzmán (2014) found a positive effect of foreign ownership on the introduction of product and process innovation. The same results are also found in the case of Argentina (Arza & López, 2010) but for process innovation only. For Peru, Tello (2015) found that foreign firms showed a higher probability of producing non-technological innovation only in high-tech sectors, but insignificant impact in technological innovation (product, process).

The link between foreign ownership and productivity is also frequently discussed. Foreign owned firms with superior firm-specific assets, are assumed to have higher productivity compared to domestic firms (Gorodnichenko et al., 2010; Johansson & Lööf, 2009). As pointed out by Castellani & Zanfei (2007), the productivity gaps between foreign owned firms and domestic firms are explained by the differences in knowledge production and the greater learning capacity of foreign owned firms, because of their global engagement. The greater the integration of foreign owned firms in their multinational group, the higher innovation capabilities they can get, because each unit of the groups learns from the different environments in which they operate and they will share the knowledge within the group (Frenz & Ietto-Gillies, 2007).

In Vietnam, foreign owned firms have contributed significantly to the growth in output and productivity of the manufacturing sector. They are expected to be more productive than privately owned firms, given that they are usually subsidiaries of large multinational corporations, they tend to be large and also can benefit from tax breaks for their activities in Vietnam (Newman et al, 2009).

2.4.4 Export

Investigating the relationship between the engagement in exporting activity, innovation, and productivity suggests that there are two types of relationships that have been addressed in the literature. First, the literature has examined the link between exports and innovation, and second, the link between exports and productivity.

First, regarding the link between exports and innovation, the literature has suggested two positive effects expected from export to innovation as a result from competition and learning processes in the firms. Many scholars believe that participation in exporting will push firms to innovate in order to gain market shares or remain competitive in the international market (Becheikh et al., 2006). Indeed, competition in the international market is fiercer than in the domestic market, forcing the firms engaging in exporting to invest in innovation activities (Janz et al., 2004). Wakelin (1998) distinguished between innovative firms and non-innovative firms to examine this effect and found that the firms with investment in R&D had a higher level of exports than firms without investment in R&D. The other empirical studies also showed a positive relation between exporting and innovation expenditure (Park et al, 2010).

Moreover, by exporting, firms can learn about new technologies or products through their interaction with foreign partners (Almeida & Fernandes, 2008). This effect has been reported

in several studies, such as Bernard & Jensen (1997), Baldwin & Gu (2004) found evidence from micro data sets that exporting is correlated with firm investment in R&D or adoption of a new technology can also affect productivity. Braga & Willmore (1991) and Alvarez (2001) reported that Brazilian and Chilean exporting firms invested more in R&D.

Second, the link between exporting and productivity is frequently discussed. The international trade literature has suggested that exporters are more productive than non-exporters. There are two hypotheses that are often used to explain the superiority in productivity of exporters compared to non-exporters. The first effect is '*self-select'*, which hypothesized that firms will participate in the export market only if they have a sufficiently high productivity level to overcome market entry costs such as market research, product modification and transportation costs. The second effect is '*learning-by exporting'*, which argues that export participation can be a source of productivity growth and exporting makes firms become more productive than non-exporters.

Bernard et al., (1995) and Bernard & Jensen (1999, 2004) are the pioneer scholars to examine the relationship between productivity and exporting. Bernard & Jensen (1999) found that the relationship between exporting and productivity is largely due to the self-select effect, rather than learning by exporting. Along the same line, Clerides et al., (1998) in a study of Mexico, Columbia and Morocco also concluded that a firm with greater productivity was more likely to "self-select" to engage in exporting. These results are observed in many countries, including developed countries, such as Germany (Bernard & Wagner, 1997), or the UK (Girma et al., 2004); and developing countries, such as the Asian country Taiwan (Liu et al., 1999), or the Latin American country Columbia (Roberts & Tybout, 1997).

In the case of Vietnam, Newman *et al.*, (2017) used the data from 4,751 manufacturing firms in the period 2005-2012 in order to examine the relationship between exporting and productivity. They found strong evidence that productive firms self-select into export markets, especially in the case of foreign firms, as there is an initial productivity gain for foreign owned firms associated with accessing foreign markets rather than learning by exporting.

2.4.5 R&D collaboration

Firms and industries not only vary appropriability at the technological level but also according to their capacity to utilize the network, to gather and use information, for their internal innovation activities, as they may not rely on only their internal resources. Freeman (1988) pointed out that a firm's innovation activity depends on its interaction with external

partners. This idea is later developed by Chesbrough (2003), which is the so-called "open innovation" theory. Chesbrough (2003) argued that firms utilize both inflows and outflows of knowledge which may boost the firm's internal knowledge and innovation.

According to Hagedoorn (1993), cooperation in R&D with other partners and firms is motivated by the needs to access technological knowledge, minimize and share the uncertainty, and costs of innovation projects. Some firms may decide to cooperate in order to absorb the knowledge and capacities which they lack, due to resource constrains, or they cooperate with the aims of extending the range of products or substituting the existing ones (Hagedoorn, 1993).

The effect of R&D cooperation is still mixed in relation to innovation. On the one hand, R&D cooperation among firms is beneficial for the growth of knowledge legacy that becomes available in companies, in as much as a technological knowledge spillover occurs, and therefore, contributes to a decrease in production cost. On the other hand, it leads to a decrease in internal R&D due to the weak appropriability of returns coming from innovation (De Bondt, 1997; Kamien & Schwartz, 1982).

In addition, the literature has also suggested that the cooperation in R&D will depend significantly on the novelty of the technology and the focus of the innovation (i.e. product, process, marketing, organization innovations (Roper et al., 2014). For example, developing new-to-the-market innovations likely involves extramural R&D activities or by a firm itself collaborating with other parties. Such partnership projects have a number of potential advantages. It allows firms to share the risk, access to a broader resource base, which can increase innovation quality and ameliorate both technological and commercial risk (Åstebro & Michela, 2005).

In the case of Vietnam, the collaboration in R&D is expected to be the main channel of innovation activities. As pointed out in OECD & Eurostat (2005) and Phan (2014), the innovation activities of Vietnamese manufacturing firms tend to be informal and the innovation outcomes are not likely to be generated through the R&D department. They tend to rely on external cooperation, which can supplement their limitations.

2.4.6 Technology acquisition

Another important factor of innovation investment is technology acquisition. As an alternative for internal innovation capabilities, firms may acquire technological innovations and knowledge through a variety of channels. New technology can be obtained by purchasing new machinery or equipment, engaging in technology licensing agreements, utilizing the

technology, or knowledge from suppliers or customers, research institute (Almeida & Fernandes, 2008).

The empirical literature on the issue of the impact of technology acquisition and innovation efforts have spawned into two different strands. The first strand finds a `complementary effect` in which these technologies can trigger a firm's innovation activities in response to the need to adapt these technologies to the local circumstances (Blumenthal, 1979; Katrak, 1994). On the other hand, the second strand finds a `substitution effect` that new technology can be acquired readily from abroad may simply suppress any need to develop it, discouraging potential innovative efforts (Kumar, 1987; Basant & Fikkert, 1996; Chuang & Lin, 1999; Fan & Hu, 2007).

The empirical studies in the developing countries do not give a unique answer on these two effects. As emphasized by Evenson & Westphal (1995), the relationship between technology acquisition and innovation activities is a complex one, and depending on the development stage of a country. Vietnam enters the global technology market as the late developers, with considerable cost and risk involved in absorbing complex existing technologies and facing numerous coordination problems. To improve the technological competences, the firms must rely on the imported technologies, adapt them to local conditions, improve them and finally use them as a base for creating innovation locally.

Besides the link with innovation investment, the link between technology acquisition and innovation output is also discussed in the literature. According to Glückler (2013), in order to acquire new knowledge for innovation, as an alternative choice to the R&D collaboration, firms may adopt non-interactive, imitation, or copying strategies. These strategies involve the purchase of intellectual property through licensing, imitation of the existing knowledge and technology (Anand & Khanna, 2000). These choices may provide different types of knowledge and provide the basis for different types of innovation.

As hypothesized above, the R&D collaboration may lead to a new-to-the-market innovation, on the other hand, the choice of importing technology or machinery may lead to an incremental innovation (new to the firm), as it involves less technical and commercial uncertainty as the market value of the imitated knowledge and technology is already established (Roper et al., 2014). However, these strategies allow firms to rapidly establish positions in new technical areas without undertaking a discovery process, and to avoid both the technological and commercial uncertainties implicate in the innovation process. Suh & Kim

(2012) suggested that technology acquisition is one of the most efficient activities, as it complements firms' insufficient resources.

2.4.7 Market competition

There are three strands of literature on the impact of market competition on innovation activities. The first strand is based on the Schumpeter hypothesis on firm size. Schumpeter (1942) emphasized the role of monopolies and postulated the *negative effect* of competition on firm innovation. He suggested that market power is necessary for firms to innovate, and the monopolist with more profits or few rivals has more incentive for innovation. Many empirical studies support this view of Schumpeter. Carlin et al., (2004) used the dataset of nearly 4,000 firms in 24 transition economies to investigate the importance of competition on a firm's innovation. They found that the presence of a few rivals is most conductive to performance than the presence of many competitors. In a study of Norway manufacturing firms and using the CDM model, Castellacci (2011) showed that firms in a high concentration market have more incentive to engage and invest in R&D activities.

In contrast to Schumpeter's view, the second strand suggests the *positive effect* of competition, which is based on (Arrow, 1962). Arrow (1962) argued that firms operating in a competitive environment have greater incentive to invest in R&D and innovation than a monopolist firm. Supporting this view, Scherer & Ross (1990) argued that the absence of competitive pressure increases bureaucracy and discourages innovation. Crepon et al., (1998) further explained that market competition allows better resource allocation and more productive firms because non-efficient firms get out of the market and new production units will be created. In a study of 47 developing countries, Ayyagari et al. (2011) also indicated that competitive pressures from foreign invested firms encouraged the local firms to innovate more.

The third strand relates to an inverted U-shape relationship between market competition and innovation. Aghion et al., (2005) found this relationship between market competition and the number of patents in the United Kingdom. Their results confirmed that raising the competitive level in a monopoly market and reducing the competitive pressure in a competitive market can stimulate firms to engage more in innovation. Furthermore, Karaman & Lahiri (2014) argued that the number of firms in an industry was found to have an inverted U-shape relationship with the percentage of R&D expenditure, and found the same results for both Eastern Europe and Central Asia.

2.4.8 Technological intensity

As reviewed in Chapter 3, microeconomic theory defines technological opportunities as the set of production possibilities which allow to translate research resources into new techniques of production employing conventional inputs. Considering the different "technological opportunities" that firms are facing allows to take into account the fact that firms' ability to innovate may vary across industries (Chang & Robin, 2006). As there is no consensus on the definition of "technological opportunities," most studies use the conventional industry dummies.

Most studies generally expect a positive relationship between technological opportunities and innovation expenditure. It is generally observed that the higher the technological levels of the industry in which firms operate, the higher the expected costs are of a firm's innovation (Jaffe, 1986).

2.4.9 Public subsidies

The institution theory argues that the role of institutions in promoting innovation and empirical studies have also suggested that innovation investment can be facilitated through public subsidies (Kemp et al., 2003; Klomp & Van Leeuwen, 2001). Governments often provide subsidies (mainly for R&D) to promote innovation activities for firms and thus the growth of the economy. The main idea behind the firm-level R&D subsidies is the positive spillover effects of social returns to R&D are higher than private returns, and thus government support to firm's R&D is justified (Arrow, 1962). The role of public support to innovation rests mainly on the assumption that new ideas have limited sale ability and the commercialization of innovations involves considerable risk, resulting in an underinvestment in R&D activities that are socially desirable.

There are two contrary effects of public support on innovation. The first one is the so-called `crowd-in` effect, according to which public subsidies tend to stimulate additional privately financed R&D or innovation. The second one is the 'crowd-out' effect, according to which public R&D subsidies offset a firm's own R&D investment. Zúñiga-Vicente et al., (2014) indicated that the majority of the studies on innovation subsidies published over the last five decades tend to suggest that public subsidies are likely to decrease a firm's R&D investment. They point out that, public R&D subsidies may serve as a replacement for a firm's own expenditure rather than as an addition investment. Furthermore, they pointed out that

financial constraints and R&D projects may contribute to the crowding-out of private investment.

For the case of developing countries, public support for innovation was not the governments' priorities due the limited budgetary resources compared to developed economies (Reçica, 2016). However, as Hashi & Stojčić (2013) argued, without financial support firms would be selective and focus only on most profitable innovation projects.

In addition to the external technology acquisition, public funding in innovation is also assumed to have a positive impact on innovation performance. Hanel (2003) analyzed the case of Canadian manufacturing firms and found that firms that received R&D subsidies are more likely to have a larger share of new products (measured by the percentage of the new product sales in total sales) than other firms.

In the same case of Canadian firms, Berube & Mohnen (2009) found that firms benefiting from R&D tax credits and R&D grants are more innovative in terms of new products than other firms that received only R&D tax credits. In a more recent study, Bronzini & Piselli (2016) evaluated the impact of R&D subsidies in a region of northern Italy on the patenting performance of firms. They found that the subsidy program of the local government in that region had a significant impact on the number of patent applications for the case of smaller firms.

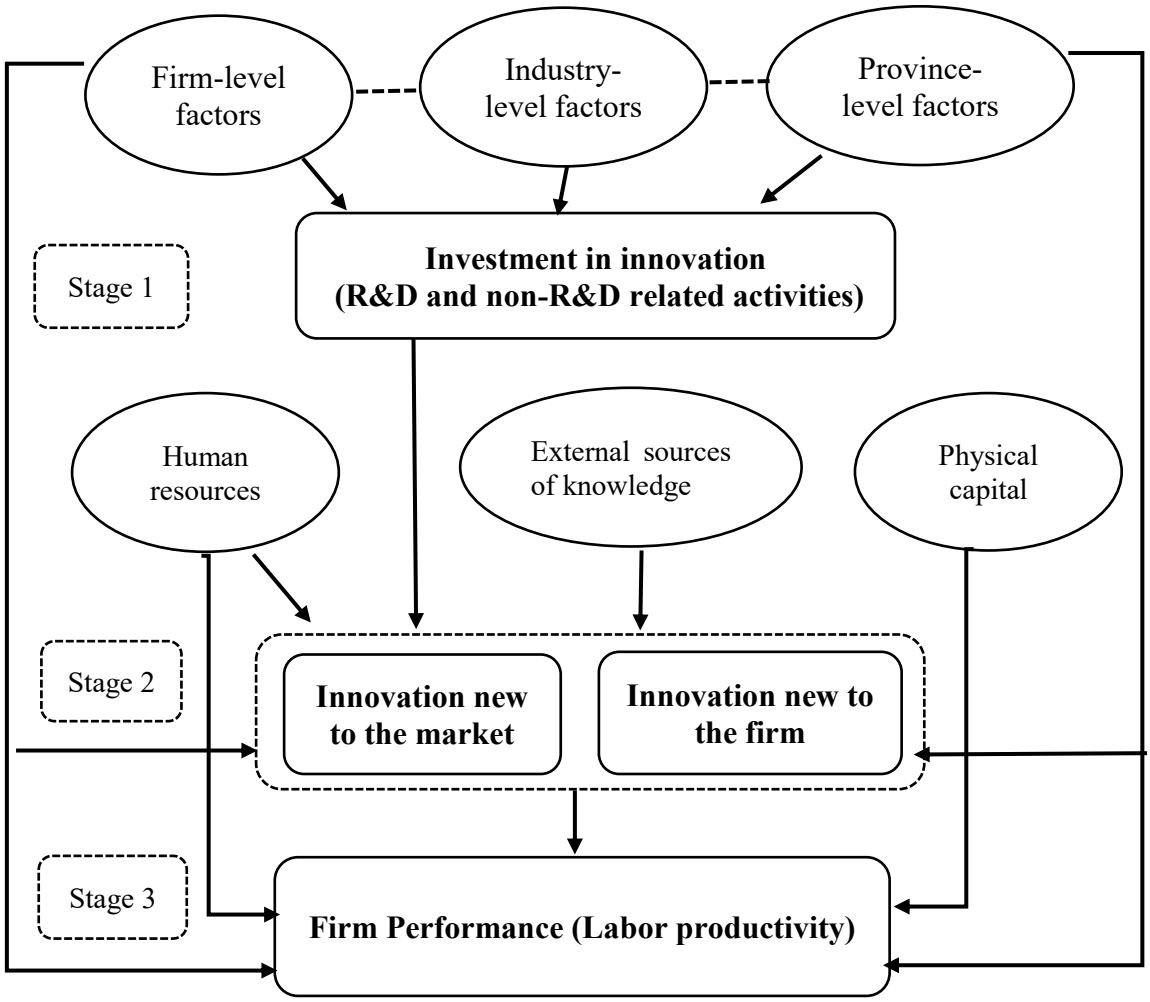
3. Conceptual Framework and Hypotheses

3.1 Conceptual Framework

In the previous section, I reviewed the literature on the relationship between innovation and productivity, and the determinants of this linkage. As suggested by the literature, in order to explore this relationship, a theoretical model for innovation and productivity needs to be taken into consideration. The CDM model proposed by Crepon et al., (1998), therefore, serves as an important theoretical foundation for this study.

Based on the CDM model and the above literature review, I build up a conceptual framework as shown in Figure 4.1. This framework indicates the relationship between innovation and a firm's productivity and comprises the most important determinants that impact this relationship, relevant to the context of Vietnam. This framework will serve as a basis for development of the estimated model presented in the next section.

Figure 4. 1 Conceptual Framework on the Innovation-Firm Productivity Relationship



3.2 Description of the Framework and Hypotheses

As shown in the conceptual framework, firms start their innovation process by making the decision of how much to spend on the innovation activities (Stage 1, *Innovation Investment*). This decision is affected by the three groups of contextual factors which consist of firm-industry-province level factors. In the second stage (*Innovation Output*), firms accumulate resources through three channels: internal research activities (measured by innovation expenditure), human resources (measured by the ratio of qualified workforce), external sources of technology and knowledge (proxied by the external technology acquisition, the collaboration in R&D). They will accumulate these resources to create a new product/technology which is new to the firm or new to the market. Finally, the outcome of this process is the expected labor productivity (Stage 3, *Firm's Productivity*).

The main argument of this model is that "A higher investment in innovation activities generates a higher probability of introducing new product/technology which is new to the firm,

new to the market, and therefore fosters a firm's labor productivity". Based on this argument, I propose the following hypothesis:

Hypothesis: *Innovation investment is positively associated with the successful introduction of innovation output (new to the market and new to the firm), which in turn, contributes to a greater level of productivity.*

This hypothesis will be tested in the estimated model described in the next section.

3.3 Estimated Model

As mentioned above, inspired by the CDM model (Crepon et al, 1998), I model the innovation activities of Vietnamese firms in a three stage-model. The estimated model and the definition of variables for each stage will be presented below.

3.3.1 Innovation Investment Stage

This stage refers to the efforts of firm in innovation, which indicates amount of expenditure to devote to innovation activities. As the dependent variable, which is the amount of innovation investment *inno_investlabor*, is censored in the data, the Tobit model will be used in this stage. The equation is shown as below:

$$inno\_investlabor = \beta_0 + \beta_1(firm\text{-}level\ factors) + \beta_2(industry\text{-}level\ factors) + \beta_3(province\text{-}level\ factors) + \varepsilon i \quad (4.1)$$

where:

- *inno_investlabor* is the dependent variable that expresses the intensity of innovation investment per employee. This variable encompasses the expenditure on all innovation-related activities (intramural and extramural R&D expenditure, modification of the existing technology/product, purchase of new machinery, equipment for innovation activities).
- Determinants that may influence the firm's innovation intensity include firm-industry-province level factors. *Firm-level factors* include firm size as dummy variables of small (<200 employees), medium (201-300 employees), large (>300 employees), dummy variables for foreign ownership, export status, R&D collaboration, technology acquisition. *Industry-level factors* include degree of competition in industry (measured by

the Herfindahl-Hirschman Index [HHI])[56] and dummy variables for industry sector. *Province-level factor* includes public subsidies, measured by the budget of the local government spent on the scientific and technological activities in the surveyed period (in billion VND).

- $\beta_1, \beta_2, \beta_3$ is the corresponding unknown parameter, and ε_i is the error term with zero mean, constant variances and are not correlated with the explanatory variables.

3.3.2 Innovation Output Stage

The second stage of the model describes the knowledge production function as proposed by Griliches (1979). This stage expresses the relationship between innovation investment and other input sources of innovation (human capital, R&D collaboration, technology acquisition), and the potential results of the innovation process, namely innovation output. Innovation output is measured by the degree of novelty of innovation, which is represented by two indicators: (i) innovation new to the market, (ii) innovation new to the firm. As the dependent variables, which are innovation outputs, are ordinal variables, I use the Probit model to estimate the equations. I specify this innovation output stage by the following two equations:

$$Pr(newmarket, newfirm)=\beta_0+\beta_1(inno\_investlabor)+\beta_2(human\ resources)+$$
$$\beta_3(external\ sources\ of\ knowledge)+\beta_4(control\ variables)+\varepsilon i \qquad (4.2)$$

where:

- *newmarket* (innovation new to the market), *newfirm* (innovation new to the firm) are dependent variables, measured as the dummy variables with the value equal to 1 if the firm has introduced innovation new to the market and new to the firm, respectively, and 0 for otherwise.
- *inno_investlabor* is innovation expenditure per employee which is predicted in the previous stage.
- *human resources* is measured by the percentage of qualified workforce. It should be noted that, in Stage 1, I do not include the variable of human resources. As discussed by

[56] As explained in Chapter 3, this study uses the HHI, which is a measurement of industry concentration (at the 2-digit level). This index can be calculated as follows: HHI = $\sum_{i=1}^{m}\left(\frac{Domestic\ sales\ of\ firm}{Total\ sales\ of\ industry}\right)^2$. The higher the value of this measure, the more concentrated the industry sector. The calculation is based on the sample of 213,313 manufacturing firms from the VES conducted by GSO.

Janz et al (2004), the introduction of human resources in Stage 1 may introduce the problem of endogeneity because the labor's skill is correlated with the labor cost of innovation activities, notably in R&D activities.

- *external sources of knowledge* include R&D collaboration, technology acquisition.
- *control variables* include the firm-industry-province level factors presented in Stage 1.
- $\beta_1, \beta_2, \beta_3$ is the corresponding unknown parameter, and ε_i is the error term with zero mean, constant variances and are not correlated with the explanatory variables.

3.2.3 Productivity Stage

The third stage analyzes the link between innovation outputs and labor productivity, using a production function, with the knowledge input (proxied by innovation outputs, resulting from Stage 2). In addition to innovation output, others factors also affect labor productivity. Therefore, I use a set of factors, which are commonly assumed to be associated with labor productivity. The model is estimated with ordinary least squares (OLS) and presented as below.

$$labor\_prod = \beta_0 + \beta_1(newmarket) + \beta_2(newfirm) + \beta_3\,(human\ resources) + \beta_3\,(physical\ capital) + \beta_3\,(control\ variables) + \varepsilon_i \qquad (4.4)$$

where:

- *labor_prod* is labor productivity, measured by the percentage of sales per employee.
- *newmarket, new firm* are the innovation outputs as explanatory variables which predicted in the previous stage.
- *human resource* is labor input in the production function, which predicted in Stage 2.
- *physical capital* is capital input, measured by the value of physical assets per employee.
- *control variables* include firm size, export, foreign ownership, labor skill, R&D collaboration, degree of competition in industry (HHI), industry sector.

Table 4.4 summarizes the description of the variables used in above mentioned models.

Table 4. 4 Description of the variables

Variables	Description	Stage 1	Stage 2	Stage 3
DEPENDENT VARIABLES				
inno_investlabor	The ratio of innovation expenditures to the number of employees	○	○	
newmarket	Dummy for firms have introduced product new-to-the-market in the surveyed period		○	○
newfirm	Dummy for firms have introduced product new-to-the-firm in the surveyed period		○	○
laborprod	The percentage of sales per employee			○
INDEPENDENT VARIABLES				
small	Dummy for firms have fewer 200 employees	○	○	○
medium	Dummy for firms have 201-300 employees	○	○	○
DExport	Dummy for export activities	○	○	○
FDI	Dummy for foreign owned firms	○	○	○
laborskill	The percentage of qualified workforce		○	○
DRD_colla	Dummy for RD collaboration	○	○	○
techtran_embodies	Dummy for the firm considers that the purchase of new equipment, machinery is a relevant source for firm's technology	○	○	
techtran_license	Dummy for the firm considers that the purchase of new technology from research institutions and external firms is a relevant source for firm's technology	○	○	
techtran_supcus	Dummy for the firm considers that the using of technology provided by main suppliers or customers with whom the firm has long-term contracts (over 12 months) is relevant source for a firm's technology	○	○	
HHI	Herfindahl-Hirschman Index for industrial competition	○		○
mediumhigh	Dummy for medium high technological industry	○	○	○
hightech	Dummy for high technological industry	○	○	○
pro_sup	Percentage of the province's expenditure on science and technology over the general budget spending of local finance	○	○	
physical_capital	Value of physical asset per employee			○

3.4 Data, Descriptive Statistics

Table 4.5 summarizes statistics of all dependent and independent variables used in the data analyses. The dataset used for the empirical analysis is the panel firm-level dataset from the TCS survey in the period 2010-2013, which I have used in the previous chapter. Due to the missing information of the innovation investment, the total number of observations is reduced into 22,813 observations. According to Table 4.5, Vietnamese firms spends 0.248 million VND per employee on innovation activities, on average. The surveyed firms have the average labor productivity of 843.798 million VND per employee. In terms of independent variables, most of the variables are distributed at the mean value.

Table 4. 5 Summary Statistics of Variables

N=22,813	Obs	Mean	Std. Dev.	Min	Max
Dependent variables					
inno_investlabor	22813	0.248	19.748	0	2857.143
newmarket	22813	0.003	0.058	0	1
newfirm	22813	0.002	0.052	0	1
laborprod	22813	843.798	2649.3	0.023	167072.5
Independent variables					
small	22813	0.799	0.400	0	1
medium	22813	0.102	0.236	0	1
DExport	22813	0.356	0.479	0	1
FDI	22813	0.231	0.422	0	1
laborskill	22813	0.376	0.294	0	1
DRD_colla	22813	0.002	0.047	0	1
Dtechtran_embodied	22813	0.808	0.393	0	1
Dtechtran_license	22813	0.658	0.474	0	1
Dtechtran_supcus	22813	0.655	0.475	0	1
HHI	22813	0.134	0.130	0.020	1
mediumhigh	22813	0.103	0.304	0	1
hightech	22813	0.033	0.179	0	1
pro_sup	22813	0.308	0.107	0.1	0.9
physical_capital	22813	739.589	4241.988	0.975	572312.5

In addition, in Table 4.6, a correlation matrix was conducted and presented, in order to examine the level of correlation between the variables. As seen in Table 4.6, almost all

correlation coefficients among the variables range from -0.009 and 0.534, indicating that multicollinearity is not a problem in the estimated model.

Table 4. 6. Descriptive Statistics and Correlation matrix

Variables	inno_investlabor	newmarket	newfirm	laborprod	small	medium	DExport	FDI	laborskill	DRD_colla	Dtechtran_embodied	Dtechtran_license	Dtechtran_supcus	HHI	mediumhigh	hightech	pro_sup	physical_capital
Dependent variables																		
inno_investlabor	1																	
newmarket	0.011	1																
newfirm	0.010	-0.003	1															
laborprod	-0.001	0.008	0.000	1														
Independent variables																		
small	0.004	-0.012	-0.019	0.009	1													
medium	-0.002	0.004	0.015	0.009	-0.501	1												
DExport	-0.006	0.003	0.006	0.028	-0.440	0.150	1											
FDI	-0.005	-0.009	0.000	0.031	-0.346	0.099	0.501	1										
laborskill	0.011	0.025	0.021	0.023	-0.001	0.002	-0.05	-0.014	1									
DRD_colla	0.001	0.124	0.085	0.015	-0.011	0.003	0.013	0.002	0.016	1								
Dtechtran_embodied	0.004	0.000	-0.004	-0.002	0.03	-0.015	-0.054	-0.068	0.033	0.008	1							
Dtechtran_license	0.004	0.015	0.004	-0.003	0.011	-0.019	-0.034	-0.029	0.038	-0.003	0.354	1						
Dtechtran_supcus	-0.012	0.009	0.006	0.000	-0.01	-0.005	0.004	0.013	0.035	0.005	0.214	0.537	1					
HHI	0.000	0.039	0.015	0.032	0.027	0.011	-0.023	0.056	0.041	0.021	-0.029	0.012	0.0038	1				
mediumhigh	-0.001	0.037	0.006	0.019	0.007	0.000	0.011	0.146	0.068	0.023	-0.004	0.011	0.012	0.491	1			
hightech	0.000	0.039	0.027	0.032	-0.037	0.038	0.026	0.063	0.052	0.001	-0.009	0.004	0.012	0.070	-0.062	1		
pro_sup	-0.004	0.033	0.027	0.027	-0.052	0.018	0.056	0.051	0.037	0.014	-0.020	0.0247	0.028	0.011	0.034	0.026	1	
physical_capital	-0.001	0.012	0.000	0.316	0.017	-0.003	0.015	0.029	0.025	0.006	0.000	0.002	0.006	0.018	0.019	0.023	0.021	1

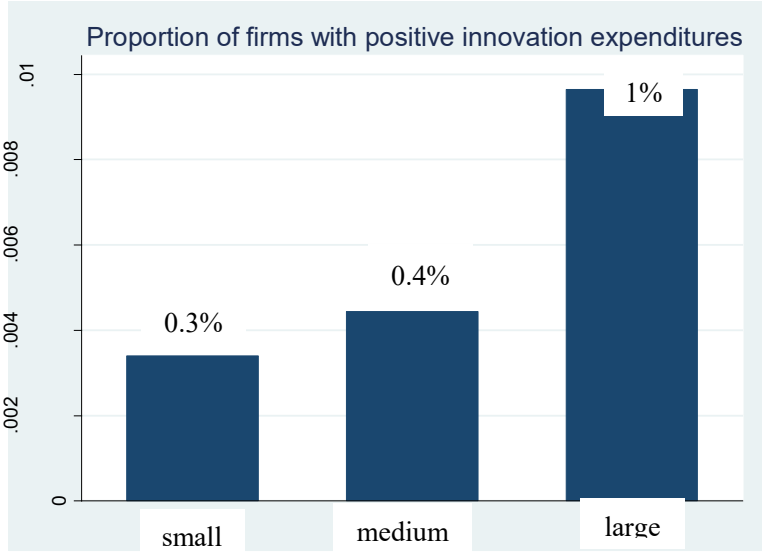
3.5 General Observations of Innovation and Productivity

Prior to the main analysis, in this section, I describe the distribution of innovation investment, innovation outputs and productivity in this dataset, within different groups of firms, e.g innovators or non-innovators, firm size, industry sector, ownership.

3.5.1 Innovation investment

Figure 4.2 shows the proportion of a firm's investment on innovation activities categorized according to firm size. At first glance, large firms spend the highest proportion and small firms spend the smallest proportion. According to the Figure, 0.3% of small firms (group 1) decided to invest in innovation activities, whereas 0.4% of medium-sized firms (group 2) and almost 1% of large firms (group 3) decided to do so. This indicates that larger firms are likely to be more intensive in innovation investment.

Figure 4. 2 Innovation investment by firm size



Next, Figure 4.3 shows the distribution of innovation investment by ownership, including private firms (triangle-connected line) and foreign owned firms (circle-connected line). The distribution of private firms tends to have more probability mass at higher values of innovation investment. This indicates a slightly higher innovation effort for private firms compared with foreign owned firms.

Figure 4. 3 Innovation investment by ownership

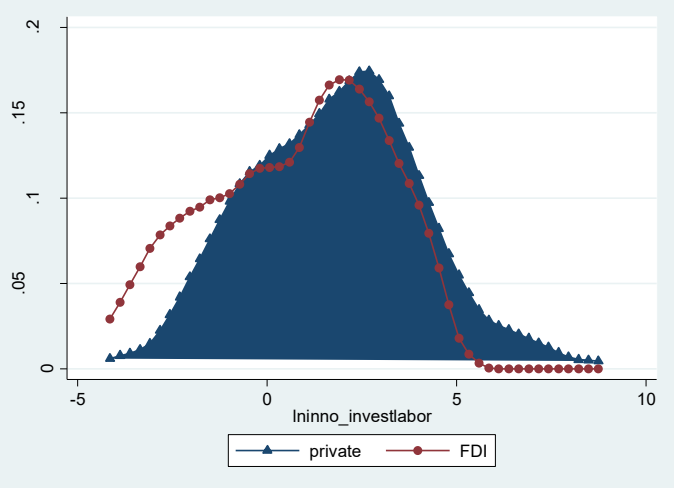
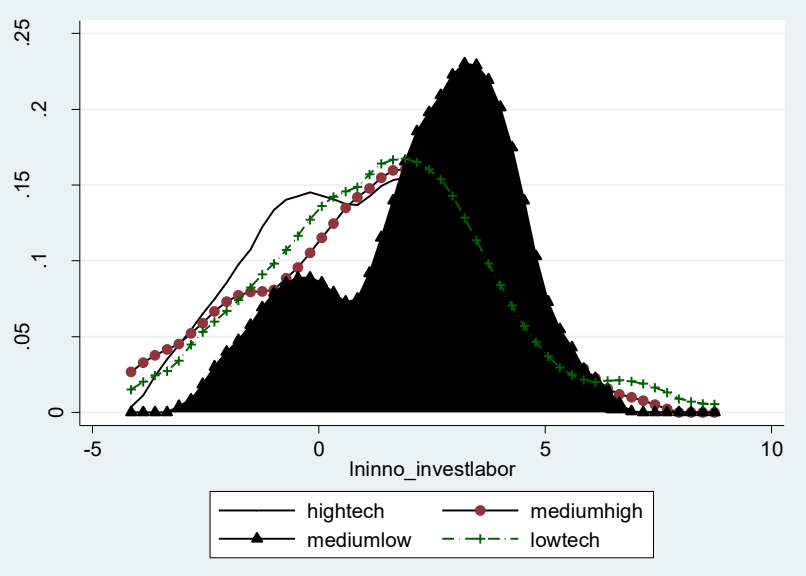


Figure 4.4 shows the Kernel density estimates of innovation investment separately for four categorizes of industry sectors: high-tech, medium-high tech, medium-low tech, and low tech industries. Among four groups, medium low tech industries are shifted to the right compared to the other groups, indicating that the firms in medium-low tech industries such as refined petroleum products, coke, basic metals, and fabricated metal products tend to be more intensive in innovation than the other sectors.

Figure 4. 4 Innovation investment by industry sector



3.5.2 Innovation output

Figure 4.5 shows the distribution of the proportion of introducing innovation new to the market by firm size, ownership and industry sector. Medium and large firms, private firms, firms in

medium-high tech and high-tech industry sectors mainly focused their innovation activities on generating innovation new to the market.

Figure 4. 5 Distribution of innovation new to the market

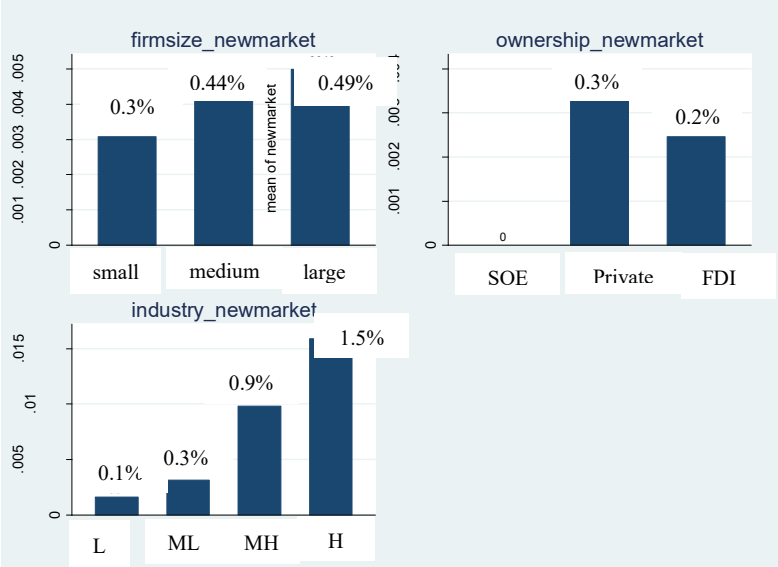
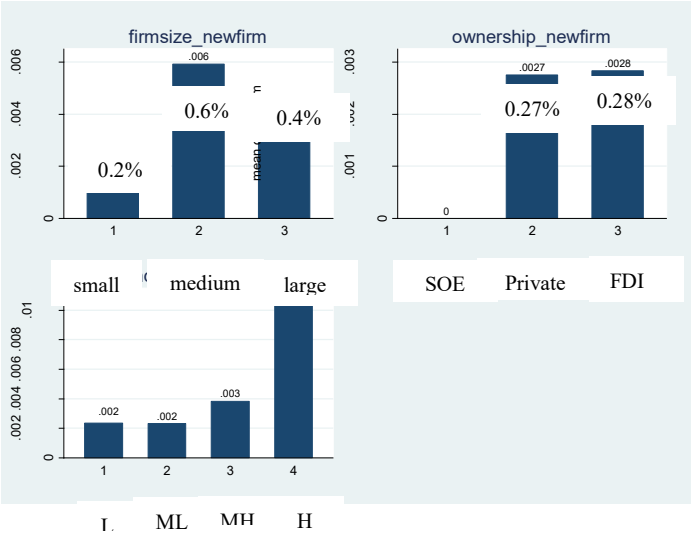


Figure 4.6 shows the distribution of innovation new to the firm by firm size, ownership, and industry sector. Medium-sized firms and high-tech industries tended to be more innovative in innovation new to the firm compared to the other firms. This performance does not differ substantially between private and foreign owned firms.

Figure 4. 6 Distribution of innovation new to the firm



3.5.3 Productivity

Figure 4.7 shows the distribution of labor productivity for all firms in the dataset. The circle-connected line is associated with innovative firms whereas the dashed line belongs to non-innovators. Compared to the distribution of non-innovator, the distribution of innovators possesses

more probability mass at higher values for labor productivity. This implies that innovative firms are in general able to achieve higher labor productivity.

Figure 4. 7 Distribution of labor productivity among innovators

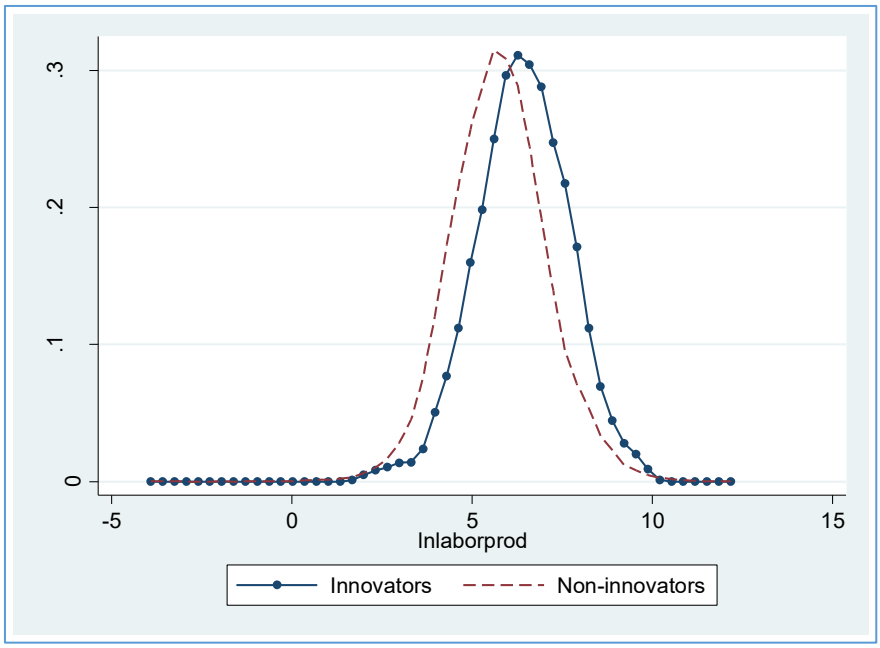
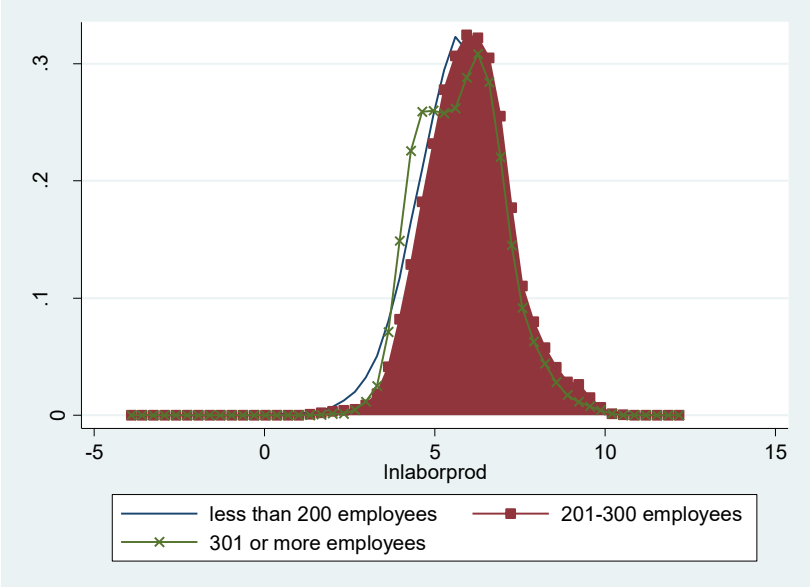


Figure 4.8 and Figure 4.9 show the Kernel density estimates for labor productivity by firm size, industry sector, and ownership. As shown in Figure 4.8, the firm size seems to have a positive effect on labor productivity, and there is no substantially difference in labor productivity over different size.

Figure 4. 8 Distribution of labor productivity by firm size



In Figure 4.9, compared to the other industries, the distribution of high-tech industries tends to have more probability mass at higher values of labor productivity. This indicates slightly higher labor productivity for firms operating in high-tech industry sectors. Similarly, Figure 4.10 shows that foreign owned firms possess more probability mass at higher values for labor productivity. This implies that foreign owned firms are likely to be more productive than private domestic firms.

Figure 4. 9 Distribution of labor productivity by industry sector

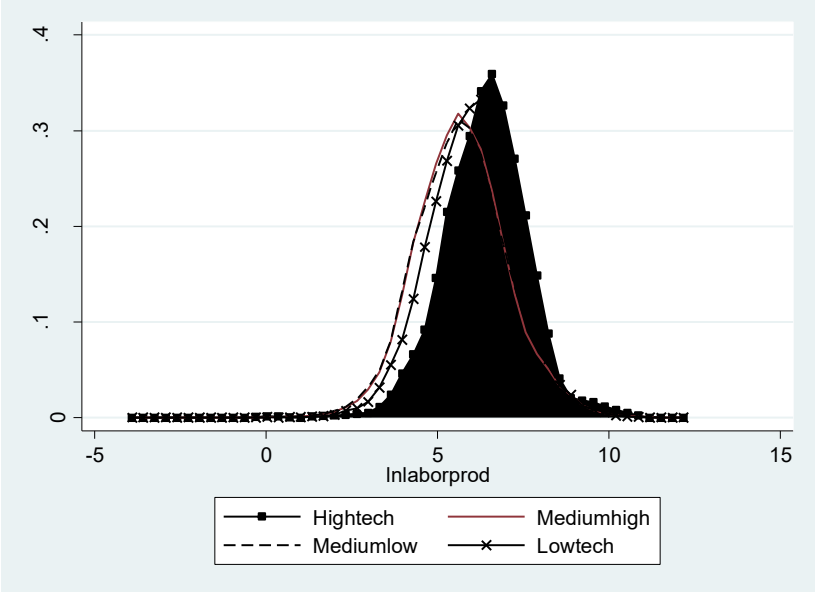
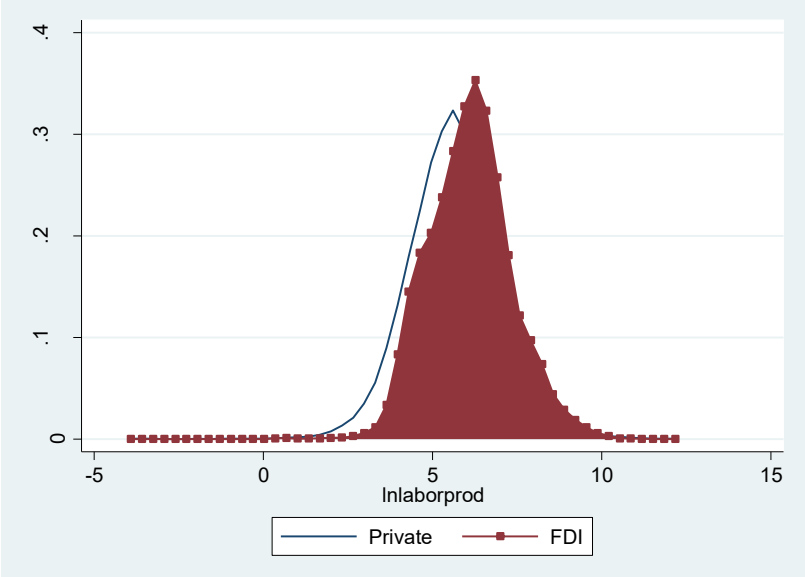


Figure 4. 10 Distribution of labor productivity by ownership



4 Empirical Results

4.1 Innovation Investment

In the first stage, the Tobit model is employed to estimate the determinants of a firm's investment on innovation activities. The results are shown in Table 4.7. The results show significant effects of small firms, export, R&D collaboration, and high-tech industry sector. There is no significant effect of FDI, technology acquisition, industry competition (HHI), and local government's support. The interpretation of these results can be explained as follows.

Table 4. 7 Factors influencing innovation investment

Variables	Innovation Investment
small	-91.60*
	(55.62)
medium	-114.2
	(79.88)
DExport	84.17*
	(48.35)
FDI	-50.17
	(42.99)
DRD_colla	443.0**
	(220.6)
Dtechtran_embodied	50.08
	(45.12)
Dtechtran_license	36.11
	(43.10)
Dtechtran_supcus	-75.85
	(57.33)
HHI	202.0
	(236.4)
mediumhigh	64.27
	(45.48)
hightech	212.3**
	(103.7)
pro_sup	141.9
	(132.3)
Constant	-1,067**
	(503.4)
Observations	22,813

Note: ***, **, * indicate that the estimate is significant at 1%, 5%, 10% respectively.

Firm-level factors

The results presented in the above table show that small firms were statistically significant at 10% level but had a negative effect on innovation investment. The estimated coefficient of 91.60 indicates that, ceteris paribus, if a firm is small-sized (below 200 employees), its investment per employee in innovation activities will decrease by 91.60 million VND, as compared with large firms. The variable of medium firms did not show a significant effect but was also negative. These results suggest that small and medium firms seem to invest less in innovation. These results support Schumpeter's hypothesis on the advantage of large firms on innovation.

Export (*DExport*) variable showed statistical significance at 10% with an estimated coefficient of 84.17. This suggests that the firms engaging in export activities will invest more in innovation activities (84.17 million VND per employee) as compared to firms that do not export. This indicates that competitive pressure from the international market stimulates exporting firms to make more investment in innovation activities.

The other variables relating to foreign ownership (*FDI*), technology acquisition *(techtran_embodied, techtran_license, techtran_supcus*) showed an insignificant effect, even negative sign (*FDI*). This indicates that neither foreign owned firms nor channels of technology acquisition affected the extent of the firm's innovation effort.

R&D collaboration (*DRD_colla*) was statistically significant at the 5% level and an estimated coefficient of 443.0. This suggests that, ceteris paribus, if a firm has a collaborative R&D with other firms, university or the research institute, its investment in innovation per employee will increase around 443.0 million VND. This result suggests that firms which cooperate with suppliers, customers, research institutes or universities tend to invest more in innovation compared with those having no collaboration partnership. This result confirms the important role of collaboration partnership in innovation.

Industry-level factors

This study also investigates the relationship with innovation investment, between two indicators relating to industry characteristics: the competition in industry (HHI) and technological level of industry. However, the results show that there is no effect of competition in industry on innovation investment, indicating that a firm's innovation investment is not conditional on the competition pressure in the industry.

The variables related to the high-tech industry sector (*high-tech*) showed positive and statistical significance at the 5% level effect on innovation investment, with the estimated

coefficient of 212.2. This result means that firms in pharmaceutical, office equipment and computing machinery, TV and communication equipment, and medical precision instruments industries have more incentive to invest in innovation activities. The coefficient suggests that these firms will spend more than 212.2 million VND per employee in innovation activities as compared to firms in other sectors. However, this study did not find a significant effect with medium-high technology industry sector and innovation investment.

Province-level factors

The variable *pro_sup* representing the local government's budget on scientific and technological activities appears insignificant with innovation investment. This result differs with the other CDM studies, such as Griffith et al. (2006), Hashi & Stojčić (2013), or Masso & Vahter (2008), which show a positive and significant effect of financial support from the central government of the EU on innovation expenditures.

4.2. Innovation Output

This second stage relates to the relationship between innovation investment as input to the innovation process, and introduction of innovation new to the market, and new to the firm as output of the innovation process. As these two dependent variables are ordinal indicators, therefore, two separated Probit models to estimate this relationship are used. Model 1 shows the Probit estimation allowing for correlation between innovation new to the market and its determinants. Model 2 shows the results for innovation new to the firm. Table 4.8 reports the marginal effects of each model at the mean values of the independent variables for the two outcomes. The results for each factor group will be presented below.

Table 4. 8 Determinants of innovation output

VARIABLES	(1) Newmarket	(2) Newfirm
inno_investlabor	5.71e-06**	5.03e-06*
	(2.76e-06)	(2.73e-06)
small	-0.001	-0.001*
	(0.001)	(0.001)
medium	-0.001	0.000
	(0.001)	(0.001)
DExport	0.000	-9.87e-05
	(0.001)	(0.000)
FDI	-0.002**	-0.000
	(0.001)	(0.001)
laborskill	2.40e-05**	2.45e-05**
	(0.001)	(0.001)
DRD_colla	0.015***	0.011***
	(0.002)	(0.002)
Dtechtran_embodied	-0.001	-0.000
	(0.000)	(0.000)
Dtechtran_license	0.002**	0.000
	(0.000)	(0.000)
Dtechtran_supcus	-0.000	0.000
	(0.000)	(0.000)
mediumhigh	0.004***	0.000
	(0.001)	(0.001)
hightech	0.006***	0.003***
	(0.001)	(0.001)
pro_sup	0.013***	0.010***
	(0.002)	(0.002)
Observations	22,813	22,813

Note: ***, **, * indicate that the estimate is significant at 1%, 5%, 10% respectively.

Innovation investment

The results in Table 4.8 illustrate some interesting patterns. First, innovation investment intensity (*inno_investlabor*) appears positive and statistically significant at the 5% level for innovation new to the market and 10% level for innovation new to the firm. They show clearly that the greater innovation effort leads to a higher probability of having at least one innovation new to the firm or new to the market. The marginal effect indicates that, holding all other variables at their mean value, an increase in innovation investment per employee by one million VND, on average

increases the probability of firms producing a innovation new to the market by around $5.71*10^{-4}$% and $5.03*10^{-4}$% for innovation new to the firm. Although the impact was quite small, but in some extents the greater effect of innovation investment on innovation new to the market suggests that Vietnamese firms tend to be more efficient in converting innovation effort into a radical innovation compared to an incremental innovation.

Other determinants of innovation output

Human resources showed significance at the 5% level and positively associated with both two indicators of innovation output. The marginal effects show that, holding all the other variables at their mean value, a 1% increase in the percentage of qualified workforce will increase the probability of introducing innovation output by around $2.4*10^{-5}$%. These results are in line with the previous studies, and support the resource-based view.

Regarding to the external sources of knowledge, the results confirm the important role of the collaboration in R&D projects (*DRD_colla*), which was highly significant (at the 1% level) and positively associated with both two indicators of innovation output. The marginal effects show that, holding all the other variables at their mean value, the firms that cooperate with the other firms or research institutions are more likely to introduce the innovation new to the market by around 1.5%, and a innovation new to the firm by 1.1%, compared with the those that do not have this partnership. The greater effect of R&D collaboration on innovation new to the market suggests that the firms have the partnership in R&D projects tend to be more efficient in introducing innovation new to the market compared with those do not have this partnership.

In terms of technology acquisition, while most of the variables were not statistically significant, the *techtran_license* variable shows a statistical significance at the 1% level and a positive effect on innovation new to the market. The marginal effects show that, holding all other variable at their mean value, the firms who considered the acquisition of new technology through licensing the production process as the most important channel of technology acquisition are more likely to introduce the innovation new to the market by around 0.21%.

This result might reflect the fact that the main component of technology acquisition of Vietnamese firms has been embodied in the licensing rights of the new production process, which is a key source of technological innovation in Vietnam. This result is in line with Chudnovsky et al., (2006) in their study of Argentinean manufacturing firms.

Control variables

Regarding the *firm-level factors*, even small firms appear statistically significant and negative at the 10% level for products new to firm, the other indicators of firm size do not show a significant effect with both types of innovation output. This means that in this stage, firm size does not seem important. The same result is also observed for the case of exporting firms.

Different from the theoretical review, foreign ownership is negative and statistically significant at the 5% level with innovation new to the market, but an insignificant effect on the innovation new to the firm. The marginal effect indicates that, holding all other variables at their mean value, foreign-owned firms will decrease the probability in producing the innovation new to the market by 0.2% compared to private domestic firms.

In terms of *industry-level factors*, the results show that firms operate in the high-tech industry are strongly correlated with both types of innovation output (at the 1% level), while firms in the medium-high industry are positive and statistically significant with only new products to the market (significant at the 1% level) and insignificant with innovation new to the firm. The marginal effects show that, holding all the other variables at their mean value, firms that operate in the medium-high and high-tech industry are more likely to introduce innovation new to the market by 0.3%~0.6%. Similar with the results obtained in Stage 1, these results confirm the significant role of the high-tech industry in Vietnam.

Regarding the effect of the financial support from the local government, the variable *pro_sup* was statistically significant at the 1% level with a positive effect on both indicators. The estimated coefficient of innovation new to the market was 0.013, bigger than products new to a firm at 0.010. These results suggest that, holding all other variables at their mean value, the financial support from the local government will increase the probability in producing the innovation output by around 1.3% and 1.0%. These findings are contrary with the indications of Hashi & Stojčić (2013), that innovation subsidies from the EU central government seem not to convert efficiently into innovation output. These results confirm the role of the local government's financial support for innovation. Although these measures do not motivate firms to increase their own investment, but when they can receive these incentives for their innovation projects, it may increase the innovation output efficiency.

In the next section, I will discuss the results of the firm performance equation as the final stage of the CDM model.

4.3 Productivity Stage

Table 4.9 shows the results of the OLS estimates of the firm performance (productivity) equation. The purpose of these estimates is to examine the effect of innovation on labor productivity. The results are presented bellows.

Table 4. 9 Determinants of productivity

Variables	Productivity
newmarket	56.00
	(168.9)
newfirm	-53.80
	(114.4)
laborskill	1.366**
	(0.686)
physical_capital	0.196**
	(0.0800)
small	212.6***
	(48.83)
medium	224.9***
	(54.82)
DExport	158.6**
	(63.08)
FDI	89.06*
	(49.19)
DRD_colla	708.8*
	(420.4)
HHI	-482.1***
	(117.7)
mediumhigh	127.9***
	(46.59)
hightech	415.8***
	(103.9)
Constant	423.2***
	(60.46)
Observations	22,813
R-squared	0.103

Note: ***, **, * indicate that the estimate is significant at 1%, 5%, 10% respectively.

Innovation Output

As shown in Table 4.9, none of the innovation output indicators have a significant impact on labor productivity in Vietnam. Similar results were reported by De Jong & Vermeulen (2006) and Alvarez et al., (2011). Although the results are contrary to expectations, appearing even negative in the case of innovation new to the firm, as suggested by Barlet et al. (2000) and Reçica (2016),

we can argue that the amount of innovation output in this survey is rather small and as such may not exert a strong impact on the labor productivity of firms.

Other determinants of productivity

The results from Table 4.9 also indicated that, the contribution of the higher educated workforce to labor productivity is positive and statistically significant at the 1% level. The coefficient of 1.366 suggests that a one percentage increase of the qualified workforce would increase the labor productivity by around 1.366 million VND. This finding is in line with the majority of empirical results about other countries and confirms the role of human capital in raising the labor productivity (e.g., France, Switzerland, Argentina, Brazil, Mexico (Raffo et al, 2008; Guzman, 2014), Chile (Benavente, 2006).

The intensity of physical capital appears positive and statistically significant at the 5% level. The estimated coefficient suggests that, holding the other variables at their mean value, an increase in physical assets per employee by one million VND, on average increases the productivity by 0.196 million VND.

Control variables

In terms of firm size, the results show that both small and medium-sized firms were positive and statistically significant at the 1%. The coefficients suggest that, holding the other variables at their mean value, small and medium-sized firms are more productive than large firms.

Export (*DExport*) is positive and statistically significant at the 1% level, indicating that participating in the foreign market stimulates exporting firms to improve their production. This result is in line with Kunst & Marin (1989). It is worth noting that, as stated in Section 2.4.2, there is a causal relationship between export and productivity. However, for the purpose of analysis, this study focuses only on the impact of export on productivity.

The effect of foreign ownership on a firm's labor productivity was positive and highly significant (at the 1% level). This finding confirms the results from the majority of previous empirical studies. This may be explained by the fact the foreign owned firms have superiority in firm-specific assets, such as technology, financial resources, brand, and management capabilities, and therefore gain a better performance in labor productivity.

In terms of industry-level factors, the Herfindahl Index (HHI) is negative and statistically significant at the 1% level, indicating that labor productivity correlates negatively with a higher market power. This result supports the theoretical review in the previous section the high level of

competition forces firms to be more efficient in order to survive in the domestic market. However it differs with the study on Vietnamese SMEs by Calza et al., (2019) in which they did not find a significant effect of HHI on a firm's productivity level.

Regarding the industry sector, both variables representing medium-high tech and high-tech industry sector was positive and statistically significant at the 1% level with labor productivity. This may be because a higher level of competition is likely to exist among firms in medium and high technological industries compared to low technological firms.

4.4 Robustness Check

Although the important findings are derived from the estimation of Table 4.9, the results are subjected to further investigation of the other potential factors. In this subsection, I extend my analysis to examine possible productivity effects through the following three channels: the interaction between firm size and R&D collaboration, the FDI presence, and foreign competition.

The results are presented in Table 4.10, with Model 1 for the interactive effects of firm size and R&D collaboration, Model 2 for the spillover effects of FDI, and Model 3 for the effect of foreign competition, respectively. The detailed explanations for the results are given below.

Table 4. 10 Robustness check

VARIABLES	Model 1	Model 2	Model 3
newmarket	48.09	3.280	-6.114
	(172.3)	(172.5)	(171.8)
newfirm	-50.09	-103.5	-110.2
	(108.2)	(110.2)	(110.3)
laborskill	1.381**	1.048	1.046
	(0.686)	(0.681)	(0.682)
physical_capital	0.196**	0.196**	0.196**
	(0.0799)	(0.0799)	(0.0799)
small	220.3***	226.1***	226.0***
	(48.85)	(49.24)	(49.24)
medium	233.1***	235.4***	235.7***
	(54.85)	(54.85)	(54.85)
small_RDcolla	-2,452	-2,484	-2,483
	(1,606)	(1,605)	(1,604)
medium_RDcolla	-2,439	-2,486	-2,502
	(1,604)	(1,601)	(1,602)
DRD_colla	2,633*	2,650*	2,650*
	(1,593)	(1,592)	(1,592)
DExport	158.8**	173.6***	173.3***
	(63.09)	(64.25)	(64.44)
FDI	88.83*	136.4***	135.6***
	(49.18)	(46.57)	(46.04)

province_FDInumber		-5.875**	-5.873**
		(2.944)	(2.944)
province_FDIlabor		-283.1***	-274.7***
		(75.14)	(80.42)
HHI	-480.4***	-484.9***	-481.7***
	(117.7)	(117.3)	(119.0)
import_penetration			35.62
			(86.23)
mediumhigh	125.0***	128.5***	100.4
	(46.70)	(46.60)	(73.64)
hightech	413.6***	414.1***	350.4*
	(103.9)	(103.8)	(206.4)
Constant	416.2***	491.0***	465.6***
	(60.17)	(59.51)	(75.07)
Observations	22,813	22,813	22,813
R-squared	0.104	0.104	0.104

Note: ***, **, * indicate that the estimate is significant at 1%, 5%, 10% respectively.

4.4.1 Interactive effects of firm size and R&D collaboration

In Table 4.9 of the previous section, the results show that small and medium firms are more productive than large firms. This could be due to a concentration of small firms in more productive industries. This result is consistent with the study of Pham & Nguyen (2017) on the determinants of 1,943 SMEs' labor productivity of Vietnam. They found a negative impact of firm size on labor productivity in apparel and rubber sector.

It is also possible that for SMEs, the R&D collaboration partnership will have a positive impact on productivity growth. Several studies concerning SMEs' innovation suggests that, as compared to large firms, SMEs are more financially constrained in undertaking R&D projects directly (Beck&Kunt, 2006; Abor&Biekpe, 2007). By engaging the R&D collaboration with competitors, suppliers, customers, research institutes and universities, SMEs can overcome this disadvantage. In particular, participating in the collaboration partnership allows SMEs to minimize the risks and costs of innovation (Das&Teng, 2000), increase their absorptive capacity because such collaboration maximizes firms' internal knowledge stock (Ur, 2016), and improve firm performance (Ahuja, 2000; Belderbos et al, 2004; Un et al, 2010).

In the literature, there is a number of empirical studies have found a positive impact of engaging in R&D collaboration on firm performance, such as labor productivity (Coe&Helpman, 1995; Adams& Jaffe, 1996; Branstetter, 2001), sales growth (Cincera et al, 2004), sales of innovative products (Klomp & Van Leeumen, 2001; Loof&Heshmati, 2002, Criscuolo&Haskel, 2003). The literature also suggests that different R&D collaboration strategies may have different impact on

firm performance. For example, Belderbos et al (2004) investigated the impact of R&D collaboration on firm performance of 2,056 Dutch manufacturing firms in the period 1996-1998. They analyzed the effect of four types of R&D partners (competitors, suppliers, customers, and universities and research institutes) on two performance measures: labor productivity and growth of sales from innovative products. They found that supplier and competitor cooperation have a significant impact on labor productivity growth, while the cooperation with university and research institute positively affects growth in sales of innovative products.

In order to check on whether R&D collaboration has positive impact on SMEs' productivity growth or not, I include interaction terms between R&D collaboration and variables for small firms and medium firms and expect the interaction terms to be statistically significant.

However, the results of Model 1 show that the both two variables of small and medium-sized firms were not significant, suggesting that for small and medium-sized firms, the R&D collaboration do not matter for productivity gains.

4.4.2 Productivity spillover effects of FDI

A potential concern when studying the effects of foreign owned firms is related to the productivity spillover effects from FDI to domestic firms. The literature suggests that the presence of FDI in the host countries generate important externalities which may improve the productivity level of local firms. These externalities, which are commonly considered as "positive spillover effects", can occur via three channels: (i) demonstration effects, (ii) competition effects, and (iii) labor turnover effects. The first refers to the imitation and acquiring of new technology, marketing and managing skills by domestic firms from foreign owned firms, which results in productivity improvement. The second relates to the competition pressure which generated through the entry of FDI into the host countries. Under increased competition, domestic firms are forced to operate more efficiently through adopting new technology, introducing new products or reorganizing the production process (Blomstrom&Kokko, 1998; Aitken&Harrison, 1999; Javorcik, 2004). Lastly, the domestic firms may also benefit from labor turnover effect when skilled workers move from FDI to domestic firms.

However, FDI can also reduce productivity of domestic firms, i.e. generate "negative spillover effect". This effect was observed in the study of Aitken&Harrison (1999) on the case of Venezuela, and interpreted as "a market-stealing effect". They explained that the foreign firms with the advantages on technology and knowhow may take the market share of domestic firms, which could force domestic firms to produce less output, making them back up their average cost, and hence

reducing their productivity. In addition, Jovorcik (2004) and Liu et al (2009) also argue that FDI may prevent the technology leakage by intellectual property and trade secrecy, or choosing to locate in the countries or industries where local firms have limited imitative capacity to acquire their technology.

Foreign presence can be measured by two ways: (i) the share of foreign firms in the total number of firms, (ii) the ratio of foreign firms' employment in the total employment in that province or industry. In this study, following Aitken&Harrison (1999) and Tran et al (2016), I extend the analysis by employing two foreign-related spillover factors as explanatory variables: (i) the share of foreign owned firms in the total number of firms, (ii) the share of total employment by foreign owned firms, within a given province[57]. These variables enable this study to investigate whether the presence of foreign owned firms contributes to the productivity growth of local firms in a province.

Model 2 in Table 4.10 provides the results for the spillover effects of foreign owned firms. The coefficients of two variables, *province_FDInumber* and *province_FDIlabor*, were negative and statistically significant at 5% and 1% level, suggesting that the high density of foreign owned firms at the province reduces the level of productivity of local firms.

These results are consistent with Aiken&Harrison (1999) on the case of Venezuela, Konings (2001) on the study of emerging market economies including Bulgaria, Romania, Poland, and Tran et al (2016) for the case of Vietnam from 2000-2005. These results might be explained by the "market stealing", or negative competition effect. As explained by Aiken&Harrison (1999), Tran et al (2016), many FDI firms in Vietnam are small in size and their presence cause tough competition in that province which could force local firms to produce less outputs; this in turn could push them up their average cost and hence lower the productivity of these firms.

4.4.3 Foreign competition

As shown in the estimated results of Chapter 3 and section 4.3 of this chapter, the coefficients of industry-level factor denoted by industry competition level (HHI) were negative statistically significant at 1% level, suggesting that firms in more competitive industries could obtain higher productivity growth. These results confirm the assumption that the high level of competition forces firms to be more efficient in order to survive in the domestic market. However, the HHI is an

[57] Ideally, the share of industrial output of foreign owned firms should be included in the analysis, in order to investigate the contribution of foreign owned firms in the province. However, due to the limitation of information in terms of industrial output in the databases, this research is not able to include this variable.

imperfect measure of competition as it does not capture the effect of foreign competition, while the Vietnam's economy is in the context of increasing economic integration. Therefore, in order to capture the impact of foreign competition on productivity, I employ a different measure of competition: import penetration.

Import penetration measures the extent of import competition in domestic market denoting the significance of import in the domestic market. It is calculated by the following way, for each industrial sector, country and year.

$$IP_{ijt} = \left(\frac{M_{ijt}}{Q_{ijt} + M_{ijt} - X_{ijt}}\right) * 100$$

where M_{ijt} is total imports of product i of industry j in year t. Q_{ijt} is the production of product i while X_{ijt} is the exports of product i in industry j in year t. Increases in import penetration is assumed to enhance productivity in developing countries. Through importation, knowledge and technology is embodied in goods can be transferred to domestic firms, that are used for developing new products, thereby leading to technological upgrade and productivity improvement (Mendoza, 2010). This effect has been witnessed in Chile (Kasahara & Rodrigue, 2008), and other Asian developing countries (Thangavelu & Rajaguru, 2004).

I follow Tinh et al (2014) and Le et al (2017) to construct a measure of import penetration in different technological level of sectors. For the calculation, I have used two sources of data. First, the import and export data were taken from UN Comtrade database, which classified into four groups of sectors: (i) low-tech, (ii) middle-low tech, (iii) medium-high tech, and (iv) high tech industrial sector. Second, the production output value in each group of sector was drawn from the Statistical Yearbook 2010-2013 published by GSO[58].

The estimation result of *import_penetration* is presented in Model 3 of Table 4.10. The coefficient of this variable is not significant, suggesting foreign competition is not correlated with firm's labor productivity. This result is consistent with the findings of Tinh et al (2014), Dang (2017) on the effects of Chinese import penetration on Vietnamese firms innovation and productivity. They explained that, most of imported products are complementary rather than substitute goods in relation to domestic products. Therefore, they do not create pressure on domestic firms to innovate. Another possible explanation is that firms may have different competitive capacities in competing with imported goods. Bloom et al (2016) explained that in compared with large firms, small firms or firms in low level of technological industries may find

[58] The calculation of import penetration is shown in Appendix 9.

it hard to compete with imported goods. This explanation can reflect the fact that most of the Vietnamese manufacturing firms tend to invest more in the improvement of existing products, in response to intensifying pressure from imports.

In summary, the overall findings are consistent with the main results of Table 4.9. Exceptions include the interaction terms between firm size and R&D collaboration, and foreign competition, which are not statistically significant in Model 1 and Model 3. This implies that the R&D collaboration (for SMEs), and foreign competition are not decisive variables for productivity. In addition, the results of productivity spillover effects of FDI suggest that the presence of foreign owned firms reduce the productivity growth of local firms.

4.5 Comparison with the other CDM studies

4.5.1 Innovation Investment

Generally, the findings are mainly in line with the previous literature and consistent with other CDM studies. Among the three groups of factors, I found that firm specific factors are shown to be important features of Vietnamese firms' innovation process. The results suggest that firms with a large size, firms in high-tech industry sectors, engaging in exporting, and having collaborating partnership in R&D projects are more intensive in innovation activities. These results are consistent with Schumpeter's hypothesis and the argument in Chapter 3. The similar effect of firm size is also reported in CIEM et al., (2016) and Hien & Santarelli (2013), reflecting the poor financial and research capacities of SMEs compared to large firms.

With respect to the collaboration in R&D, the results show a strong positive relation with innovation investment. This result is in line with Vergelers & Cassiman (1999) and OECD (2009), in the case of industrialized countries which states that R&D collaboration is associated with higher innovation efforts. This evidence that Vietnam firms differ with six Latin American countries shows that cooperation in R&D is complementary to innovation investment (Crespi & Zuniga, 2010).

Regarding the effect of export and foreign ownership, operating in the international market stimulates firms to invest more in innovation, while foreign ownership and technology acquisition are not shown to have significant impacts on a firm's innovation activities. These results can be interpreted that operating in a highly competitive environment in the international market with high innovation activity of foreign competitors pushes Vietnamese firms to invest more in R&D and non-R&D activities. On the contrary, the non-significant result and negative effect of foreign

ownership indicates foreign owned firms are less intensive in innovation than private domestic firms. This result is consistent with Newman et al., (2009) and Vu et al., (2017).

Contrary to expectations, public subsidies from the local government do not promote innovation efforts of Vietnamese firms. This result indicates that the local government's policy in innovation does not have a real effect on a firm's innovation. This problem has been raised by some research. CIEM/UNDP (2004) and Newman et al (2009) argued that there is a gap between the policy and the reality which constraints firms in getting financial support from the government. In fact, most of the policies concentrate on high-technology projects, which is more suitable for large firms and state-owned firms. As shown in the previous section, most of the innovative firms in Vietnam are small in size and privately owned, so they have less incentive in getting support from the government compared with large firms and state-owned firms. Furthermore, in a research study on textile and chemical sectors in Hanoi and Ho Chi Minh city, CIEM (2004) showed that over 90% of firms believe that the main factor influencing their decision to invest in innovation is competitiveness in the market rather than government incentives (as cited from Newman et al, 2009).

4.5.2 Innovation Output

In line with the literature, I found that more investing in innovation, meant a higher probability of obtaining innovation output with a higher degree of novelty, specifically in the case of innovation new to the market. These results were also observed in both developed and developing countries. For example, Griffith et al., (2006) reported the coefficient of 0.3 for R&D investment on product innovation in four European countries, France, Germany, Spain and the United Kingdom. In developing countries, Crespi & Zuniga (2012) reported a coefficient of 0.18 for Costa Rica, and even 1.16 for Chile.

Furthermore, human resources, the collaboration in R&D, licensing agreement, and public subsidies were also found to have a positive and significant impact on innovative performance. Among these, the collaboration R&D variable showed a strong statistical significance at 1% and a positive impact on both indicators of innovation output. This indicates that for Vietnamese firms, collaboration seems to be an important strategy to develop new products, which may lower the risk and cost of large research projects, reduce the time requirements, but also enable firms to learn about the new technologies at a relatively low cost (CIEM et al., 2012).

Interestingly, I found that foreign owned firms have a negative association with innovation new to the market and no relation with innovation new to the firm. This negative result coincides

with the estimates for Chile, Colombia, Panama, Argentina, Uruguay, and Mexico (Crespi & Zuniga, 2012; Brown & Guzman, 2014). The aforementioned might be explained by the fact that innovation is usually carried out by multinationals in their countries of origin or in other locations in industrialized countries. It may also reflect the patterns of export-oriented FDI in developing countries in general, and Vietnam in particular. Xing&Wan (2006) found that most Japanese FDI in four ASEAN countries (Indonesia, Malaysia, Philippines and Thailand) exported their products to their home country and other overseas markets. As one of the largest FDI recipient countries in the region, Vietnam has been also used as an export-platform for foreign owned firms. Indeed, as calculated by Xuan & Xing (2008), on average, USD2.5 of FDI in Vietnam is associated with one dollar in export.

Moreover, unlike the findings from some studies, most of the external technology acquisition was found to be not significant in enhancing a firm's innovative performance for either of the innovation indicators, suggesting that among the technology acquisition channels, only licensing agreements are directly aimed at strengthening firms' innovation capabilities.

Although the results suggest that the collaboration in R&D and licensing agreements can supply resources to help firms improve their innovative performance and increase the degree of novelty of innovation, they do not imply that such a strategy is either necessary or a sufficient condition for innovation. Kang et al., (2015) argued that a heavy reliance on these external resources may cause the trade-off effect between external technology acquisition and internal R&D activities, that is, the more resources a firm uses to invest in external technological acquisition the less they are able to invest in internal R&D. They also called this situation a "double-edge sword".

The results of this study have two implications. Firstly, they support the idea that innovation is a process that is largely built on a firm's internal capabilities and resources and warns against the risk of overrating external knowledge sources. The results also confirm that internal R&D activities still present a strategic asset in the development of new products, and that developing and implementing these activities is significantly more important than employing strategies involving external partners. In this respect our study brings additional insight into the complex process of innovation and proves that not all external knowledge sources are equally important for innovation. According to our results, firms need to establish and nurture collaboration with different partners in the wider international environment in order to boost their innovativeness

4.5.3 Productivity

In the productivity model, as the importance of product innovation for productivity may differ by the degree of novelty, I disentangle product innovation into two categories: (i) new to the market, (ii) new to the firm, and estimate their effects. Unexpectedly, the results did not show a significant impact from both categories of innovation output on labor productivity. These results are consistent with the evidence from other developing countries such as Chile (Benavente, 2006) and Brazil (Goedhuys, 2007b). In Vietnam, CIEM et al., (2016) also reported similar results in Vietnamese SMEs. The reasons for these results could be explained in the following ways.

First, as mentioned in Chapter 3, most of the Vietnamese manufacturing firms are characterized by a small size and a weakness in their technological capability as well as a lack of financial resources, so they may not have enough available capabilities to effectively producing their innovations. The capability to produce innovation can be seen as a complementary asset (Teece, 1984) to the innovation and may only be present in a large firm.

Second, it may be that Vietnamese firms are less motivated to develop new technology/products to improve their productivity. They might strive to develop new technology/products only when they are forced to do so or by market developments (Vermeulen et al, 2003).

Finally, one possible reason is that it takes some time for innovation to affect a firm's productivity due to longitudinal effects (Vermeulen et al, 2003; Alvarez et al, 2010). The innovation of the current period would affect the labor productivity performance in the next period, not in the current or previous periods.

Instead of a non-significant relationship between innovation output and productivity, this study found significant effects from the other determinants, consistent with the traditional patterns in the empirical literature on innovation. These results suggest that the higher percentage of higher educated workforce the firms have, participation in exporting activities, firms with foreign ownership, the higher technological intensity of the industry sector, the higher level of market competition, therefore, the higher productivity level that they have.

Firm size is one of the important factors which directly affects firms' productivity. Contrary with the general view on the role of large firms, in this study large firms seem to be less productive than smaller firms. This result supports the evidence found from Italian manufacturing firms in the study of Hall et al., (2009).

The level of competition in industry directly affects the relative productivity of a firm, indicating that in more competitive sectors, firms must be efficient in order to survive, and consequently, their average levels of productivity are higher than less competitive sectors.

5. Conclusion

In this chapter, I have examined the relationship between innovation and productivity in Vietnam's manufacturing sector using firm level data over the four-year period of 2010 to 2013. The link between innovation and productivity is estimated in a three-stages model, namely the CDM model, that describes the innovation process, including (i) innovation investment, (ii) innovation output, and (iii) productivity.

The major findings are as follows. First, consistent with much of the literature on the link between innovation and firm performance, the findings confirm that in Vietnam, firms that invest more in knowledge are more likely to introduce new technological advances. Second, in the stage of making the decision on innovation investment, Vietnamese firms relied on the resources from the collaborators in R&D projects, the knowledge accumulated from foreign partners through the participation in exporting. Third, unexpectedly, regarding the effect of innovation output on productivity, this study did not find an association between both categories of innovation output with labor productivity. Finally, the study also takes into account the combined effect of firm size and R&D collaboration, the productivity spillover effects of foreign owned firms and foreign competition as robustness check. The negative sign of two estimated coefficients of productivity impact of foreign owned firms suggests that the presence of them may reduce the productivity in local firms.

Thus, these empirical results partly support the research hypothesis "*The innovation expenditure is positively associated with the successful introduction of innovation output (new to the market and new to the firm), which in turn contributes to a greater level of productivity.*"

The results of this study have important implications for the Vietnamese economy. First, large firms are also found to invest more in innovation and have a higher probability of developing innovation, compared with the smaller firms. This finding suggests that Vietnamese small firms are at a disadvantage against large firms due to factors that prevent them to engage in those kinds of activities. To remove these obstacles which may be preventing SMEs to engage in innovation activities is a concern for policy-makers.

Second, a worthy implication from the results relates to foreign ownership. I found that it was not foreign owned firms, but rather less productive private domestic firms that were the main drivers of innovation activities. Foreign owned firms were found to have an insignificant effect on innovation intensity, and even did not exert a positive impact on producing innovation new to the market compared to domestic private firms. This result provides proof that foreign ownership is not a guarantee for innovation in Vietnam. This phenomenon is also pointed out by several other studies, such as Newman et al., (2009) and Vu et al., (2017). Indeed, this can be explained that foreign owned firms in Vietnam focus on the cheap labor industry and low technology industry, which is not active in innovation. After more than 20 years attracting FDI, despite numerous policies to promote technology transfer from foreign owned firms, it is hard to see any clear innovation-related effect from this investment. It may also imply to policy makers that it is crucial to create an environment, especially a legal framework, to encourage innovation for private domestic firms.

Third, the high significant and positive effect for high-tech industry sector in all three models implies the advantages the high-tech industry has in innovation. In the long run, Vietnam should keep prioritizing the development of high-tech industries instead of relying on cheap labor and natural resources in the low-tech industry sector.

On the practical side, this study is one of the first studies using the CDM model to examine the impact of innovation process on productivity in Vietnam. However, this study has also faced some limitation. First, with respect to the methodology, the future research should account for selection bias and the endogeneity problem in the relationship between innovation and firm performance which limited the robustness of the study. The literature suggested the potential endogeneity of innovation outcomes leads to productivity, since firms that are more productive are potentially more likely to carry out innovations. One of the common solutions for this problem is the employment of instrumental variables.

However, the main issue in using instrumental variables is finding the proper instruments, which affects innovation but does not affect directly with firm performance. Unfortunately, the lack of suitable instrumental variables in this dataset did not allow for the inclusion of this endogeneity problem. Thus, future research should extend survey datasets and focus on addressing this problem.

Second, future research could be extended to the feedback effect of a firm's performance in the innovation process. As suggested by Kline & Rosenberg (1986) and Marques & Monteiro-

Barata (2006), the innovation process includes various feedbacks. Innovation output may affect the level of investment in innovation. The firm's performance can influence all the earlier phases of the innovation process. These feedback effects can be analyzed by using a simultaneous equation model, as suggested by Kline & Rosenberg (1986).

CHAPTER 5. INNOVATION AND PRODUCTIVITY- A COMPARATIVE STUDY OF OWNERSHIP STRUCTURE

1. Introduction

In Chapter 4, I examined the relationship between innovation and labor productivity in Vietnamese manufacturing firms in general, using three-stage econometric models. In order to have a more comprehensive analysis on a firm's behavior in a related topic, in this chapter I further investigate the innovative behavior of Vietnamese manufacturing firms by conducting a comparative study of ownership structures. Specifically, I investigate the differences in innovation patterns, innovation performance, and productivity between foreign owned and private firms.

For manufacturing firms in Vietnam, firm ownership is a crucial point for comparison of innovation performance and productivity. The economic theory of foreign owned firms is based on the assumptions of their superiority in technology and productivity over the domestic firms, which leads to the differences in innovative performance (Dachs & Ebersberger, 2009; Ebersberger et al, 2005; Bellak, 2004). It is commonly argued that foreign owned firms possess productivity advantages that allow them to compete under better conditions in external markets and that could explain the technological gaps between them and non-internationalized domestic firms (Bellak, 2004).

An effective means of comparing foreign and private firms is by comparing their innovative indicators, such as innovation inputs and outputs. As suggested by Criscuolo et al, (2010), Stiebale & Reize (2008) and Knell & Srholec (2005), the differences in productivity of foreign firms relative to domestic firms could be explained by the differences in knowledge, and using a production function approach in studying the effect of FDI may identify the mechanisms of their innovative behavior (and knowledge spillover to domestic firms).

A set of empirical works have attempted to estimate the differences of these two groups of firms, however, the evidence is mixed. While some studies found a higher propensity of foreign firms to get involved in R&D and develop innovation in developed countries (Castellani & Zanfei, 2003; Criscuolo et al., 2010; Dachs et al, 2008; Siedschlag et al, 2010), others revealed the weak effects of foreign ownership on innovation and productivity in some developing countries (Almeida & Fernandes, 2008; Alvarez, 2001; Masso et al, 2012). These results indicated that the relationship between firm ownership and innovation has been more complex than initially thought.

Moreover, conclusive evidence with regard to the effects of foreign ownership on innovation is still not available, particularly for developing countries and transition economies like Vietnam, the focus of this study.

Vietnam provides a particularly interesting context to examine links between ownership and innovation for at least three reasons. First, it is a transition economy with the role of private firms accounting for 90% of the total number of firms and 40% of the total GDP (GSO, 2015). Second, as one of the most largest FDI recipients among the developing countries, it has a relatively FDI-intensive industrial economy, reflected in the fact that FDI via wholly owned MNC subsidiaries account for 70.2% of the export output in 2016[59] . Third, it has gone through a phase of macro-economic change in the last three decades, and it may reflect common characteristics of other developing countries that went through similar phases.

This chapter aims to answer the question *whether foreign ownership matters for innovation activities of Vietnamese manufacturing firms?*

In order to answer this question, this study first compared the selected statistic descriptions of the innovation performance and productivity, and the various sources of knowledge, including internal sources such as R&D activities and non-R&D activities, as well as external sources through collaboration with other firms, and technology acquisition. Then, in the main section, this study conducts the empirical analysis to see how the innovative behavior and these sources are related to successful innovation performance.

The analysis yielded the following results. First, foreign firms are likely to be less intensive in innovation than private firms. Over the period 2010-2013, just 2.68% of foreign firms reported engaging in either R&D activities or non-R&D based innovative activities, with an average innovation expenditure (as the ratio of sale values) of 0.006%. In contrast, 9.38% of private firms reported engaging in innovation activities with the average innovation expenditure of 0.23% in the total value of sales. This result is in line with the evidence of Masso et al (2012) in the case of Estonia.

Second, there is a similar propensity of two groups of firms introducing innovation outputs, even in innovations new to the market, private firms seem to be more innovative than foreign firms. Furthermore, the evidence shows that the majority of innovation performance of private firms is

[59] Website of EU-Vietnam business network (https://evbn.org/vietnam-fdi-2017-almost-us25-5-billion-34-3-last-year/)

accounted for by their intensive access to external knowledge sources via the collaboration partnership.

Finally, I also found that although foreign firms are less likely to be active in innovation than private firms, their labor productivity is substantially higher than that of private firms. This superiority can be explained by a larger amount of physical capital (such as facilities, factory), one traditional input indicator of production function.

This study contributes to the literature in two ways. First, , this study seems to be one of the first studies that investigates the innovative performance of foreign ownership, on the comparative perspective with domestic firms, in the context of Vietnam. By using the Vietnam Technology and Competitiveness Survey with a large sample of firms on two types of ownership, this study tracked the differences of innovative performance, and also studied the effect of other contextual factors on the link between innovation and productivity. Second, for the analysis, being consistent with Chapter 4, I used the CDM model to identify the relationship between innovation and productivity of two groups of firms. By doing so, I extended the model of Criscuolo et. al (2005) by considering the production function, rather than focusing only on the knowledge production function.

The structure of this chapter is as follows. In the next section, I review the literature and outline the hypothesis explored in this chapter. In section 3, I present the methodology and the comparison of the selected variables between foreign firms and domestic firms. In section 4, I report the estimation results. The main findings and conclusion are discussed in section 5.

2. Literature Review and Hypotheses

2.1. Literature review on the effects of foreign ownership in innovation

In recent years, investigating the effects of foreign ownership (in this context is the Multinational Enterprises' (MNEs) subsidiaries from abroad) in relation to innovation activities has been a focal analysis in the literature, especially for manufacturing firms in developing countries. There are three streams of literature on the relationship between foreign ownership and innovation in developing countries. The first stream relates to the motives and patterns of international R&D activities of the MNEs. The second stream investigates the innovation performance of foreign subsidiaries in the host country. The third stream focuses on the knowledge spillover effect of foreign subsidiaries on the domestic firms in the same sector as well as in other sectors. In this study, for the purposes of analysis, I focus on the first two streams of existing literature.

In the first stream of literature, there are two types of motivations for the foreign subsidiaries to undertake R&D in the host country that have been identified: (i) home-base exploiting, and (ii) home-base augmenting R&D (Dunning & Narula, 1995; Kuemmerle, 1997). The former view is based on the product life cycle model proposed by Vernon (1966), which suggests that R&D activities of FDI are primarily motived by the exploitation of their existing firm-specific advantages in foreign investment, in terms of technological capabilities. Vernon (1966) argued that the R&D activities and product innovations are concentrated at the headquarters in the home country, allowing efficient communication and coordination among researchers and management (Hegde & Hicks, 2008). In this argument, the MNEs might not shift their R&D activities abroad, and if any, these activities are limited to a mere supportive role in adapting the existing products and technologies to the requirements of the local host market (Lall, 1979). This adaptive type of R&D activities are more common in foreign subsidiaries in developing countries, where are weak in the technological field (Kuemmerle, 1999; Marin & Bell, 2010). Despite some criticism on its insufficient explanation of the decentralization of the MNEs' innovation activities, this theory has shown that home-base exploiting R&D activities are still an important motive for the MNEs' R&D activities abroad (Hegde & Hicks, 2008; Sadowski & Sadowski-Rasters, 2006).

The latter types of foreign subsidiaries' motivation on innovation relates to "home-base augmenting R&D". It is argued that the MNEs invest in R&D abroad not only to exploit their competitive advantage, but also to gain new advantages or complementary assets which help sustain or further global competitive advantages. This kind of investment consists of targeting technologies in which the investing firms have a relative advantage at home and the host country is also relatively strong in technological capabilities (Le Bas & Sierra, 2002). Such R&D activities are aimed at acquiring competitive advantages which are complementary to those already possessed by the firm (Dunning & Narula, 1995).

This perspective is based on the evolutionary theory of firms, which provides a complementary view of the product life cycle theory. In this view, the MNEs are considered as a knowledge integrating institution which "create a regular and cumulative flow of knowledge and capabilities from locationally differentiated sources" (Cantwell, 2014). Thus, the MNEs create networks of subsidiaries that are interconnected by knowledge flows. Relating to the role of subsidiaries within these networks, Gupta & Govindarajan (1991) demonstrated that each subsidiary can be a recipient of knowledge (knowledge inflows) and a contributor of knowledge (knowledge outflows) to the rest of the corporation, as the existence of an international dispersion of specific knowledge and the declining technological gaps among countries (Gupta & Govindarajan, 1994). In short, this line

of arguments emphasizes the role of the subsidiaries on R&D and innovation activities, which allows the MNEs to acquire, combine, and integrate new knowledge in the world to gain technological advantages as sources for their competitive advantage.

Concerning the internationalization of R&D activities, the second stream of literature relates to the empirical studies which focuses on assessing the innovation performance of foreign subsidiaries in the host country. This line of literature is based on the assumption of the gaps in technology, innovation, and productivity between foreign owned firms and domestic firms. According to this literature, foreign owned firms (and exporting firms) possess the productivity advantages that allow them to compete under better conditions in international market (Bellak, 2004). The productivity can be explained by a higher input of capital or technology intensity of foreign owned firms (Bellak, 2004). For example, Oulton (1998) examined the productivity gaps in the UK manufacturing sector by using production function and found that in foreign owned firms, labor productivity is 38% higher than that of domestic firms, which is mainly determined by their higher physical and human capital intensity. Oulton (1998) explained three reasons for these gaps: (i) domestic firms face a higher cost of capital than foreign owned firm, which relates to the financial constraints to acquire funds for investment, (ii) the domestic firms are more exposed to the domestic markets, while foreign firms may be better able to spread the risk globally, and (iii) foreign firms may be using superior technology and management methods which happen to be more intensive in both capital and skilled labor.

More recent literature has shifted their focus on productivity gaps to the differences in innovation indicators, such as innovation input and output. Stiebale & Reize (2008) suggested that investigating the differences in innovation indicators is a better way to estimate the innovation performance of foreign owned firms in comparison with domestic firms, rather than the differences in productivity. In line with this suggestion, there is a body of literature that uses the CDM model to assess the innovation performance of foreign owned firms.

A notable study from Criscuolo et al. (2010) examined the role of global engagement (foreign owned firms and exporters) and innovation activities of firms in the UK during the period 1994-2000. They argued that the differences in productivity can be explained by the differences in knowledge production and the greater learning capability. They found that globally engaged firms are likely to generate more innovation outputs (measured by the value of sales of product new to the firm and the number of product or process innovation), which feeds into higher productivity. They demonstrated that the superiority of innovation performance is not only by their internal

research, but mostly accounted for by their greater use of different sources, such as suppliers, customers, universities, and their intra-firm pool of information.

In a similar vein, Siedschlag et al, (2010) also confirmed that foreign owned firms in the UK are more likely to invest in innovation and furthermore they are more likely to be successful in introducing innovation output and higher productivity level than domestic firms.

Dachs et al, (2008) compared the innovative performance of foreign owned and domestically owned firms in five European countries (Austria, Denmark, Finland, Norway and Sweden). They concluded that there was a common pattern of innovative behavior among foreign firms in these countries: foreign firms are at similar levels of innovation input, but higher levels of innovation output and higher labor productivity compared to domestic firms. Even, in four of the five countries, subsidiaries showed a similar or even a higher propensity to cooperate with the other partners than domestic firms.

For developing countries, in a set of works using the CDM model found that foreign ownership is weakly associated with innovation. In a study of Estonia, Masso et al (2012) found that foreign firms have lower innovation intensity, and even less innovative than domestic firms (after the inclusion of control variables). They explained that this is due to the small size of the local market and the lack of local skills are the main constraints for foreign firms to innovate.

Alvarez (2001) showed that for Chilean manufacturing firms, exporting was a more important determinant of technological innovation than foreign ownership. The results of Alvarez (2001) also suggested that foreign ownership is likely not associated with product and process innovation, but it affects the probability of introducing marketing and design innovation.

In a larger sample, Almeida & Fernandes (2008) studied the relationship between the openness and technological of 43 developing countries and found that firms with majority foreign ownerships were less likely to engage in innovation than those with a minority foreign ownership.

In short, the theoretical literature suggests a role of foreign ownership in innovation activities in developing countries, while the empirical studies show mixed results, especially in the context of developing countries. Given the literature review, in the next section I propose the hypothesis to be tested in this chapter.

2.2 Hypotheses

The estimation results of Chapter 4 showed that foreign ownership does not matter in determining the intensity of innovation investment of firms. What does matter are the collaboration

partnership, firm size, export activities, and high-tech industrial sector. This indicates a low propensity of innovation in foreign firms.

Furthermore, the results of innovation output from the total sample also suggests that foreign firms have a negative association with innovation new to the market and no relation with innovation new to the firm. Based on these results and the literature, I propose the following hypothesis:

Hypothesis: *Private firms are more innovative than foreign owned firms, because they have more extensive resources of internal and external knowledge*.

3. Methodology and Comparisons of Selected Variables

3.1 Methodology

This chapter focuses on assessing the innovation performance of foreign and private firms. As reviewed by Albis & Alvarez (2017), there are two approaches to investigating the innovation performance of foreign owned firms: (i) focusing on the patterns of innovation strategies in subsidiaries without making comparison with local firms (e.g. Cantwell & Mudambi, 2005; Marin & Bell, 2010), and (ii) including the type of ownership (foreign firms or local firms) in the estimated model and comparing the significance of their effect. To make a comprehensive analysis, this study combines these two approaches.

Therefore, the methodology of this chapter is two-fold. First, I try to identify the different patterns of innovative behavior and performance between two types of firms by comparing the related innovation indicators. Second, I analyze the determinant factors that can explain the mechanism underlying the differences of two groups of firms, by employing the CDM model in the regression analysis.

3.2 Variables and Econometric Model

Table 5.1 provides the descriptions of variables used in the models which will be discussed in the next section.

Table 5. 1 Descriptions of variables

Variables	Descriptions
FDI	Dummy for foreign owned firms
private	Dummy for domestic private firms
inno_investlabor	The ratio of innovation expenditures per employee
newmarket	Dummy for innovation new to the market
newfirm	Dummy for innovation new to the firm
laborprod	The percentage of sales per employee
DRD_colla	Dummy for R&D collaboration
techtran_embodies	Dummy for the firms considers that the purchase new equipment, machinery is relevant source for firm's technology
techtran_license	Dummy for the firms considers that the purchase new technology from research institutions and external firms is relevant source for firm's technology
techtran_supcus	Dummy for the firms considers that the using of technology provided by main suppliers or customers with whom the firm has long-term contract (over 12 months) is relevant source for firm's technology
laborskill	the percentage of qualified workforce
physical_capital	The ratio of physical asset per employee
Firm size	Dummy for small (<200 employees), medium (201-300 employees), large firm (>301 employees). Small and medium firms are reference category.
DExport	Dummy for export status
HHI	Herfindahl-Hirschman Index for industrial concentration
Industrial sector	Dummy for low-tech, medium-low tech, medium-high tech, high-tech sector. Low-tech and medium-low tech are reference category.
Provincial support (pro_sup)	Percentage of the province's expenditure on science and technological activities over the general budget spending of local finance

Equation 1: Innovation Investment

To compare the innovation effort of two types of firms, I estimate two innovation investment models separately for each type. As the measure of innovation investment is continuous, and equals zero for many of sampled firms, I estimate this variable by using the Tobit model.

Specifically, innovation investment model is shown in the following equation:

$$inno\_investlabor = \beta_0+\beta_1(firm\text{-}level\ factors)+\beta_2(industrial\ sector) +\beta_3(provincial\ support)+\varepsilon i \quad (5.1)$$

Where *inno_investlabor* is the dependent variable expressing the innovation effort of firms, which is defined by the ratio of total innovation expenditure to the number of employees. *Firm level factors* include firm size as dummy variables of small (<200 employees), medium-sized firms

(201-300 employees), large firms (>301 employees) and a dummy variable of export status (*DExport*). *Industrial sector* refers to the industrial concentration proxied by the Herfindahl-Hirschman Index, and industrial dummy variables for the firm, which includes two out of four industrial groups introduced in the previous chapter (low-tech and medium-low tech are used as reference categories). *Provincial support* denotes the local government support in innovation activities, measured by the budget of the province spent on the scientific and technological activities, as introduced in the previous chapter. $\beta_1, \beta_2, \beta_3$ is the corresponding unknown parameter, and ε_i is the error term with a zero mean, constant variances, and not correlated with the explanatory variables.

Equation 2: Innovation Output

This stage describes the transformation of innovation inputs into innovation output. Innovation outputs are measured by two indicators representing the degree of novelty of innovation: (i) innovations new to the market, and (ii) innovations new to the firm. Similar to the previous stage, I estimate two innovation output models separately for foreign owned and domestic firms.

Moreover, following Criscuolo et al., (2010) and Albis & Álvarez (2017), in order to have a comprehensive analysis on the factors that explain the innovation output differences between these two types of firms, I organize the explanatory variables into three groups: (i) internal knowledge inputs (including predicted innovation expenditure, human resources), (ii) external knowledge inputs (including R&D collaboration, technology acquisition), and (iii) control variables (firm size, industrial sector, provincial support). In addition, as two dependent variables are binary variables, I use a Probit model with marginal effects. Based on these, this stage comprises two following equations:

$$newmarket=\beta_0+\beta_1(internal\ inputs)+\beta_2(external\ inputs)+\beta_3(control\ variables)+\varepsilon i \quad (5.2)$$

$$newfirm=\beta_0+\beta_1(internal\ inputs)+\beta_2(external\ inputs)+\beta_3(control\ variables)+\varepsilon i \quad (5.3)$$

where *newmarket* and *newfirm* refers to innovation output proxied by two indicators, the innovation new to the market and new to the firm. *Internal inputs* include predicted innovation expenditure (*inno_investlabor*), human resources (*laborskill*). *External inputs* include R&D collaboration (*RD_colla*), technology acquisition (*techtran_embodies, techtran_license, techtran_supcus*). The control variables include the explanatory variables predicted in the previous chapter (*firm level factors, industrial sector, provincial support*). $\beta_1, \beta_2, \beta_3$ is the corresponding unknown parameter, and ε_i is the error term with a zero mean, constant variances, and not correlated with the explanatory variables.

Equation 3: Productivity

The final equation in this model is the productivity equation. To compare the productivity output of foreign owned and domestic firms, and in line with the previous chapter, I estimate two production functions separately for these firms. Specifically, the production function comprises two innovation outputs, the other production inputs, such as human resources or physical capital. Hence, the production function is defined as follows:

$$labor\_prod = \beta_0 + \beta_1(newmarket) + \beta_2(newfirm) + \beta_3\ (human\ resources) + \beta_4\ (physical\ capital) + \beta_5\ (control\ variables) + \varepsilon_i \quad (5.4)$$

where *labor_prod* denotes the labor productivity, measured by the percentage of sales per employee, *new market* and *newfirm* denote the innovation output that firm has introduced, human resources refers to labor input which is measured the proportion of qualified workforce (*laborskill*). Physical capital denotes the capital input, measured by the value of physical assets per employee. Control variables are the similar variables which have been used in the above equation. $\beta_1, \beta_2, \beta_3, \beta_4, \beta 5$ are the corresponding unknown parameters, and ε_i is the error term with a zero mean, constant variances, and not correlated with the explanatory variables.

3.3 Data and Correlation Matrix

The data used for the empirical analysis of this chapter was utilized from the same dataset in the earlier chapters. As this chapter focuses on comparing the innovative performance of foreign and domestic private firms, two groups of firms are constructed. Following the definition of ownership in previous chapter, foreign owned firm is defined as one that have capital directly invested by foreign investors, regardless of any percentage share of capital, including wholly owned firms and joint venture firms. Domestic private firms are privately owned or shared an individual group or shared with the government with the capital proportion is equal to or less than 50%. Based on these definitions, there are 17,461 private firms and 5,291 firms with foreign participation of the total 22,183 manufacturing firms.

The shares of these two groups by size and sector are given in Table 5.2. Private firms are mostly small sized (15,308 firms), belonging low-tech (9,700 firms) and medium-low tech (5,923 firms) industry sectors. Regarding foreign firms, most of them are small (2,989 firms) and large sized (1,854 firms), in low tech (2,651 firms) and medium-low tech (1,387 firms) industry sectors.

Table 5. 2 Distribution of the sample of firms by size, sector

Number of firms	Private (N=17461)	Foreign firms (N=5291)
Firm size		
Small	15,308 (87.6%)	2,898 (54.7%)
Medium	804 (4.6%)	539 (10.1%)
Large	1,349 (7.7%)	1,854 (35%)
Industry		
Low-tech	9,700 (55.5%)	2,651 (50.1%)
Medium-low tech	5,923 (33.9%)	1,387 (26.2%)
Medium-high tech	1,366 (7.8%)	970 (18.3%)
High-tech	472 (2.7%)	283 (5.3%)

Source: Construct from the TCS Survey in 2010-2013.

In addition, I examine the level of correlation between the variables in Table 5.3. Except for private ownership, the little correlation between the other variables can be found on the table, which is falling between 0.001 and 0.502. In essence, these descriptive statistics are consistent with what has been found for firms' innovation in previous scholarship.

Table 5. 3 Correlation Matrix of the Variables

No	Variables	Obs	Mean	Std. Dev.	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ownership categories																									
1	FDI	22813	0.232	0.422	0	1	1																		
2	private	22813	0.765	0.424	0	1	-0.993	1																	
Dependent variables																									
3	inno	22813	0.008	0.089	0	1	-0.003	0.001	1																
4	inno_investlabor	22813	0.248	19.748	0	2,857.14	-0.006	0.006	0.014	1															
5	newmarket	22813	0.003	0.058	0	1	-0.009	0.009	0.651	0.011	1														
6	newfirm	22813	0.003	0.052	0	1	0.001	0.000	0.585	0.011	-0.003	1													
7	laborprod	22813	843.799	2,649.30	0.023	167,072.50	0.031	-0.032	0.013	-0.001	0.008	0.001	1												
Independent variables																									
8	DRD_colla	22813	0.002	0.047	0	1	0.003	-0.005	0.152	0.002	0.124	0.086	0.015	1											
9	Dtechtran_embodied	22813	0.809	0.393	0	1	-0.069	0.068	-0.003	0.004	0.000	-0.004	-0.003	0.009	1										
10	Dtechtran_license	22813	0.659	0.474	0	1	-0.030	0.029	0.021	0.005	0.015	0.004	-0.003	-0.003	0.354	1									
11	Dtechtran_supcus	22813	0.655	0.475	0	1	0.013	-0.014	0.018	-0.012	0.009	0.007	0.001	0.005	0.214	0.538	1								
12	laborskill	22813	37.627	29.446	0	100	-0.015	0.011	0.036	0.011	0.025	0.021	0.024	0.017	0.033	0.039	0.035	1							
13	physical_capital	22813	739.589	4,241.99	0.975	572,312.50	0.030	-0.030	0.011	-0.001	0.013	-0.001	0.317	0.006	-0.001	0.003	0.007	0.025	1						
14	large	22813	0.141	0.348	0	1	0.331	-0.330	0.017	-0.004	0.011	0.012	-0.018	0.010	-0.024	-0.001	0.016	0.000	-0.018	1					
15	DExport	22813	0.357	0.479	0	1	0.502	-0.499	0.006	-0.006	0.003	0.006	0.029	0.013	-0.054	-0.035	0.004	-0.051	0.016	0.404	1				
16	HHI	22813	0.135	0.131	0.021	1	0.045	-0.044	0.004	-0.006	0.007	-0.003	-0.016	0.008	0.059	-0.011	-0.008	0.013	0.000	0.037	0.041	1			
17	mediumhigh	22813	0.103	0.304	0	1	0.146	-0.146	0.031	-0.002	0.037	0.007	0.019	0.024	-0.005	0.011	0.012	0.068	0.020	-0.010	0.012	0.177	1		
18	hightech	22813	0.033	0.179	0	1	0.063	-0.061	0.052	0.000	0.040	0.028	0.032	0.002	-0.010	0.004	0.012	0.052	0.023	0.017	0.026	0.169	-0.063	1	
19	pro_sup	22813	0.308	0.107	0.1	0.9	0.051	-0.052	0.051	-0.004	0.034	0.027	0.028	0.015	-0.020	0.025	0.029	0.037	0.021	0.048	0.057	0.000	0.035	0.026	1

3.3 Comparison between foreign owned and domestic private firms

Prior to analysis, it is useful to compare the innovation performance of Vietnamese manufacturing firms, in particular, private and foreign owned firms. Table 5.4 presents the mean values of innovation input indicators for Vietnamese manufacturing firms, which includes: (i) innovation expenditure, and (ii) technology acquisition channels. Innovation expenditure is the total sum of expenditures in two different categories of innovation engagements including: (i) R&D based innovation, and (ii) non-R&D based innovation, including the expenditures on modification of the existing technology/product, purchase of machinery and equipment related to innovations. The technology acquisition channels include five specific indicators representing: (i) purchase new machinery and equipment, (ii) licensing the production process, (iii) using the technology from customer and suppliers, (iv) using the technology from another entity within the group, and (v) skill from new employees. These two groups of innovation indicators capture the efforts that the firms devote into innovation activities.

It is shown in Table 5.4 that, the mean value of innovation, R&D and technology expenditure for private firms are 11.79, 7.59 and 4.20, respectively, whereas those of foreign firms are 25.38, 14.04 and 11.35. These results suggest that, in the period 2010-2013, private firms spent VND 11.79 million in average for innovation (in which the expenditures for R&D activities are VND 7.59 million and for technology acquisition are VND 4.20 million), while these expenditures in foreign firms are VND 25.38 million. This is somewhat as predicted, because in such developing countries as Vietnam, foreign firms are suggested to be superior in technological and financial resources than private firms.

Surprisingly, there is a big difference in the average innovation expenditure as a share of sales. The mean value of this indicator for private firms is 0.23, while that for foreign firms is 0.006. The results suggest that on average, private firms spent 23% of their total revenue on innovation, while the respective indicator of foreign firms is only 0.6%. This provides a preliminary indication that private firms are likely to devote more effort on innovation activities, than foreign firms.

Regarding the technology acquisition channels, differences are small within both types of firms. In general, Vietnamese manufacturing firms consider the most important channel for technology acquisition is the purchasing new equipment and machinery (0.82 for private firms, 0.75 for foreign firms), followed by the skills from new employees, licensing the production process or using the technology of customers or suppliers.

Table 5. 4 Innovation input indicators

Variable	Private (N=17461)	Foreign firms (N=5291)
Innovation expenditure		
Innovation expenditure (million VND)	11.79	25.38
R&D expenditure (million VND)	7.59	14.04
Technology expenditure (million VND)	4.20	11.34
Innovation expenditure as % of sales	0.23	0.006
R&D expenditure as % of sales	0.18	0.004
Technology expenditure as % of sales	0.05	0.002
Technology acquisition channels (dummy)		
Purchase new machinery, equipment	0.82	0.75
Licensing the production process	0.66	0.63
Using the technology from customer, suppliers	0.65	0.66
Using the technology from the group	0.56	0.67
Skill from new employees	0.75	0.74

Source: Construct from the TCS Survey in 2010-2013.

Table 5.5 reports the mean value of innovation output and labor productivity. Innovation output is defined in this study as the innovation new to the market and new to the firm. As shown in the table, in both indicators, private and foreign firms have similar levels of innovativeness. In terms of innovation new to the market, although the small difference, private firms are even ahead of foreign firms. This reveals that private firms are more active in making products new to the market as compared to foreign firms.

The next indicator is the labor productivity, measured by the sales per employee. Table 5.5 reports the average productivity record of the firms in the sample by firm size, export status, and industrial sector. Overall, foreign firms are more productive than private firms in all indicators. The mean value of labor productivity is 797.55 in private firms, and 994.91 in foreign firms. These results suggest that, on average, the labor productivity of private firms is VND 797.55 million, lower than that of foreign firms with VND 994.91 million, for the period 2010-2013.

The same trend is also true for all categories of firm size. Table 5.5 shows that on average, foreign firms are more productive than private firms in any size. Especially, in medium-size group, the mean value of labor productivity in foreign firms (VND 1,319.86 million) is twice than in private firms (VND 699.25 million).

Regarding the productivity performance of exporting firms, the results show that although the difference is small, exporting private firms are likely to be more productive than foreign exporters. On the other hand, for non-exporting firms, the results suggest that domestic market oriented foreign firms are more productive than that of private firms.

In terms of the industry sector, the major contrast difference between private and foreign firms is in the low-tech industry. While the private firms belonging to low tech industry is productive at an average value of 821.77, for the foreign firms, the mean value is 688.55. This result reflects the fact that the private firms in low tech industry do better than foreign firms in the same sector.

In short, the significant finding from the above descriptive statistics is that foreign firms' labor productivity is substantially higher than that of private firms. The reason for this difference may be in the large stock of physical capital of foreign firms. Table 5.5 shows that on average, physical assets of foreign firms are VND 967.9 million, much larger than that of private firms (VND 669.89 million).

Table 5. 5 Indicators of innovation outputs and firm performance (mean value)

Variable	Private (N=17,461)	Foreign firms (N=5,291)
Innovation output		
New to market	0.003	0.002
New to the firm	0.002	0.002
Labor Productivity (sales per employee, million VND)	*797.55*	*994.91*
By size		
Small	813.62	1,080.85
Medium	699.25	1,319.86
Large	673.74	766.11
By export status		
Exporting firms	972.03	920.73
Non-exporting firms	742.03	1,281.46
By industry		
Low tech	821.77	688.55
Medium low tech	745.46	1,206.05
Medium high tech	703.67	1,398.86
High tech	1,224.91	1,445.34
Qualified workforce (%)	37.80	36.83
Physical capital (asset per employee)	669.89	967.59

Source: Construct from the TCS Survey in 2010-2013.

In summary, the above comparison of the selected indicators reveals several interesting observations regarding the innovation behaviors and the gaps in productivity between private and foreign firms. In terms of labor productivity, foreign firms exceed private firms in almost all indicators. This is not surprising as the productivity level of foreign investors is superior to Vietnamese firms. Ni et al., (2017) found in a study of FDI's productivity in Vietnam that the average total productivity factor (TPF) levels of Asian, European, and North American firms are all higher than that of Vietnamese firms.

However, in terms of innovation input and output measured by the innovation investment per employee and by the introduction of innovation new to the market and new to the firm, private firms are likely to be more active. This provides a preliminary indication that there are gaps in innovation propensity and capabilities in developing innovation. In order to answer the question to what extent these gaps are across these firms can be explained by the contextual factors, I conduct the analysis of the empirical results in the next section.

4 Estimation Results

4.1 Comparison of innovation investment

Estimation results of Equation 5.1 are presented in Table 5.6 separately in foreign firms and private, which are labelled as Model 1 and Model 2, respectively. Evidence from the estimation of Model 1 and Model 2 suggests that R&D collaboration plays a significant role in determining innovation effort of Vietnamese firms. The variable of R&D collaboration shows a positive and significant score at the 1% level in foreign firms and at the 10% level in private firms. The estimated coefficients suggest that, holding all the other variables at the mean, if a firm has a collaborative R&D with an external knowledge institute, its investment in innovation per employee will increase around VND 49.58 million in the case of foreign firms, and VND 530.2 million in the case of private firms. These indicate that private firms are more active in R&D collaboration projects compared to foreign firms.

Table 5. 6 Factors influencing innovation investment

VARIABLES	(Model 1) FDI	(Model 2) Private
DRD_colla	49.58***	530.2*
	(15.55)	(282.1)
Dtechtran_embodied	-3.978	156.7
	(3.786)	(104.4)
Dtechtran_license	3.309	49.44
	(4.076)	(64.35)
Dtechtran_supcus	-7.320	-89.37
	(4.702)	(77.49)
large	3.059	156.6*
	(3.926)	(90.88)
DExport	3.022	113.5*
	(5.400)	(65.13)
HHI	-103.1**	227.2
	(50.56)	(361.6)
mediumhigh	4.253	150.9*
	(4.971)	(85.78)
hightech	3.111	353.8**
	(7.034)	(170.4)
pro_sup	15.77	115.7
	(13.44)	(179.0)
Constant	-69.06***	-1,535**
	(12.65)	(733.5)
Observations	5,291	17,461

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5.6 also shows that, foreign firms' innovation intensity does not rely on the access to external knowledge, firm size, export status, and industrial sector. Industrial competition proxied by HHI, is negatively associated with foreign firms' innovation investment. The estimated coefficient of HHI is -103.1, indicating that increasing 1unit increase in concentration in the market might reduce innovation investment per employee by VND103.1million.

On the other hand, in case of private firms, firms that engage in exporting, large in size, belong to the medium-high or high-tech industrial sector are likely to be more intensive in innovation activities.

4.2 Comparison of innovation output

The estimated results of Equation 5.2 and 5.3 are presented in Table 5.7. As explained in the above section, in this stage the factors related to innovation output comprise three groups of variables: (i) internal knowledge inputs, (ii) external knowledge inputs, and (iii) control variables.

Table 5. 7 Factors influencing innovation output

VARIABLES	FDI newmarket	FDI newfirm	Private newmarket	Private newfirm
inno_investlabor	0.000**	0.000*	5.51e-06**	4.87e-06*
	(0.000)	(0.000)	(2.67e-06)	(2.67e-06)
laborskill	-2.70e-05	3.64e-05	3.68e-05***	1.86e-05
	(2.72e-05)	(2.23e-05)	(1.40e-05)	(1.31e-05)
DRD_colla	0.005	0.008	0.016***	0.011***
	(0.006)	(0.005)	(0.002)	(0.002)
Dtechtran_embodied	-0.001*	0.001	-0.000	-0.001
	(0.000)	(0.001)	(0.001)	(0.001)
Dtechtran_license	0.002**	-0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Dtechtran_supcus	-0.001	0.000	0.000	0.000
	(0.001)	(0.001)	(0.000)	(0.001)
large	0.001	-0.000	0.001	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
DExport	-0.002*	-0.000	0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
HHI	-0.014	0.024	0.012***	0.002
	(0.015)	(0.024)	(0.004)	(0.007)
mediumhigh	0.001	-0.003	0.005***	0.001
	(0.001)	(0.003)	(0.001)	(0.001)
hightech	0.003*	0.003	0.007***	0.003**
	(0.002)	(0.001)	(0.001)	(0.001)
pro_sup	0.003	0.010**	0.016***	0.011***
	(0.003)	(0.004)	(0.002)	(0.002)
Observations	5,291	5,291	17,461	17,461

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

First, regarding the knowledge inputs, in both types of firms, innovation investment intensity appears positive and statistically significant at the 5% level for innovation new to the market, and the 10% level for innovation new to the firm. Although the impact is quite small, the marginal effect of foreign firms (0.0005 and 0.0004, respectively) are higher than that of private firms ($5.51*10^{-4}$% and $4.87*10^{-4}$%, respectively). This indicates that foreign firms are likely to be more efficient in transforming innovation input into innovation output, compared to private firms.

Human resources show a positive and statistically significant result at the 1% level with innovation new to the market of private firms. The marginal effects show that, holding all other variables at the mean value, a 1percentage point increase in the percentage of qualified workforce will increase the probability of private firms in introducing products new to the market by around

$3.68*10^{-5}$%. This result supports the resource-based view and confirms the important role of human resources in innovation capabilities of private firms.

Second, regarding the external knowledge inputs, the results reveal significant differences in the effect of R&D collaboration on innovation performance of these two types of firms. While the variable *DRD_colla* shows an insignificant association with foreign firms in both two indicators of innovation, it reveals a positive and statistically significant effect on private firms. The marginal effects shows that, holding all other variable at the mean value, private firms that cooperate with other firms or research institutes in R&D projects are more likely to introduce an innovation new to the market by around 1.6% and an innovation new to the firm by 1.1%, compared with those that do not have this partnership. The favorability of cooperation in innovation is common in the developing countries. Rahmouni (2013) reports that in Tunisia, manufacturing firms rely on the collaboration partnership in both product and process innovation.

Another difference from the result that can be observed is in the technology acquisition. *Dtechtran_license* (licensing the production process) plays an important role in innovation activities of foreign firms, while private firms do not depend on any channel of technology acquisition. Interestingly, *Dtechtran_embodied* (purchase of new machinery, equipment) is shown to be statistically significant at the 10% level and a negative effect on innovations new to the market for foreign firms. This reveals evidence on the substitute relationship between internal innovation activities and the acquisition of new machinery or technology.

Third, regarding the control variables, while foreign firms that operate in the high tech industry are positive and statistically significant at the 10% level, the exporters with foreign ownership are negatively associated with innovations new to the market. This result suggests that foreign owned exporters might not undertake any technological activities in Vietnam. This might reflect the phenomenon “export-platform” FDI in developing countries, indicating the foreign firms produce products to export back to the home countries or other third countries (Ruane & Ali, 2006).

In the group of private firms, industrial competition, sectors belonging to medium-high and high-tech industries and local government’s support are positive and statistically significant at the 1% level, suggesting the determining role in innovation new to the market. The results indicate that the firms belonging to a competitive industry, operating in medium high and high-tech industry sector, and financial support from the local government are the important incentives for innovation output efficiency of private firms.

4.3 Comparison of productivity

The estimated results of Equation 5.4 are presented in Table 5.8. Two categories of innovation output (new to the market and new to the firm) show their insignificant influence on the labor productivity of firms. The interpretation of these results could be the "longitudinal effect" of innovation that has been explained in Chapter 4, that the innovation in the current period would affect the labor productivity performance in the next period.

Table 5. 8 Factors influencing productivity

VARIABLES	(Model 1) FDI	(Model 2) Private
newmarket	717.0	-286.6
	(662.9)	(285.4)
newfirm	63.55	27.26
	(285.3)	(109.9)
laborskill	4.264***	-0.123
	(0.941)	(0.867)
physical_capital	0.121***	0.548***
	(0.0241)	(0.116)
large	-164.5***	-170.2***
	(55.40)	(56.58)
DExport	-204.9***	212.4***
	(71.97)	(73.22)
HHI	5,000***	1,669***
	(928.3)	(645.4)
mediumhigh	61.17	-280.3***
	(85.37)	(66.75)
hightech	378.7**	22.68
	(166.8)	(114.8)
Constant	694.8***	360.0***
	(81.18)	(65.96)
Observations	5,291	17,461
R-squared	0.248	0.158

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Regarding the other determinants of productivity, Table 5.8 confirms that the qualified workforce is a more significant determinant of foreign firms' productivity performance than in private firms. The estimated coefficient suggests that, on average, a 1percentage point increase in the proportion of qualified workforce would increase the level of foreign firms' productivity by around VND 4.264 million. Physical capital variable appears positive and statistically significant

at the 1% level in both groups of firms. The estimated coefficient reveals that physical capital has a more significant impact on the level of productivity of private firms than foreign firms.

Regarding the control variables, large sized firms are negative and statistically significant at the 1% level in both foreign and private firms. This indicates that small firms in Vietnam are likely to be more productive than the large size firms. The results of exporting activities are mixed: the participation in export increase the level of productivity of private firms, while the effect on foreign firm is negative. Table 5.7 also shows that monopoly power for competition market is an important factor to enhance labor productivity of both groups of firms. The technological intensity is found to have a mixed effect: foreign firms in high-tech industry are likely to be more productive, while private firms in low-tech and medium-low tech are more productivity, compared to medium-high and high-tech industry.

5. Main Findings and Conclusions

In this chapter, I have conducted the regression analysis to answer the question of what are the differences in innovative behavior and productivity of foreign and private firms, and how much these differences can be explained by their using of knowledge inputs as well as the contextual factors. For the analysis, I have employed the CDM model which explains the relationship between innovation and productivity, using the panel dataset from the Vietnam Technology and Competitiveness Survey, covering the period 2010-2013. There are three models with each of them comparing foreign firms with domestic private firms. In each model, the differences between the two groups of firms are analyzed based on the estimated coefficient differential between them. The estimated results reveal several notable features as follows.

First, in terms of innovation expenditure, the descriptive statistics and estimated results suggest that, on average, foreign firms have a lower expenditure, compared to private firms. Combining the results from Chapter 3, it is shown that just 2.68% of foreign firms reported engaging in either R&D activities or non-R&D based innovative activities, with an average innovation expenditure (as the ratio of sale values) of 0.006%. In contrast, 9.38% of private firms reported engaging in innovation activities with the average innovation expenditure of 0.23% in the total value of sales.

This result is in line with the evidence of Masso et al (2012) in the case of Estonia. This can be explained that foreign firms are assumed to be superior in the stock of knowledge and technology, thus they may spend less than private firms on innovation activities (Dachs et al, 2008).

The estimated results also indicate the effects of other contextual factors in this difference. For private firms, the collaboration partnership, exporting, a larger size, and higher technological intensity are important determinants of their innovation intensity. This indicates that private firms are sure to innovate when they are large in size, engaging in exporting, and belonging to medium and high-tech industrial sector. They must rely on the collaboration with the external partners to conduct R&D project. These results are consistent with the evidence of other developing countries, such as Rahmouni (2013) on the case of Tunisian exporting firms.

Second, the descriptive statistics suggest a similar propensity of the two groups of firms in introducing innovation outputs, even in innovation new to the market, private firms seem to be more innovative than foreign firms. Regarding the knowledge sources, the results suggests that external sources of knowledge are complementary to their internal innovation activity. This result is in line with Freeman (1991) and Veugelers & Cassiman (1999) who demonstrated that the combination of the external sources with internal R&D activities are crucial in explaining the success of a firm's innovation.

However, the evidence shows that there are several differences in the mechanism leading to the successful innovation performance between two types of firms. Private firms proved to be dependent mostly on the collaboration with other firms in both types of innovation activities, and skilled personnel play a significant role in the innovations new to the market. This is a major finding for this study: the majority of the innovation performance of private firms is accounted for by their intensive access to external knowledge sources via the collaboration partnership. This may be due to the low level of technological capabilities and the financial constraints of Vietnamese private firms, as they do not have the necessary financial resources and knowledge for undertaking innovative projects. This result is consistent with the evidence from Tunisia (Rahmouni, 2013) and Tanzania (Goedhuys, 2007a).

In contrast, foreign firms focus their innovation activities in developing innovation new to the market through investment in internal innovation activities and using the foreign-licensing technology or equipment. Foreign firms in Vietnam seem to exploit their competitive advantage in Vietnam rather than creating new technology in order to increase the knowledge stock or innovation capability of their MNEs. Their innovation activities in Vietnam are generally toward adapting products or processes to the local market. This result is in line with the evidence of other developing countries. Albis & Alvarez (2017) reported that foreign subsidiaries in the Colombian manufacturing sector seemed to combine creation and exploitation strategies in innovation, and the latter being more dominant.

Finally, although foreign firms are less likely to active in innovation than private firms, the results show that their labor productivity is substantially higher than that of private firms. Moreover, the descriptive statistics suggest that foreign firms have comparatively larger amount of physical capital, one traditional input indicator of production function. This means that the superiority of foreign firms in productivity is due to the larger stock of capital.

From the above findings, I conclude that for the two models of innovation process, private firms have a higher innovation performance than foreign firms, and their superiority is by their greater use of knowledge inputs and external knowledge (such as R&D collaboration), in which the latter is more dominant. My conclusion supports the hypothesis that *the differences in innovation performance between foreign firms and private firms can be explained by the intensive use of internal and external knowledge inputs*. However, these results contrast with the findings from developed countries, such as Criscuolo et al., (2010) and Siedschlag et al., (2010) in the case of UK firms, which found a positive impact of foreign ownership in innovation performance.

The study reveals some important policy implications. It suggests that government policies should be oriented toward not only promoting the engagement of foreign firms in innovation activities, but also toward building opportunities for more extensive linkage in cooperating R&D of private firms. The cooperation network seems to bring important incentives for private firms in Vietnam during the process of innovation.

This study reveals some important limitations. In this study, I focused on assessing the innovation performance of foreign ownership, without taking into account their role of knowledge spillover with the domestic firms in the same sector as well as other sectors. The spillover effects can be an effect directly by their advanced management skill, or indirectly through the knowledge transmission by mediators (Blomström & Kokko, 1998), such as local suppliers or distributors who service both foreign firms and domestic firms, or by labor mobility and personal interaction (Meyer, 2014). These effects should be investigated further in the future.

CHAPTER 6. CONCLUSION

1. Overview of the Study

This thesis consisted of three essays on the determinants of innovation, the relationship with productivity, and ownership performance. Although each essay was separated into its own chapter (Chapter 3,4,5), all of them addressed the common topic related to innovation and its impact on a firm's productivity. Firstly, Chapter 3 examined the determinants of innovation decision made by Vietnamese manufacturing firms. Secondly, Chapter 4 investigated the relationship between the innovation process and productivity by estimating with a three-stage econometric model in combination with the determinants predicted in Chapter 3. Thirdly, based on the results obtained in Chapter 4, Chapter 5 conducted a further analysis on the sub-group of ownership structure by making a comparative study of the differences in innovation performance between foreign owned and domestic private firms.

For the analysis of these three essays, this thesis combined the firm-level database of Vietnamese manufacturing firms on technology and innovation, and the province-level data on the local government's budget for firms' innovation. The analytic period covered the period 2010-2013 due to the availability of data.

This chapter summarizes the main findings of three essays and provides some policy implications. It also discusses the limitations of the thesis and suggests directions for future research.

2. Main Findings

This section aims at answering the research questions, which are correspondent with the three essays. The main findings from the empirical analysis are summarized as follows:

2.1 What are the key determinants in firm-industry-province level affecting innovation decision made by Vietnamese firms?

The analysis from Chapter 3 provided the answer to this research question. This chapter explained the determinants affecting the innovation decision made by firms. In this study, innovation activities are categorized into two types: (i) R&D based innovation activities (including intramural R&D and extramural R&D), and (ii) non-R&D innovation activities (including the modification of existing technologies/products). The summary of the statistics from innovative firms showed that there were 12.43% of firms engaging in innovation activities, among which 8.8%

of firms were engaging in R&D and 5.85% in non-R&D activities. The results indicate quite a low level of innovative firms in comparison with other developing countries, for example, in a study of innovative behavior of 43 developing countries, Almeida & Fernandes (2008) reported that 48% of firms conducted R&D activities and 56% of firms engaged in non-R&D activities. Furthermore, the results also showed that the most innovative firms in Vietnam are small and medium in size, privately owned firms and activate in low and medium-low technological sectors (such as, food or garments), which are consistent with (Vu et al., 2017).

In the empirical analysis from Chapter 3, the effect of firm-specific factors (firm size, human resources, export activities, foreign ownership), industry-level factors (industrial concentration, technological intensity), province-level factors (local government's budget on innovation) on the firm's decision to participate in innovation activities was tested using a Probit model. The estimation results showed that most of the factors positively affect the firm's decision to take part in innovation activities. The results generally support the views of Schumpeter's hypothesis on the role of large firms, the assumption of learning-by-exporting effect, the resource-based view on human resources, and the theory of regional innovation system.

However, the effects of foreign ownership had a mixed result, while the wholly foreign owned firms had a negative, joint venture ownership had a positive impact on innovation activities. These results are different than the evidence from other Asian countries on the role of foreign direct investment on innovation.

Regarding the effect of the local government's support on a firm's innovation activities, this study did not find evidence of it having a significant role in promoting a firm's innovation decision, which suggests a gap between policies and realities in the innovation practice of Vietnam.

2.2. What is the relationship between innovation and productivity?

This question addresses the main topic of this thesis and it is empirically explored in Chapter 4. The relationship between innovation and productivity was examined by three equations. In the first equation, the effect of contextual factors on the level of innovation investment was tested using a Tobit model to account for censoring of the innovation expenditure. The results showed that small sized firms spend less on innovation. This result supports Schumpeter's hypothesis on the advantage of large firms in innovation, and consistent with Hien & Santarelli (2013) on the poor financial performance of Vietnamese SMEs. Firms participating in exporting activities, collaborating with the other firms in R&D projects, and being active in the high-tech industrial sectors seem to be more intensive in innovation.

In the second equation, the effect of investment level on generating two types of innovation output, (i) innovations new to the market and (ii) innovations new to the firm, was tested using two Probit models. The estimated results showed that the investment level on innovation was positive and significant at the 5% level for innovation new to the market and 10% for innovation new to the firm. Although the estimated coefficients were quite low ($5.71*10^{-4}$%, and $5.03*10^{-4}$%), the results suggest that Vietnamese firms tend to be more efficient in converting innovation efforts into a radical innovation compared to an incremental innovation. These results are consistent with the evidence of both developed and developing countries, for example France, Germany, Spain and the UK in Griffith et al, (2006), and Costa Rica and Chile in Crespi & Zuniga (2012).

The third equation estimated the effect of two innovation outputs on the level of labor productivity, using a production function. This linkage was tested using an Ordinary Least Square (OLS) model. Unexpectedly, this study did not find a significant effect from both indicators of innovation outputs on labor productivity. This result is consistent with the findings of Benavente (2006) in the study of Chilean firms. The reasons for these results might be because: (i) the weakness of Vietnamese firms' innovation capabilities to effectively produce their innovation, (ii) the target of their innovation development is not related to the improvement of productivity, and (iii) the 'longitudinal effect' of innovation, which requires a longer period of time for the innovation to affect a firm's productivity, was not in the surveyed period of 2010-2013.

2.3 Does foreign ownership matter for innovation activities of Vietnamese manufacturing firms?

The analysis in Chapter 5 provided the answer to this question. As an extension of Chapter 4, this chapter examined the innovation-productivity relationship from the perspective of ownership. The sampled firms are categorized into two groups: (i) firms with foreign ownership (including the wholly foreign owned and joint venture firms) and (i) privately owned firms. Due to the minority number of innovative state-owned firms, the firms with state ownership were excluded from the sampled set.

Following Chapter 4, this chapter estimated the differences in innovation performance and productivity between foreign owned firms and private firms with three equations. In the first equation, the results showed that foreign firms had a lower investment intensity on innovation, compared to private firms. This result, which is consistent with Masso et al (2012) in the case of Estonia, can be explained by assumption that foreign firms have a superiority over their domestic counterparts in the stock of knowledge and technology, so that they may spend less than private

firms (Dachs et al, 2008). The results also indicated that for domestic private firms, the collaboration partnership, exporting, a larger size, and higher technological intensity are important for their innovation investment.

The results of the knowledge production function showed a similar propensity for the two groups of firms in introducing innovation outputs. However, there were several differences in the mechanism leading to the successful introduction of innovation between these two types of firms. While private firms proved to be dependent mostly on the collaboration with other firms on both innovation outputs, foreign firms focused their development on new products/technology by investment in internal innovation activities and using the foreign-licensing technology or investment. These results are in line with the evidence of other developing countries, for example, Columbia manufacturing firms in the study of Albis & Álvarez (2017).

In the production function, as hypothesized, foreign firms seemed to be more productive than private firms, and this gap is explained by their superiority in physical capital.

The estimated results from all chapters are summarized in Table 6.1

Table 6. 1 Summary of empirical results for the hypotheses

	Hypotheses	Results
Hypothesis 1.1	The larger firm size, the higher the propensity of innovation	Supported
Hypothesis 1.2	Firms with higher qualified human resources have higher innovation propensity	Supported
Hypothesis 1.3	Firms with foreign ownership have higher innovation propensity	Partially supported
Hypothesis 1.4	Firms participating in exporting have higher innovation propensity	Supported
Hypothesis 1.5	Industrial competition has a positive relationship with innovation propensity	Not supported
Hypothesis 1.6	Firms in higher technological industry are more likely to innovate	Supported
Hypothesis 1.7	There is a positive relationship between local government's innovation support with innovation propensity	Not supported
Hypothesis 2	Innovation investment is positively associated with the	Partially supported

	successful introduction of innovation output (new to the market and new to that firm), which in turn contributes to a greater level of productivity.	
Hypothesis 3	Private firms are more innovative than foreign owned firms, because they have more extensive resources of internal and external knowledge	Supported

3 Policy Implications

In order to catch up with the global frontiers and avoid the "middle-income trap" as mentioned in Chapter 2, promoting innovation has become an important component of the Vietnamese government policy. In recent years, a broad range of policies have been initiated with the aim of promoting technology and innovation of business enterprises. The empirical analysis of this thesis has indicated that, while domestic private firms have been playing an active role in innovation activities, foreign owned firms have shown a negative performance in innovation in Vietnam. These findings lead to at least two important issues are worthy of policy makers' concern to encourage innovation for domestic private firms, as well as to induce foreign owned firms to become more involved in innovation activities in Vietnam.

3.1 Encouragement of innovation in domestic private firms

The findings from three essays provides the suggestion for policy makers to recognize the important role that human resources play in fostering firms' innovation. Better human resources can enhance their absorptive capacity and increase the opportunities for integrating knowledge to create new technologies and develop R&D activities (Fleming, 2001). The government can provide the support with training program for human resources in innovation, such as the capacity-building programs on the use of technology, technology transfer, product development for workers, business skills for managers (OECD, 2014).

The results also recommend that the collaboration relationship is an efficient route to promote innovation as it increases opportunities and enhances innovation capabilities for firms. Policy makers and managers should focus on building a more extensive cooperative network, which may boost the firm's internal knowledge, help the firms to minimize the uncertainty and costs of innovation as well as enhance their capabilities in the transformation of innovation investment into outputs.

Beside of above recommendations, the results of this thesis also imply some other important issues for the policy makers. First, the findings of Chapter 3 suggest that Vietnamese small firms are at a disadvantage against large firms due to factors that prevent them from engaging in innovation activities. It implies a need for policy makers to remove the obstacle which may prevent SMEs to engage in innovation activities. Second, the insignificant result of the local government's support indicates that the supports provided by the local government proved to be ineffective, suggesting a need for a more in-depth assessment in order to be designed more efficiently.

3.2 Promotion of innovation in foreign owned firms

The estimation results showed that, while wholly foreign-owned firms are less likely to innovate, joint venture firms are more associated with innovation. This is important information as the policies could be targeted at promoting innovation in foreign owned firms. On one hand, this suggests that collaboration with foreigners in the form of joint venture could be an efficient channel for promoting the adoption of technology in Vietnam. On the other hand, it also implies that, in the long run, given the important role of FDI in the growth of the Vietnamese economy since the start of Doi Moi, Vietnam should keep prioritizing in attracting FDI into high-tech industries instead of the labor intensive sectors which mainly focus on cheap labor and natural resources (Tran, 2013b)[60]. Through the acquisition of advanced technology into high technological sectors, Vietnam might upgrade the industrial structure, and therefore, might avoid the so-called "middle-income trap", as consistently pointed out by Ohno (2009) and Tran (2013a, 2013b).

4. Limitations and Future Research

Although this thesis has attempted to provide a comprehensive analysis of the innovation in Vietnamese manufacturing firms, it is facing several important limitations stated below.

The first limitation relates to the availability of data. Although the TCS has been conducted yearly since 2009, the lack of information to construct the necessary variables did not allow this study to be conducted over a longer period for a panel analysis, as well as different proxies for the innovation activities. For example, this survey does not capture the introduction of new products, new production processes, new marketing methods, or new organizational structures, as defined by Schumpeter (1934). Future research could use the information from the other firm-level survey for a more detailed study.

[60] As reported by UNCTAD (2007), a large number of FDI projects has been directed in the export-oriented labor intensive industries, such as textile, garment and footwear.

The second limitation relates to the methodology. As suggested by the CDM studies, future research should account for the endogeneity problem in the relationship between innovation and productivity. The literature suggests the potential of endogeneity is that innovation outputs to productivity, since firms that are more productive are potentially more likely to carry out innovation. To deal with this problem, it is suggested to employ instrument variables. However, the main issue in using instrumental variables is to find the proper instruments, which affects innovation but does not directly affect productivity. Unfortunately, the lack of an appropriate instrument variable in the dataset did not allow for the inclusion of handling the endogeneity problem. Thus, future research should extend the survey datasets and focus on addressing this problem.

The third limitation relates to the feedback effect of productivity in the innovation process. As suggested by Kline & Rosenberg (1986) and Marques & Monteiro-Barata (2006), the innovation process includes various feedbacks. Innovation outputs may affect the level of innovation investment, and productivity can influence all the earlier phases of the innovation process. Future research can analyze these feedback effects by using a simultaneous equation model, as suggested by Kline & Rosenberg (1986).

Finally, another important limitation of this thesis is that it does not investigate the role of the agriculture or service sector in the innovation-productivity relationship. In fact, the agriculture sector accounts for a dominant share of employment in Vietnam, and the service sector shows a high growth rate as well as a dominant share of the total GDP, as shown in Chapter 2. Future research could consider firms in all economic sectors in order to have an entire picture of innovation in the Vietnamese economy.

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Appendix 1. The TCS Questionnaire

GENERAL STATISTICS OFFICE OF VIETNAM

Quest No: 3-ĐTDN-KHCN	**Ent No:**	

(Filled in by Statistics Office– The same Ent code filled in Quest No: 1A-DTDN)

INFORMATION QUESTIONAIRE ON USING TECHNOLOGY IN THE PRODUCTION

(Promulgation in accordance with the Law on Statistics)
(Application to all types of enterprises in the processing and manufacturing sector, which are sampled surveys)

Province/City code | | |

- **Name of enterprise:** . . . .
  (Filled in by Statistics Office)

- **Enterprise address (Province/City):** . . . .

1. **Production technologies/machines currently in use for your firm**

		PT1:	**PT2:**
1	Please name the two **production technologies**/machines (PT) currently in use that are most relevant for your firm *(rank by importance, type)*	………………..………………. ………..………………………..	…………..…………………. …………..………………….
1.1	Country of Origin	Country: . . . . Country code (Filled in by Statistics Office): …..	Country: . . . . Country code (Filled in by Statistics Office): …..
1.2	Name of Brand	………..………………………..	………..………………………..
1.3	Year of construction	In	In . . . .
1.4	Tech. Complexity of the PT: (Circle 01 digit which is the most suitable selection)	1 = mechanic hand tools 2 = power driven hand tools 3 = man controlled machinery 4 = computer controlled machinery	1 = mechanic hand tools 2 = power driven hand tools 3 = man controlled machinery

		5 = other, *please specify:* ……..	4 = computer controlled machinery 5 = other, *please specify:* ……
1.5	Year of purchase/set up in company	In.	In. . . . .
1.6	Cost of technology/machines	…….. VND million	……..….. VND million
1.7	a. Do you pay any license fee?	1= Yes 2= No	1= Yes 2= No
	b. The cost per annum (or 2009)	…….. VND million	……..…….. VND million

1. Information and communication technologies

		ICT1:	ICT2:
2.1	Please name the two **information and communication technologies** or **equipments** currently in use that are most relevant for your firm *(rank by importance)*	……...…… ……...……	……...…… … ……...…… …
2.2	Country of Origin	Country…….Code…….	Country…….Code…….
2.3	Name of Brand	……	……
2.4	Year of construction	In……..	In……..
2.5	Tech. Complexity of the ICT:	1 = telephone (landline) 2 = mobile phone 3 = fax machine 4 = personal computer (without internet) 5= internet 5 = other (*explain*) ……	1 = telephone (landline) 2 = mobile phone 3 = fax machine 4 = personal computer (without internet) 5= internet 5 = other (*explain*) ……
2.6	Year of purchase/set up in company	In.	In. . . . .
2.7	Cost of technology/machines in the first time	……... VND million	……VND million

2.8	a. Do you pay any license fee?	1= Yes 2= No	1= Yes 2= No
	b. The cost per annum (or 2009)	…….. VND million	…….. VND million

3. The using technology in the sourcing input and output structure

<table>
<tr><td>3.1</td><td colspan="4">a. Which percentage of raw materials currently in your firm are bought;
1. Within same province : ……
2. Outside province, but w/in same region : ……
3. Outside region, but w/in country : ……
4. Outside country, but w/in ASEAN : ……..
5. International, outside ASEAN : ……
Total (should add up to 100%)</td></tr>
<tr><td></td><td>b. If answer a item is 4) or 5): →</td><td>List 3 most important countries) →
1. Country Code: .
2. Country Code: .
3. Country Code: .</td><td>Percentage of raw materials in your firm are used:
……%
……%
…..……%</td><td>Since when (year):
……
……
……</td></tr>
<tr><td>3.2.</td><td colspan="4">a. Which percentage of intermediate inputs (processed and manufactured details, accessories, ….) are bought:
1. Within same province : ……
2. Outside province, but w/in same region : ……
3. Outside region, but w/in country : ……
4. Outside country, but w/in ASEAN : ……..
5. International, outside ASEAN : ……
Total (should add up to 100%)</td></tr>
<tr><td></td><td>b. If answer a item is 4) or 5): →</td><td>List 3 most important countries) →
1. Country Code: .
2. Country Code: .
3. Country Code: .</td><td>Percentage of intermediate materials in your firm are used:
……%
…%</td><td>Since when (year):
……</td></tr>
<tr><td></td><td>c) Please name the three the most important raw materials or processed and manufactured details, accessories which your firm were used for production processing in 2009</td><td colspan="3">1.……..……..
2.……..……..
3.……..……..</td></tr>
</table>

	d) *If answer 3.1 item. is 4) or 5):* Do you deal directly with traders in export country or do you operate through an import intermediary in Vietnam *(Circle 01 digit which is the most suitable selection)?* 1. Deal directly with traders in export country ⟶ 2. Operate through an import intermediary in Vietnam		Please name the three most important raw materials export countries for your firm: 1. Country……Code: . . . . 2. Country……Code: . . . . 3. Country……Code: . . . .
3.2.1	1. Do you have any **long term contracts** (over 12 months) with national or international suppliers about raw materials or details, accessories?	a) **National** 1 Yes⟶ Number of suppliers: 1.1 SOEs:……. 1.2 FOE: …… 1.3 Private:……... 1.4 Others :……. 2. No	b) **International** 1 Yes⟶ List of three most important countries (range important level): 1.1 Country……Code: . . . . 1.2 Country……Code: . . . . 1.3. Country……Code: . . . . 2 No
	2. In which: Number of main suppliers are?	Circle 01 digit which is the most suitable selection: 1 SOEs:……. 2 FOE: ……. 3 Private:…….. 4 Others :……	
	3. Average contract duration	1 National:…….....month 2 International:……month	
3.2.2	In general, do raw material, details; accessories suppliers require any special investments in technology to your firm? (specialization)		1 Yes 2 No
3.2.3	In general, do contracts cover technology transfer from the contracting supplier to your firm?		1 Yes 2 No ⟶ Skip to 3.2.5
3.2.4	In general, is the technology transfer from the contracting supplier to your firm? *(Circle 01 digit which is the most suitable selection)*		1. Part of a contractual agreement 2 User's guide attachment but no contractual agreement 3 No user's guide attachment but no contractual agreement
3.2.5	Please name the three helpful supports in order to facilitate international integration: (Eg: Find partners to supply intermediate inputs, decrease import tax, support preferential…)		1…… 2…… 3……
3.3	Are the main output (product) structures of your firm? *(Circle 01 digit which is the most suitable selection)*		1= final goods 2= intermediate goods 3= final and intermediate goods
	1. If answer 3.3 item is 2) ~~or 3)~~⟶ Which percentage of intermediate goods are sold; :		

<table>
<tr><td>3.3.1</td><td colspan="4">a. Within same province : ……
b. Outside province, but w/in same region : …….
c. Outside region, but w/in country : …….
d. Outside country, but w/in ASEAN : ……..
e. International, outside ASEAN : ……
Total (should add up to 100%)</td></tr>
<tr><td></td><td>2. If answer 1 item is d) or e): →</td><td>Please name the three countries, where your firm export goods
1. Country…Code: . . . .
2. Country…Code: . . . .
3. Country…Code: . . . .</td><td>Percentage in firm's export:
……%
……%
……%</td><td>Since when (year):

……
……</td></tr>
<tr><td>3.3.2</td><td>a. What does your firm export? →</td><td colspan="2">Intermediate goods (details; accessories,):
Please name three most important goods:
1 Goods…..…Code:…
2. Goods….Code:
3. Goods….Code:.</td><td>Final goods:

Please name three most important goods:
1 Goods….:…...……Code:……..
2. Goods….:…...……Code:……..
3. Goods….:…...……Code:……..</td></tr>
<tr><td></td><td colspan="2">b. If your firm exports goods: Do you deal directly with traders in import country or do you operate through an export intermediary in Vietnam?
1 Export directly 2 Through export intermediary
(Skip to.3.3) →</td><td colspan="2">Please name the three countries, where your firm is the most exporting
1. Country……Code: . . . .
2. Country……Code: . . . .
3. Country……Code: . . . .</td></tr>
<tr><td>3.3.3</td><td>1. Do your firm have any long term contracts (over 12 months) with customers?</td><td>a) National
1 Yes
2 No ↓</td><td colspan="2">b) International
1 Yes
2 No ↓</td></tr>
<tr><td></td><td>2. If answer 1 item is Yes: →</td><td>Customer are:
(Circle 01 digit which is the most suitable selection)
1 State owned
2 Foreign owned
3 Private owned ↓
4. Other</td><td colspan="2">Please name the three most important countries:
1. Country……Code: . . . .
2. Country……Code: . . . .
3. Country……Code: . . . .</td></tr>
<tr><td></td><td>3. Number of main customers (NCs)?</td><td>a) State owned: . . . . .
b) Foreign owned: . . . .
c) Private owned:…. ↓</td><td colspan="2">Please name the three most important countries:
1. Country……Code: . . . .
NCs….
2. Country……Code: . . . .
NCs….</td></tr>
</table>

			3. Country……Code: . . . . NCs….
	4.Percentage of firm's goods in 2009 to customers	a) State owned: . . . . .% b) Foreign owned: . ..% c) Private owned:…..% d) Other. . . . . .% (Total is 100%)	Please name the three most important countries: 1. Country……Code: . . . . Per…. % 2. Country……Code: . . . . Per…. % 3. Country……Code: . . . . Per…. %
	5. Average contract duration:	……. month	……. month
	6. In general, do goods suppliers require any special investments in technology to your firm? (specialization)		1 Yes 2 No
	7. In general, do contracts cover technology transfer from the contracting supplier to your firm?		1 Yes 2 No
	8. In general, is the technology transfer from the contracting supplier to your firm? *(Circle 01 digit which is the most suitable selection)*		1. Part of an contractual agreement 2 User's guide attachment but no contractual agreement 3 No user's guide attachment but no contractual agreement

4. Upgrading Potential

4.1	Does your firm pursue an **upgrading** strategy through: *(Circle 01 digit which is the most suitable selection)* 1. improvement of process organization 2. improvement of product quality 3. expansion of product variety 4. expanding firm activities into a new sector 5. changing into a different sector	
4.2	Does your firm face any constraints delaying or obstructing, upgrading technologies or machines? If Yes, range (*Circle 01 digit which is the most suitable selection in below each items*) *0= does not apply, 1=slightly important, 5= normal 10= very important*	1 Yes 2 No
	1) basic infrastructure (electricity, energy, land)	0 1 2 3 4 5 6 7 8 9 10
	2) transport infrastructure (roads, airports,..)	0 1 2 3 4 5 6 7 8 9 10
	3) communication infrastructure	0 1 2 3 4 5 6 7 8 9 10
	4) financing constraints (credits, foreign capital	0 1 2 3 4 5 6 7 8 9 10
	5) labor force (number of)	0 1 2 3 4 5 6 7 8 9 10
	6) skilled labor, technical know-how	0 1 2 3 4 5 6 7 8 9 10

	7) other (*specify*)	0 1 2 3 4 5 6 7 8 9 10

5. Competitiveness

5.1	What is the main mode for **competition**? *(Circle 01 digit which is the most suitable selection)*	1. no competition 2. mainly price competition 3. mainly quality competition 4. mainly quantity/supply competition	
5.2	Estimated number of major competitors	**a) national** 1. no competitors 2. less than 5 3. between 5 and 10 4. more than 10	b) **international** 1. no competitors 2. less than 5 3. between 5 and 10 4. more than 10

6. Technology/machine Development

6.1	Does your firm undertake research and development activities (production technology/machine (PT) development, ICT development…)? 1 Yes 2 No → Skip to 7.

		PT	**ICT**
6.2	a. In general, what is firm's technology?	1 Buy 2 Other firms supply 3 Firm's R&D activities 4 other (*specify*)	1 Buy 2 Other firms supply 3 Firm's R&D activities 4 other (*specify*)
	b. If answer a item is 1) or 2) Who is main technology supplier? (*Circle 01 digit which is the most suitable selection*)	1. Enterprise w/in the province, same region 2. Enterprise w/in the province, but outside region 3. Outside country, but w/in ASEAN 4. International, outside ASEAN 5. Other	1. Enterprise w/in the province, same region 2. Enterprise w/in the province, but outside region 3. Outside country, but w/in ASEAN 4. International, outside ASEAN 5. Other
	c. If answer b item is 2, is the code of supplier?	Region .....Region code.....	Region .....Region code.....
	d, If answer b item is 3 or 4, is the code of country?	Country……Country code……..	Country……Country code……..
	e. Who does partner supply technology to your firm?	1 SOEs 2 Private, w/in same group 3 Private, outside group 4 FOE 5 other (*specify*):…….	1 SOEs 2 Private, w/in same group 3 Private, outside group 4 FOE 5 other (*specify*):…….

		PT	ICT ↓
6.3	a. Do you pay any license fee??	1 Yes 2 No	1 Yes 2 No
	b. If answer a) is Yes, the cost per annum is	…….. VND million	…….. VND million
6.4 .	Are the production technology maintained in your firm?	1 In-house 2 Out of house 3 Both → Percentage estimation: - In-house: …… % - Out of house: ……. % (Total is 100%)	1 In-house 2 Out of house 3 Both → Percentage estimation: - In-house: …… % - Out of house: ……. % (Total is 100%)
6.5	a. Did the number of workers change due to the use of PT/IT?	1 Yes 2 No	1 Yes 2 No
	b. If answer 6.5a item is Yes, By how many workers since the introduction of this PT?	1. Workers increase: … persons 2. Workers decrease: ….persons	1. Workers increase:…. persons 2. Workers decrease: …..persons
6.6.	a. Does your firm undertake research and development activities?	1 Yes 2 No	1 Yes 2 No
	b. *If answer a item is Yes,* Since when?	From:	From: . . . . .
6.7.	1. Are R&D activities performed?	1 In-house 2 Out of house 3 Both → Percentage estimation: - In-house: …… % - Out of house: ……. % (Total is 100%)	1 In-house 2 Out of house 3 Both → Percentage estimation: - In-house: …… % - Out of house: ……. % (Total is 100%)
	2. Is the **aim** a general or special purpose innovation?	1= general purpose 2= special purpose	1= general purpose 2= special purpose
	3. *if innovation is special (answer code is 2)*: Is this innovation target…?	*1= new to the firm* *2= new to the market* *3= new to the world*	*1= new to the firm* *2= new to the market* *3= new to the world*
6.8	1. Indicate the **number** of R&D projects and initiatives in 2009	a) Ongoing …… b) Finished ……. c) Cancelled……	a) Ongoing…… b) Finished…… c) cancelled……
	2. Are you currently involved in any research collaborations?	1 Yes 2 No	1 Yes 2 No

		PT	ICT ↓
	3. Are your main cooperation partners?	1= only w/in same province 2= w/in same region 3= w/in same country 4= w/in ASEAN 5= internationally, outside ASEAN *If answer is 4 or 5:* ↓ Please name the three most important countries: a. Country……..…Code…… b. Country……..…Code…… c. Country……..…Code…	1= only w/in same province 2= w/in same region 3= w/in same country 4= w/in ASEAN 5= internationally, outside ASEAN *If answer is 4 or 5:* ↓ Please name the three most important countries: a. Country……..…Code… b. Country……..…Code c. Country……..…Code
	4. How are R&D activities mainly funded? (*Circle 01 digit or more than digits which is suitable selection*)	1=state funds 2=equity 3=credit 4=venture capital 5=other	1=state funds 2=equity 3=credit 4=venture capital 5=other

6.9	How many **national** patents do you hold? a) New in 2009: …….. b) Stock/total (the end of 2009): …….
6.10	How many **international** patents do you hold? a) New in 2009: …….. b) Stock/total (the end of 2009): …….

7. Technology Transfer Channels

Do you consider the following *transfer channels as* ***relevant sources for technology in your firm***?

(*Circle 01 digit which is most suitable selection*):

Indicate the percentage from 0= not relevant to10= very relevant

7.1	a) Purchase *technology* through intermediate channels	0 1 2 3 4 5 6 7 8 9 10
	b) Purchase of technology from research institutions and external firms	0 1 2 3 4 5 6 7 8 9 10
	c) Use of technology provided by other *firm within group* (e.g. shareholder(s)	0 1 2 3 4 5 6 7 8 9 10
	d) Use of technology provided by *main suppliers or customers* with whom the firm has long-term contracts (over 12 months)	0 1 2 3 4 5 6 7 8 9 10
	If answer 7.1 item is c) or d) with more relevant, Is the technology transfer……	1. Part of an contractual agreement 2 User's guide attachment but no contractual agreement 3 No user's guide attachment but no contractual agreement

7.2	The percentage of your current technology is related to newly employed labor force /new workers: ……..……%	
7.3	Who is the most important human source for technology transfer?	1 mainly foreigners 2 mainly nationals 3 Nationals that recently returned to the home country

8. Successfully modify production or process technologies

8	Did you **successfully** modify production or process technologies in order to use them?	1 Yes 2 No → Skip to *9*		
8.1	Number of past successful changes/modifications : …….Time			
		SA 1:	SA 2:	SA 3:
8.2	1. Name and describe the three most relevant successful technology adoption	…… …… ……	…… …… ……	…… …… ……
	2. Year	……	……	……
	3. Cost of technology adoption	……VND million	……VND million	……VND million
	4. What was the motivation to modify (*Circle 01 digit which is most suitable selection*)	1= capacity restrictions 2= low productivity 3= quality improvements 4= expand production variety 5= outdated technology 6= legal requirements 7= other (*specify*)	1= capacity restrictions 2= low productivity 3= quality improvements 4= expand production variety 5= outdated technology 6= legal requirements 7= other (*specify*)	1= capacity restrictions 2= low productivity 3= quality improvements 4= expand production variety 5= outdated technology 6= legal requirements 7= other (*specify*)
	5. What did you modify?	…… ……	…… ……	…… ……
	6. Why did you not buy a ready-to-use technology? (*Circle 01 digit which is most suitable selection*)	1= does not exist 2= did not know about it 3= too expensive 4= no access 5= other (*specify*)	1= does not exist 2= did not know about it 3= too expensive 4= no access 5= other (*specify*)	1= does not exist 2= did not know about it 3= too expensive 4= no access 5= other (*specify*)
	7. How did you finance adoption activities?	1=state funds 2=equity 3=credit 4=venture capital	1=state funds 2=equity 3=credit 4=venture capital	1=state funds 2=equity 3=credit 4=venture capital

	(*Circle 01 digit which is most suitable selection*)	5=other	5=other	5=other
8.3	Was the success a result of an intended process or rather an accidental by-product of other activities? (*Circle 01 digit which is most suitable selection*)		Indicate on a scale from 0 = intended process to 10= accidental, by-product) 0 1 2 3 4 5 6 7 8 9 10	

9. Unsuccessfully modify production or process technologies

9	Did you **unsuccessfully** modify production or process technologies in order to use them?		1 Yes 2 No → Skip to *10*
9.1	Number of past failed or unsuccessful attempts/effort of changes and modifications : …….. time		
		FA 1:	FA 2:
9.2.	1. 1. Name and describe the two most relevant unsuccessful technology adoption	…… …… ……	…… …… ……
	2. Year	……	……
	3. Cost of technology adoption	……VND million	……VND million
	4. What was the motivation to modify (*Circle 01 digit which is most suitable selection*)	1= capacity restrictions 2= low productivity 3= quality improvements 4= expand production variety 5= outdated technology 6= legal requirements 7= other (*specify*)	1= capacity restrictions 2= low productivity 3= quality improvements 4= expand production variety 5= outdated technology 6= legal requirements 7= other (*specify*)
	5. What did you modify?	…… ……	…… ……
	6. Why did you not buy a ready-to-use technology? (*Circle 01 digit which is most suitable selection*)	1= does not exist 2= did not know about it 3= too expensive 4= no access 5= other (*specify*)	1= does not exist 2= did not know about it 3= too expensive 4= no access 5= other (*specify*)
	7. How did you finance adoption activities? (*Circle 01 digit which is most suitable selection*)	1=state funds 2=equity 3=credit 4=venture capital 5=other	1=state funds 2=equity 3=credit 4=venture capital 5=other

10. Adaptation potential

10	Are there any changes in production or process technologies that you would like to make?		1 Yes 2 No → Skip to *11*
		PA1:	PA2:
10.1	1. Name and describe up to two potential/ desired		

	changes in products or technologies in the future ?	…… ……	…… ……
	2. desired time span	Year ……	Year ……
	3. What would be the motivation to modify?	1= capacity restrictions 2= low productivity 3= quality improvements 4= expand production variety 5= outdated technology 6= legal requirements 7= other (*specify*) …….	1= capacity restrictions 2= low productivity 3= quality improvements 4= expand production variety 5= outdated technology 6= legal requirements 7= other (*specify*) …….
	4. What would you modify?	……	……
	5. Does your firm have instead buy a ready-to-use technology? 1 Yes 2 No →	Reasons: 1= does not exist 2= did not know about it 3= too expensive 4= no access 5= other (*specify*)	Reasons: 1= does not exist 2= did not know about it 3= too expensive 4= no access 5= other (*specify*)
	6. How did your firm finance adoption activities?	1=state funds 2=equity 3=credit 4=venture capital 5=other	1=state funds 2=equity 3=credit 4=venture capital 5=other
10.2	Does your firm face any constraints delaying or obstructing the realization? . If Yes, *Circle 01 digit which is most suitable selection in each items* *range 0= does not apply, 1=slightly important, 10= very important*		1 Yes 2 No → Skip to *11*
.	1) basic infrastructure (electricity, energy, land) 2) transport infrastructure (roads, airports,..) 3) financing constraints (credits, foreign capital 4) labor force (number of) 5) skilled labor, technical know-how 6) other (*specify*)		0 1 2 3 4 5 6 7 8 9 10 0 1 2 3 4 5 6 7 8 9 10 0 1 2 3 4 5 6 7 8 9 10 0 1 2 3 4 5 6 7 8 9 10 0 1 2 3 4 5 6 7 8 9 10 0 1 2 3 4 5 6 7 8 9 10

11. **Technology Diffusion**

11	Does your firm have any adoptions/innovations/ new products in general usable outside? 1 Yes 2 No *(If answer is No, The end questionnaire)*

11.1	a. Please name the two adoptions/innovations/ new products usable outside from your firm?	**TD1:** …… ….....	**TD2:** …… ….....
	b. Are firm's adoptions/innovations/ new products usable outside used?	1 Yes 2 No	1 Yes 2 No
	c. Do you receive any license payments or other forms of financial compensation?	1 Yes 2 No	1 Yes 2 No
11.2	Describe partner, who is received transfer adoptions/innovations/ new products from your firm a. operating: 1 in the same sector 2 outside the sector b. Legally dependent on your firm? 1 Yes 2 No c. personally related to you or your firm? 1 Yes 2 No		
11.3	Is this technology/knowledge transfer? (*Circle 01 digit which is most suitable selection*)	1= intended and part of a legal contract 2=intended, voluntary commitment 3=not intended, but tolerated from your firms' side 4=not intended case of piracy or imitation 5=other (specify) ……	

Interviewer:

Full name: . . . . . .
Tel: . . . . . .

Date

Director
(Signature and seal)

Appendix 2. Export Structure of Vietnam and other Asian countries (%)

	Vietnam		Philippines		Thailand		China	
	2000	2010	2000	2010	2000	2010	2000	2010
Agricultural products	27.5	23.2	5.3	8.1	7	9.3	6.5	3.2
Minerals	27.4	12.3	3.4	6.9	4.3	5.6	8.3	6.4
Industrial products	45.1	64.5	91.3	85.1	88.7	85.1	85.1	90.4
Heavy manufactures	1.3	4.6	1	3.4	2.2	2.4	6.8	7.9
Machinery	8.8	16.4	74.2	70.5	54	57.5	33.1	49.5
Information technology	4.0	7.5	22.3	22.3	23	18.6	15.3	24.5
Electronics	3.2	4.7	50.6	42	19.6	14.7	9.9	12.1
Others	1.6	4.2	1.3	6.2	11.4	24.2	7.9	12.9
Light manufactures	35.1	43.5	14.1	11.2	32.5	25.2	45.3	33
Textile, apparel	14.9	18.8	7.6	3.9	10.4	5.7	21.1	13.2
Footwear	10.4	7.5	0.2	0	1.4	0.6	3.8	2.1
Others	9.7	17.2	6.4	7.3	20.7	19	20.4	17.7
Total export	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Tran (2013b)

Appendix 3. The Strategy for S&T Development for the 2011-2020

I. Viewpoints on Science and Technology Development

Development of science and technology together with education and training are the top national policies and key motivations for the country's fast and sustainable development. Science and technology must play a decisive role to make development breakthrough in productive force, innovate growth models, enhance the competitiveness of the economy and speed up the country's industrialization and modernization.

2. Focused and synchronized fulfillment of three essential tasks as continuing to reform basically, comprehensively and synchronously science and technology organizations, management structures and operational mechanisms; strengthening national science and technology potentials; promoting research and development, and linking science and technology development tasks with socio-economic development ones at all levels and branches.

3. The State increases investment level of and prioritizes investment for national science and technology tasks and national products. The socialization and mobilization from all resources are pushed up, especially from enterprises to invest in science and technology development.

4. The development of science and technology market is linked with the enforcement of the law on intellectual property in order to boost results of technology research and development and encourage science and technology innovation.

5. International integration on science and technology is an objective and at the same time an important solution which contributes to Vietnam's science and technology to soon reach at the international level. International integration on science and technology must be implemented in an active, proactive and creative manner, ensuring the national independence, sovereignty and national security, equality and mutual benefits.

II. Objectives of Science and Technology Development

1. Overall objectives

To develop in a synchronized manner social sciences and humanity, natural sciences, technical and technological science; make science and technology to really become a key motive force, meet basic requirements of a modern industrial country. By 2020, a number of Vietnam's science and technology fields will reach the advanced and modern level of ASEAN region and that of the world.

2. Specific targets

a/ By 2020, science and technology will contribute a significant part to the economic growth and restructure of the economy, value of hi-tech products and hi-tech application products will account for about 45% of the GDP. The speed of technology and equipment innovation will reach at 10-15%/year for the 2011- 2015 period and over 20%/year for the 2016-2020 period. Transaction value of the science and technology market will increase 15-17%/ year on the average.

b/ The number of international announcements from research themes funded by the State budget will increase 15-20%/year on the average. The number of innovations registered for protection for the 2011-2015 period will increase 1.5 times higher as compared to those of the 2006-2010 period and the number of the 2016-2020 period will be twice higher than that of the 2011 - 2015 period, especially the number of innovations innovated from State key science and technology programs will be increased fast.

c/ It is strived to increase the total social investment in science and technology at the level of 1.5% of the GDP by 2015 and over 2% of the GDP by 2020. It is ensured that investments from the State budget in science and technology reach at least 2% or more of the total annual State budget expenditure.

d/ By 2015, the number of officers in charge of scientific research and technological development will reach 9-10 persons per ten thousand people; training and examination are of the international standards, 5,000 engineers are fully capable of managing and operating hi- tech production lines of the country's branches and fields of development priorities.

By 2020, the number of officers in charge of scientific research and technological development will reach 11-12 persons per ten thousand people; training and examination are of the international standards, 10,000 engineers are fully capable of managing and operating hi- tech production lines of the country's branches and fields of development priority.

dd/ By 2015, 30 basic research and use organizations of the regional and international levels, which are fully capable of solving issues of national importance relating to science and technology; 3,000 science and technology enterprises; 30 hi-tech technology incubators and hi-tech enterprise incubators will be formed.

By 2020, 60 basic research and use organizations of the regional and international levels , which are fully capable of solving issues of national importance relating to science

and technology; 5,000 science and technology enterprises; 30 hi-tech technology incubators and hi-tech enterprise incubators will be formed.

III. Main tasks:

1. To focus resources on implementation of national science and technology programs and projects and improve the national science and technology capacities.
2. To reform mechanisms on use of the State funds for science and technology, and mobilize social resources for science and technology
3. To synchronously formulate policies on attracting, employing and applying important preferential treatments for science and technology officers
4. To develop science and technology markets with linkages to the enforcement of intellectual property rights
5. Active and proactive international integration in science and technology
6. To promote communications and raise awareness of the pubic on roles of science and technology

Appendix 4. Overview of Productivity Measures

Type of output measure	**Type of input measure**			
	Labor	Capital	Capital and Labor	Capital, Labor, and Intermediate inputs (energy, materials, service)
Gross Output	Labor productivity (based on gross output)	Capital productivity (based on gross output)	Capital-labor multifactor productivity (based on gross output)	KLEMS* multifactor productivity
Value Added	Labor productivity (based on value added)	Capital productivity (based on value added)	Capital-labor multifactor productivity (based on value added)	-
	Single factor productivity measures		Multifactor productivity measures (TFP)	

* KLEMS=capital-labor-energy-materials

Source: OECD (2001)

Appendix 5. OECD's classification of manufacturing industries by technology level (2-digit Vietnam Standard Industrial Classification code)

VSIC Code	Industry
Group 1: Low technological industry	
10, 11	Food products and beverages
12	Tobacco products
13	Textile
14	Wearing apparel
15	Leather and related products
16	Wood and wood products
17	Paper and paper products
18	Printing and reproduction of recorded media
31,32	Furniture and other products are not classified elsewhere
Group 2: Medium-low technological industry	
19	Coke, refined petroleum products, nuclear fuel
22	Rubber and plastics products
23	Other non-metallic mineral products
24	Basic metals
25	Fabricated metal products, except machinery and equipment
Group 3: Medium-high technological industry	
20	Chemicals and chemical products
26	Computer, electronic and optical products
28	Machinery and equipment
29,30	Motor vehicles and other transport equipment
Group 4: High technological industry	
21	Pharmaceuticals, medicinal chemical and botanical products
27	Electrical equipment

Appendix 6. Herfindahl-Hirschman Index of 2-digit manufacturing industries in 2010-2013

Code	Industry	2010	2011	2012	2013
Group 1: Low technological industry					
10, 11	Food products and beverages	0.048	0.044	0.067	0.188
12	Tobacco products	1	1	1	1
13	Textile	0.053	0.042	0.045	0.059
14	Wearing apparel	0.140	0.059	0.418	0.059
15	Leather and related products	0.091	0.128	0.350	0.170
16	Wood and wood products	0.167	0.087	0.454	0.160
17	Paper and paper products	0.045	0.111	0.218	0.131
18	Printing and reproduction of recorded media	0.094	0.026	0.027	0.047
31	Furniture	0.100	0.175	0.086	0.098
32	Other products are not classified elsewhere	0.149	0.104	0.080	0.413
Group 2: Medium-low technological industry					
19	Coke, refined petroleum products, nuclear fuel	0.647	0.376	0.405	0.645
22	Rubber and plastics products	0.084	0.053	0.185	0.092
23	Other non-metallic mineral products	0.138	0.299	0.053	0.132
24	Basic metals	0.141	0.085	0.076	0.078
25	Fabricated metal products, except machinery and equipment	0.083	0.020	0.068	0.037
Group 3: Medium-low technological industry					
20	Chemicals and chemical products	0.051	0.174	0.099	0.887
26	Computer, electronic and optical products	0.333	0.087	0.164	0.271
28	Machinery and equipment	0.055	0.186	0.056	0.163
29,30	Motor vehicles and other transport equipment	0.127	0.110	0.074	0.245
Group 4: High technological industry					
21	Pharmaceuticals, medicinal chemical and botanical products	0.944	0.225	0.391	0.206
27	Electrical equipment	0.175	0.044	0.549	0.044

Note: Herfindahl-Hirschman Index is calculated based on the total domestic sales of firm with its total sales of industry.

Source: Author's calculation from the Vietnam Enterprise Survey in 2010-2013.

Appendix 7. The share of provincial budget allocated for scientific and technological activities: 2010-2013

(Unit: %)

	2010	2011	2012	2013		2010	2011	2012	2013
Ha Noi	0.22	0.27	0.31	0.40	Quang Nam	0.17	0.18	0.15	0.16
Ha Giang	na	0.23	0.19	0.15	Quang Ngai	0.21	0.17	0.16	0.17
Cao Bang	0.31	0.36	0.25	0.27	Binh Dinh	0.43	0.39	0.19	0.46
Bac Kan	0.33	0.26	0.26	0.26	Phu Yen	1.83	0.31	0.24	0.21
Tuyen Quang	0.30	0.20	0.16	0.27	Khanh Hoa	0.21	0.24	0.27	0.24
Lao Cai	na	0.22	0.17	0.22	Ninh Thuan	na	0.19	0.33	0.23
Dien Bien	0.17	0.17	0.14	na	Binh Thuan	0.19	0.18	0.19	na
Lai Chau	0.07	0.06	0.06	0.07	Kon Tum	0.17	0.13	0.14	0.24
Son La	0.21	0.21	0.17	0.20	Gia Lai	0.17	0.15	na	0.13
Yen Bai	0.36	0.26	0.38	0.33	Dak Lak	0.14	0.21	0.19	0.16
Hoa Binh	0.48	0.32	0.18	0.27	Dak Nong	0.17	0.21	0.16	0.11
Thai Nguyen	0.34	0.34	0.33	0.26	Lam Dong	0.32	0.29	0.32	0.29
Lang Son	0.25	0.23	0.20	0.10	Binh Phuoc	0.41	0.30	0.40	0.27
Quang Ninh	0.52	0.39	0.50	0.89	Tay Ninh	0.27	0.37	0.28	0.26
Bac Giang	na	0.15	0.22	0.49	Binh Duong	0.29	0.26	0.22	0.18
Phu Tho	0.24	0.20	0.22	0.28	Dong Nai	na	0.48	0.40	0.34
Vinh Phuc	0.16	0.15	0.21	0.19	Ba Ria-Vung Tau	0.45	0.59	0.28	0.32
Bac Ninh	0.25	0.30	0.40	0.27	Ho Chi Minh	0.41	0.26	0.35	0.37
Hai Duong	0.37	0.20	0.28	na	Long An	0.24	0.38	0.28	0.34
Hai Phong	na	0.54	0.55	0.49	Tien Giang	0.31	0.30	0.47	0.26
Hung Yen	0.29	0.31	0.38	0.40	Ben Tre	0.30	0.37	0.35	0.38
Thai Binh	0.29	0.22	0.38	0.35	Tra Vinh	na	0.14	0.13	0.20
Ha Nam	0.34	0.30	0.22	0.29	Vinh Long	0.31	na	0.27	0.36
Nam Dinh	0.25	0.19	0.21	0.20	Dong Thap	0.19	0.23	0.17	0.25
Ninh Binh	na	0.28	0.27	0.26	An Giang	na	na	0.32	0.49
Thanh Hoa	0.08	na	na	0.18	Kien Giang	na	0.19	0.23	0.30
Nghe An	0.35	0.12	0.11	0.10	Can Tho	0.26	0.23	0.37	0.31
Ha Tinh	na	0.11	na	0.13	Hau Giang	0.10	0.08	na	0.23
Quang Binh	0.40	0.26	0.24	0.25	Soc Trang	0.20	0.36	0.17	0.39
Quang Tri	0.36	0.26	0.21	0.24	Bac Lieu	0.35	0.35	0.34	0.21
Thua Thien Hue	na	0.15	0.10	0.22	Ca Mau	0.36	0.21	0.36	0.53
Da Nang	0.16	0.17	0.20	na					

Source: Author's calculation from the Vietnam Provincial Statistical Yearbook 2010-2013, Ministry of Finance.

Appendix 8. Share of foreign owned firms in the total number of firms by province: 2010-2013

	2010	2011	2012	2013		2010	2011	2012	2013
Ha Noi	1.75	2.93	0.44	1.70	Quang Nam	1.78	1.68	0.37	1.67
Ha Giang	0.14	0.39	0.09	0.18	Quang Ngai	0.15	0.34	0.08	0.29
Cao Bang	0.59	0.80	0.56	0.78	Binh Dinh	0.50	0.47	0.06	0.46
Bac Kan	0.45	0.20	0	0.40	Phu Yen	1.54	1.43	0.13	1.48
Tuyen Quang	0.13	0.33	0	0.43	Khanh Hoa	1.08	1.10	0.14	0.74
Lao Cai	1.47	1.17	0.42	0.92	Ninh Thuan	1.37	1.27	0.20	1.20
Dien Bien	0.19	0.14	0.26	0.26	Binh Thuan	1.44	1.63	0.24	1.55
Lai Chau	0.29	0.28	0.27	0.27	Kon Tum	0.23	0.09	0	0.09
Son La	0.43	0.39	0.11	0.34	Gia Lai	0.12	0.15	0	0.10
Yen Bai	0.76	0.84	0.30	0.80	Dak Lak	0.08	0.10	0.04	0.11
Hoa Binh	0.80	0.75	0	0.33	Dak Nong	0.69	0.57	0.13	0.53
Thai Nguyen	0.71	0.64	0.29	1.10	Lam Dong	3.72	3.16	0.40	2.95
Lang Son	2.43	2.22	1.27	1.65	Binh Phuoc	2.71	2.23	0.21	2.75
Quang Ninh	1.56	1.29	0.58	1.18	Tay Ninh	7.01	7.39	0.14	7.41
Bac Giang	3.38	3.44	0.35	4.05	Binh Duong	18.10	16.80	0.53	14.36
Phu Tho	2.40	2.27	0.18	2.52	Dong Nai	10.29	9.57	0.55	9.48
Vinh Phuc	3.42	2.76	0.24	2.53	Ba Ria-Vung Tau	3.58	4.32	0.71	2.53
Bac Ninh	4.69	5.08	0.43	5.53	Ho Chi Minh	2.14	3.18	0.50	2.29
Hai Duong	4.16	3.73	0.28	3.75	Long An	5.69	7.23	1.19	7.68
Hai Phong	3.17	3.12	0.68	2.88	Tien Giang	0.63	1.03	0.17	1.18
Hung Yen	5.68	5.89	0.59	5.91	Ben Tre	0.90	1.25	0.16	1.36
Thai Binh	1.54	1.52	0.14	1.60	Tra Vinh	0.92	0.99	0.38	1.15
Ha Nam	1.71	2.19	0.11	2.43	Vinh Long	0.64	0.62	0.11	0.63
Nam Dinh	0.51	0.64	0.16	0.78	Dong Thap	0.40	0.58	0.15	0.41
Ninh Binh	0.93	0.89	0.15	0.80	An Giang	0.21	0.17	0.04	0.12
Thanh Hoa	0.39	0.57	0.15	0.44	Kien Giang	0.13	0.14	0.05	0.19
Nghe An	0.38	0.48	0.13	0.45	Can Tho	0.56	0.47	0.40	0.72
Ha Tinh	0.90	1.54	0.18	1.53	Hau Giang	0.25	0.31	0.18	0.36
Quang Binh	0.09	0.08	0	0.03	Soc Trang	0.08	0.22	0.07	0.43
Quang Tri	0.31	0.27	0	0.19	Bac Lieu	0.60	0.62	0	0.63
Thua Thien Hue	0.69	0.85	0.31	0.81	Ca Mau	0.09	0.04	0	0.04
Da Nang	0.95	1.26	0.29	1.31					

Source: Author's calculation from the Vietnam Enterprise Survey 2010-2013.

Appendix 9. Import penetration by industry: 2010-2013

Code	Industries	2010	2011	2012	2013
Group 1: Low technological industry		**0.491**	**0.710**	**0.661**	**0.745**
10, 11	Food products and beverages	0.202	0.280	0.268	0.273
12	Tobacco products	0.165	0.186	0.172	0.181
13	Textile	1.400	1.647	1.796	1.845
14	Wearing apparel	-0.089	-0.067	-0.068	-0.063
15	Leather and related products	7.777	-0.800	-0.609	-0.589
16	Wood and wood products	0.427	0.503	0.452	0.512
17	Paper and paper products	0.385	0.383	0.349	0.357
18	Printing and reproduction of recorded media	0.228	0.257	0.234	0.217
31,32	Furniture and other products are not classified elsewhere	0.400	0.326	0.186	0.256
Group 2: Medium-low technological industry		**0.595**	**0.747**	**0.692**	**0.667**
19	Coke, refined petroleum products, nuclear fuel	1.274	1.721	1.829	1.420
22	Rubber and plastics products	0.427	0.507	0.535	0.563
23	Other non-metallic mineral products	0.104	0.117	0.140	0.146
24	Basic metals	0.902	1.002	0.851	0.900
25	Fabricated metal products, except machinery and equipment	0.213	0.285	0.278	0.304
Group 3: Medium-high technological industry		**0.957**	**1.170**	**1.561**	**2.052**
20	Chemicals and chemical products	0.935	1.080	1.055	1.025
26	Computer, electronic and optical products	0.760	0.983	2.464	-18.201
28	Machinery and equipment	1.651	2.239	3.799	5.894
29	Motor , trailers, semi-trailers	0.393	0.438	0.347	0.346
30	Other transport equipment	0.452	0.461	0.489	0.496
Group 4: High technological industry		**1.252**	**1.912**	**2.927**	**3.373**
21	Pharmaceuticals, medicinal chemical and botanical products	0.552	0.714	1.192	1.038
27	Electrical equipment	1.520	2.290	3.272	3.912

Source: Author's calculation from UN Comtrade database and GSO Statistical Yearbook.