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STOCHASTIC FRONTIER ANALYSIS OF VIETNAMESE MANUFACTURING FIRMS

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by

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Chapter 1: Introduction

1.1. Vietnam's Economic Background and Objectives of the Dissertation

Vietnam has achieved successful economic development since the government initiated *Doimoi* (renovation) policy in 1986, with the goal of creating a socialist-oriented market economy, which was pronounced in 1989. Two primary issues in the *Doimoi* reform were (1) restructuring the domestic economy, and (2) opening up the economy to external trade and investment. Since the 1989 reforms, Vietnam has recorded remarkable economic achievements in GDP growth, macroeconomic stabilization, export expansion, and poverty reduction. It is now generally recognized as one of the best developing countries which has sustained relatively high economic growth (7% per annum over the period 1990-2008).

During the course of transition to a market economy, structure of the economy witnessed gradual changes in economic sectors and ownership structure, targeting at industrialization and modernization. Industrialization is a critical means of creating employment, upgrading technological level, and improving productivity. Productivity is higher in the manufacturing than in the agricultural sector. Because manufacturing is considered more dynamic than any other sectors, transfer of productive resources to more dynamic sectors contributes to growth (Cheong, Pham, and Nguyen, 2010). This is evident in Vietnam's statistics when the proportion of the primary sector in GDP declined from 32% in 1990 to 26%, 23%, and 20% in 1995, 2000, and 2005, respectively, while that of the secondary sector rose from 25% to 30%, 35%, 41% for the same years. Importantly, the share of the leading manufacturing sector increased from 15% in 1995 to 19% in 2000 and 23% in 2005 in total GDP, which is equivalent to more than one-fifth of GDP in whole economy's business sectors.

Structural change has also arisen in terms of firm ownership. While the share of state-owned (state for short henceforth) firms decreased, the share of foreign-invested (foreign for short henceforth) firms and that of domestic privately-owned (private for short henceforth) firms increased after the *Foreign Investment Law* in 1987. Nonetheless, the share of output by ownership had been relatively stable and state firms had occupied a large share up to 2005. For example, the output share of state firms reduced from over 50% in 1995 to 42% in 2000 and 34% in 2005; that of foreign firms increased from 25% to 36% and 37% for the same years. It was after 2005 that output value of foreign firms exceeded that of state firms. Private firms had also increased their role: Their share of output had increased one-fourth to one-third of the economy from 1995 to 2005.

Private firms emerged in response to Vietnam's industrial policies. The government first legally approved operation of private firms at the seventh National Congress of the Communist Party of Vietnam in 1991 and further stimulated development of private firms via the *Enterprise Law* in 1999. These policies targeted at a key role of private firms in the economic development, along with restructuring of traditional state firms. Consequently, private firms have markedly developed and contributed to the economic growth. Data from the General Statistics Office (GSO) of Vietnam show that private firms attained a high growth rate of industrial outputs, 7% on average, during the period of 2000-2005. The data also show that the share of private firms in total employment increased from 29% to 48% and that their share in total long-run investment also increased from 8% to 21% over the six years. In particular, the manufacturing sector led the economic development and produced one-third of total turnover, resulting in 48% of total job creation and 32% of total long-run investment during the period.

The aforementioned data were only available at the aggregated level and were not freely open to the public throughout the 1990s.

It was fifteen years later from the initial renovation policy that the GSO decided to start the Enterprise Survey in 2000 to evaluate business performance of firms, which has been conducted annually up to date. Although the data are made available to socio-economic researches for official use, only a few researchers have utilized the data to study productivity of the manufacturing sector, the leading sector for economic development of Vietnam. Such valuable data should be used to ask, for example, if domestic private and state firms have actually raised their productivity after the renovation policy and how they have (or have not) raised their productivity.

In the manufacturing sector, emerging private firms are substantially smaller in size, but they account for a much larger share than state firms in various economic terms. For example, the GSO data in 2008 shows that private and state firms respectively hired 4.7 and 1.6 million employees and had turnovers of 2,973 and 1,349 trillion Vietnam dongs (VND), meaning that private firms had 2.9 and 2.2 times higher employment and turnover than state firms in 2008. Despite their larger effects on the economy, private firms still face many difficulties (e.g., limited access to the formal financial system, shortage of qualified human capital, lower management skill, etc.), although the government tried to alleviate their difficulties and supported them through the legal system. On the other hand, the government continues protecting state firms and providing them with capital investment, particularly in important industries such as steel, motorcycle, and industrial equipment manufacturers, which is likely to result in less competitive state firms. Under such severe circumstances, private firms are likely to have much lower productivity than state firms. However, they have to raise their productivity for further Vietnam's economic development because of their dominant share in the leading manufacturing sector. Therefore, it is important to verify that small private firms actually have lower productivity and investigate reasons why their productivity is so low. These are the motivations for the empirical analysis in Chapter 3.

In the process of economic development, some manufacturing firms may choose to exit the market because of their low profits, while others may choose to stay in the market even though their productivity is not so high. Their decision on exit can have serious impacts on productivity of the manufacturing sector. For example, if the product market for the manufacturing sector is competitive enough for firms with low productivity to exit, the average productivity of this sector should rise after their exit. On the other hand, if the government gives credits to state firms with low productivity and to protect them, they might not exit the market and the average manufacturing productivity will be consequently lower. Despite such close relationship between firm exit and productivity, only a few studies have incorporated this behavior into the empirical analysis of productivity, which offers motivation for the empirical analysis of Chapter 4.

Estimation of stochastic production frontiers (SPFs) provides one of the best ways to effectively compare productivity of private and state firms as well as examine the relationship between firm exit and productivity. Comparison of production frontiers and technical efficiency (TE) reveals details about productivity differences between the two types of firms. Furthermore, SPF estimation allowing for endogeneity of firm exit help us know whether exit decision of firms is actually affect their production technology. Finally, estimation results of these SPFs are expected to give various policy implications for the Vietnamese manufacturing firms to raise their productivity and hence to help sustain development of the manufacturing sector.

1.2. Productivity Analysis in Relation to Firm Size and Ownership

Investigating production performance of firms has been a focal analysis in the literature especially for manufacturing firms in developing countries. This analysis is important because productivity improvement is a powerful means of moving towards industrialization and achieving a sustainable economic development. Manufacturing firms in developing countries face several difficulties for their successful development. For example, emerging small firms have lower production technology (more labor-intensive technology) than existing large firms (with more capital-intensive technology); they lack technical capacity to perform well (Söderbom and Teal, 2004); and they suffer from discrimination in access to various production resources.

Firm size is often thought of as one of main factors affecting productivity of firms in the literature because it can determine managerial organization of firms and their production technology (Diaz and Sanchez, 2008). Large firms may be more efficient because of their greater product differentiation, their ability to access specialized resources, their greater market power, the cost advantages of scale economies, their higher prestige, and their perquisites to attract more competent managers and workers (Jovanovic, 1982; Ahuja and Majumdar, 1998). On the other hand, small firms may have higher production efficiency because they have more flexibility in response to changes in the economic environment (e.g., instantaneous labor adjustments) and they have lower supervision costs (Chapelle and Plain, 2005; Yang and Chen, 2009). Despite its important implications, few studies for Vietnamese manufacturing firms have empirically investigated effects of firm size on production technologies (or technology adoption) and hence productivity.

For domestic manufacturing firms in Vietnam, another natural point of productivity comparison is from firm ownership, private or state. The literature commonly argues that private firms are more productive than state firms. In developing countries, private firms are often managed by a family member working for a family firm and hence the manager puts a great deal of effort into firm management to increase profits, which causes higher productivity of private firms (Bottasso and Sembenelli, 2004). Furthermore, state firms are free of competitive pressure, they lack a scheme for transferring residual claims, and they lack a system to monitor manager’s behavior, which causes lower productivity of state firms. On the other hand, stronger supports from the government (e.g., state credits, protection and privileges in some specific business fields) might cause higher productivity of state firms in socialist economy such as Vietnam.

1.3. Productivity Analysis in Relation to Firm Exit

The developing countries as Vietnam in which markets are still dysfunctional seem to tolerate inefficient large state firms. At the same time, they encourage to establish small private firms under economic liberalization policies without strong commitment to business continuation of these firms (i.e., without protection). Consequently, these small firms tend to face a business environment that is closer to the real market economies (i.e., perfect market competition). When the markets work properly, less productive firms might have no other way than to choose to exit the market due to the competitive pressure, while more productive ones will stay in business. This process increases aggregate productivity of the industry or the economy in general (Söderbom, Teal, and Harding, 2006; Shiferaw, 2009). Such an important determinant as productivity in firms' exit decision appears in the long literature of firm exit analysis (e.g., Alvarez and Vergara, 2010; Bernard and Jensen, 2007; Frazer, 2005), in which firm productivity is examined along with other firm-specific characteristics (e.g., firm size, firm age, firm ownership, capital intensity, firm debt, labor wages) and industry-specific characteristics (e.g., market competition, presence of foreign firms).

When examining relations between productivity and firm exit decision, most studies examine only the effect of productivity on firm exit decision using a two-step estimation method. This method might cause biased estimation results in each step: one for the production frontier estimation at the first stage and the other for the exit probability estimation at the second stage. The former bias may arise directly in estimating the production frontier if we do not consider endogeneity of firm exit decision. The latter bias may arise if productivity or technical efficiency is estimated using the result in the first step (Tsionas and Papadogonas, 2006). It might be natural to assume a direct relationship between the firm exit and production technology adoption because exit from the market is the firm's own decision. Accordingly, firms with lower production technology might also be more likely to exit the market. Mayen, Balagtas, and Alexander (2010) and Kumbhakar, Tsionas, and Sipiläinen (2009) are two outstanding studies which allow for endogenous self-selection (i.e., endogeneity of technology adoption) in estimating the production frontier using propensity score matching (PSM) method or full information maximum likelihood estimation method.

1.4. Productivity Analysis and Stochastic Production Frontier (SPF) Analysis

An effective means of comparing productivity between different types of firm is by estimating their stochastic production frontiers (SPF). SPF method not only captures random noise but also allows hypothesis tests, which cannot be handled by the method of data envelopment analysis (Coelli et al., 2005). SPF estimation allows us to examine the difference not only in their technology levels but also in their technical efficiency (TE), both of which are important components of productivity (Nishimizu and Page, 1982). Technology level represents the best production technology potentially available for all firms of interest. On the other hand, TE represents how efficiently each firm actually produces outputs in comparison with the outputs that could be produced using the best technology. Decomposition of productivity changes (or differences) into changes (or differences) in production frontiers and those in TE help us find which contributes more to productivity gains for firms in developing countries. Furthermore, we can investigate factors determining changes (or differences) in production frontiers and TE and derive policy implications for productivity enhancement and further economic development.

Despite its importance for productivity analysis, most studies that estimate SPFs for different groups have focused only on difference in TE and ignored difference in production frontiers. One important exception is Kumbhakar, Tsionas, and Sipiläinen (2009), who specify separate production technology for different types of farmers to investigate productivity difference for organic and conventional farmers. The other exception is Mayen, Balagtas, and Alexander (2010), who introduce a dummy variable of different types of farmers and interact it with inputs to represent different production technology for organic and conventional farmers. If we compare TE index of different types of firms (private versus state firms or exiting versus staying firms) assuming their identical production technology, we might reach a misleading conclusion about their productivity differences.

Technical inefficiency term appears as a non-negative error term besides the conventional statistical disturbance, which is usually assumed to be standard normal. In empirical studies, assumptions on the distribution of technical inefficiency term (e.g., half normal, truncated normal, exponential distributions) can differ depending on the characteristics of data. Empirical studies assuming a half normally distributed technical inefficiency tend to seek determinants of the TE variation using a two-step approach, in which TE index is computed in the first stage and the estimated TE is then regressed on a vector of explanatory variables in the second stage. On the other hand, empirical studies assuming a truncated normally distributed technical inefficiency seem to provide more reliable results for determinants of the TE variation because they estimate the model in a single step. Because the data in this dissertation often encounters non-convergence in applying the latter specification, empirical analyses in Chapters 3 and 4 of our dissertation assume that technical inefficiency follows a half normal distribution.

1.5. Summary

This dissertation is organized as follows. Chapter 2 summarizes construction of data on the Vietnamese manufacturing firms used for the subsequent analysis and conducts a preliminary productivity analysis based on these data. The GSO has collected the firm-level data to evaluate business performance of all existing firms in Vietnam since 2000, in which we focus on domestic private and state firms in the manufacturing sector. We use these data to preliminarily predict productivity difference between private and state firms and similar different between exiting and staying firms.

Chapter 3 compares productivity of private and state firms in the Vietnamese manufacturing industries using the SPF method. We decompose the productivity difference between the two groups into production frontier difference and TE difference. Our empirical results show that state firms have higher productivity than private ones because they have a much higher production frontier. We also find that state firms have a higher frontier probably because they benefit more from favorable governmental policies in state credit access and privileges for natural resource exploitation. This empirical result suggests that the government should give private firms the same rights and privileges as state firms to increase productivity of private firms and achieve further economic development in the long-run.

Chapter 4 focuses on the relationship between firm exit and firm productivity. By applying the propensity score matching (PSM) method of Mayen, Balagtas, and Alexander (2010), we find some biases coming from endogeneity of firm exit decision in estimation SPFs. Specifically, over the full sample, exiting firms have 5% and 15% lower production frontiers for private and state firms. On the other hand, over the matched samples, exiting firms show a significantly lower frontier (9%) only for state firms. Furthermore, over the full sample, exiting firms have 8% lower TE index for both private and state firms, whereas over the matched sample, exiting private (state) firms have 2% (3%) lower TE index. Consequently, firms with lower productivity (i.e., both lower production technology and lower TE) are likely to exit the market in the Vietnamese manufacturing sector between 2000 and 2004.

Chapter 5 concludes the dissertation by stating its contributions, political implications and its remaining issues for future study.

Chapter 2: Variable Construction for Firm-Level Data and Preliminary Analysis

2.1. Description of the Survey Data

This dissertation uses data from the Enterprise Survey annually conducted by the GSO since 2000. The survey contains detailed information on various production activities of individual firms in all industries and in all regions of the 64 municipalities and provinces in Vietnam. A firm in the survey is defined as "an economic unit that independently keeps business account and acquires its own legal status". It may be set up and operate under regulations of *State Enterprise Law*, *Cooperative Law*, *Enterprise Law*, *Foreign Investment Law* or the Agreements between the Government of Vietnam and the Government of Foreign Countries (GSO, 2010). A surveyed firm might be a single firm or a multi-plant firm, which has more than one factory/branch located in different provinces that have independent business accounts paralleled with the mother firm. There are three types of firms in terms of ownership in the survey. They are state firms, non-state firms (private firms in our dissertation), and foreign firms.

Specifically, these types of firms in the survey are defined as follows. State firms, either at central or local (provincial) level, are under the control of the State and mass organizations and their capital is provided by the State (or the government). Private firms are set up by domestic capital. The capital may be owned cooperatively or privately by one owner or shared with an individual group or shared with the government when the capital proportion of the government is equal to or less than 50% of registered capital. Foreign firms have capital directly invested by foreign investors, regardless of any percentage share of capital, which includes wholly-owned foreign firms and joint venture firms.

The survey contains indicators to identify name, address, ownership, and various economic activities of each firm. It also contains variables used in production such as number of employees, labor compensation, assets and capital sources, turnover, profit, investment capital, and evaluations on the investment environment. The survey is conducted in one of the following two ways. First, the data investigators deliver the questionnaires to firms with necessary instructions and time allowance for completion and their addresses to receive the answers back. Second, they directly interview the firms' managers/owners especially with the questionnaire related to investment environment. The methodologies and contents of the survey are generally kept similar year to year in order to assure comparability of information among years.

Using the regional index, we can classify 64 municipalities and provinces into six regions, which include Red River Delta, Northern Midlands and Mountain areas (henceforth Northern Mountains), North and South Central Coast (henceforth Central Coast), Central Highlands, South East, and Mekong River Delta.[1] These province codes are merged to with the individual firm code to identify multi-plant firms because each factory/branch of multi-plant firms is considered as an independent firm in our analysis. We create six regional dummy variables from this regional code for later use.

Finally, we discuss details about classification of industries. Industrial classification at the two-digit level follows the International Standard Industrial Classification (ISIC) and it is based on main activity that contributes the largest share to total gross output of the firm. Consequently, each firm is assigned a unique industrial code. The survey counts the number of firms only when they are still in operation by December 31st, although the following firms or units are excluded for counting: firms that received business licenses and tax codes but still do not operate, those that were dissolved or jointed to other firms, those that got operation permission but are not present in the registered location, or economic units that do not independently keep business account such as dependent economic units and other non-economic bodies. The manufacturing sector includes twenty-three individual industries, which range from the ISIC 15 through the ISIC 37.

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1 Observations for the "non-province" regions are dropped because they have no administrative status in reality. Furthermore, the three-digit province codes for 2000-2003 are changed to the compatible two-digit province codes for 2004 and later.

For our empirical analysis, the manufacturing sector can be classified into four industrial groups of similar production technologies: resource-based, low-tech, medium-tech, and high-tech industries (Ministry of Industry and Trade (MoIT) and United Nations Industrial Development Organization (UNIDO), 2011).

Resource-based industry includes food products and beverages (15), tobacco products (16), wood and wood products (20), paper and paper products (21), and coke, refined petroleum products and nuclear fuel (23), where the numbers in parentheses are ISIC codes. These manufactures are associated with agricultural products and other simple manufactures derived from extractive industries. Except for the oil processing industry, the other industries require relatively simple technologies and low-skilled labor.

Low-tech industry includes textiles (17), wearing apparel, dressing and dyeing of fur (18), tanning and dressing of leather (19), publishing, printing and reproduction of recorded media (22), rubber and plastic products (25), other non-metallic mineral products (26), basic metals (27), furniture and other products not classified elsewhere (36), and recycling (37). These manufactures are characterized as labor-intensive and use relatively simple technologies, with research and development (R&D) tending to be low and limited innovation.

Medium-tech industry includes chemicals and chemical products (24), fabricated metal products (28), machinery and equipment (29), electrical machinery and apparatus (31), motor vehicles, trailers and semi-trailers (34), and other transport equipment (35). 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 techniques and procedures.

High-tech industry includes office, accounting and computing machinery (30), radio, television and communication equipment (32), and medical, precision and optical instruments (33). Production of these industries requires advanced capabilities and imposes significant risks on investors. However, the assembly ends of many of these firms do not require skilled labor or processes calling for high technical competence in

Vietnam. Consequently, Vietnam's high-tech industry might not utilize higher technologies compared with the medium-tech industry.

Table 2.1 presents number of observations for state, private, and foreign firms and their percentage shares. The upper panel of the table presents the original number of firms in the survey. If we look at all firms (including manufacturing firms), private firms occupied 90% (393,272 of 438,766) on average throughout the period of analysis. The number of these firms in 2005 was three times as many as the one in 2000, or their share increased from 83% to 93% during the six years. On the contrary, the number of state firms decreased by nearly 30% and their share gradually decreased from 14% to 4% during the same period. The number of foreign firms increased from 1,529 in 2000 to 3,697 in 2005, although their share remained unchanged at 3-4%. Manufacturing firms accounted for more than 21% of all firms. Among manufacturing firms, state firms occupy 8%, private firms occupy 81%, and foreign firms occupy 11%. It is noteworthy that while state firms decrease their share from 15% in 2000 to just 5% in 2005, private firms increase their share from 75% to 85% in the same period, with foreign firms keeping their constant share.

The lower panel of the Table 2.1 presents the number of the three types of firms and their percentage shares in the manufacturing sector, after we consider all missing values of the relevant variables. The remaining observations should have positive (net) turnover, number of employees, fixed asset and long-term investment (fixed asset for short henceforth), total profit, non-negative liability, labor compensation, and labor fringe benefits. Also, observations with multiple records are removed from our sample when we merge observations for different years.

The number of manufacturing firms after the adjustment is 72,409, which includes 6,695 (9%) state firms, 58,485 private firms (81%), and 7,229 foreign firms (10%), where the corresponding shares are shown in parentheses. State firms decreased from 1,306 in 2000 to 897 in 2005, while private firms doubled their number from 7,314 to 14,655, and foreign firms increased nearly three-fold from 642 to 1,774 during the same period.

These firm ownership changes in the manufacturing sector in Vietnam represents changes in the governmental policies in (1) restructuring and privatizing unprofitable state firms while keeping and strengthening profitable and capable state firms, (2) promoting the establishment and development of domestic private firms and foreign firms. This evidence suggests interesting insights for studying the Vietnamese manufacturing sector, particularly in examining performance or productivity of different types of firms and their life cycles (decisions on business exit or continuation). In this dissertation, we mainly focus on domestic private and state firms and rarely use data on foreign firms.

2.2. Definition of Main Variables and Their Preliminary Analysis

Main variables in our empirical analyses of the Chapters 3 and 4: labor, capital, and output are defined and constructed in the following ways. Labor input is defined as the number of employees hired by the firm. Specifically, employees for state firms include those paid by the firm and do not include those who receive materials of the firm to produce goods at home (i.e., household employees); those who are working as unpaid apprentices sent from educational and training units for practice; and those who are sent to the firm to work in joint-venture projects with partner firms but are not paid. However, employees for private firms include members of the proprietor's households who participate in management and/or directly work for the firm but are not paid.

Capital input is defined as fixed asset of the firm. Specifically, it is one of the components of the firm's total assets, which includes tangible, intangible fixed asset and rented fixed asset such as rented value of office and/or factory site. It includes the total remaining values of fixed asset, value of under-construction projects, amount of paying security, long-term consigning and other long-term financial investment. Fixed asset is a production means that is used more than one year and has at least VND 10 million values. When private firms report zero fixed asset value, their fixed assets are replaced with one tenth of the smallest positive value of fixed asset in the sample to avoid unavailability in the empirical analysis.

Output is defined as value-added, which is in turn defined as the sum of total profit and total labor compensation. We use value added for output because data on production materials are unavailable for some years. Total profit is the amount of gains that firms acquire before paying taxes. Total labor compensation is defined as the sum of labor compensation and fringe benefits. Labor compensation includes salary, bonus and other allowances counted as production cost such as payment for allowance of working at night shift, travel subsidy, meals during working days, and renting house. Fringe benefits are social insurance paid to replace salary by the firm directly to the security agencies. They are then paid for employees when they are ill or in delivery period, or in incident on-leave period by the security agencies. For private firms which do not report fringe benefits, we replace them with zero because most private firms are unlikely to pay them.

Value-added and fixed assets are deflated by the distinct producer price indexes proposed by Javorcik (2004). These indexes are defined as follows. Output deflator is the price index of each corresponding two-digit level industry, whereas capital deflator is the average price index of following five representative industries: Machinery and equipment (29), office, accounting and computing machinery (30), electrical machinery and apparatus (31), motor vehicles, trailers and semi-trailers (34), and other transport equipment (35), where the number in parentheses are two-digit level ISIC codes. These price indexes are uploaded on the GSO home page as "*producer's price index of industrial products*" with the base year 1995 = 100, i.e., they are constant 1995-year prices.

Constructing the price indexes for our empirical analysis needs the following adjustment to allow for 1) different naming of the two-digit level industries in the *producer's price index of industrial products* (PPI) data and 2) three industries with ISIC codes 23, 33, and 37 that lack price indexes. First, based on the similarity of industry names, the price indexes of "*Other metal*" and "*Metal articles*" in the PPI data are respectively used for the industries with ISIC codes 27 and 28; the price index of "*Machinery, other equipment*" is used for the industries with ISIC codes 30 and 31; and the price index of "*Manufacture of radio and communication equipment and apparatus*" is used for the industries with ISIC codes 32 and 33. Second, because we do not find similar industries with ISIC codes 23 and 37, this dissertation uses the average price of the twenty-one manufacturing industries.

Table 2.2 introduces the number of sample firms by types of firm ownership (state, private, foreign) and by region, and by industry. As we discussed in Section 2.1, due to the re-organization and privatization of the state-owned sector and the promotion of developing the private sector, our sample of manufacturing firms for 2000-2005 show clear changes in firm-ownership: decreasing number of state firms and increasing number of private and foreign firms. The number of observations for state firms is 6,597 (10%), while that for private firms is 54,644 (80%), and that for foreign firms is 6,834 (10%), where the percentage shares are shown in parentheses. Furthermore, the number and share of state firms declined from 1,301 (14%) in 2000 to 885 (5%) in 2005, whereas those of private firms increased from 7,261 (79%) to 14,024 (85%), and those of foreign firms increased from 641 (7%) to 1,686 (10%) for the same period.

Regarding locations, while private firms capture the largest share in all regions (70-93%), more state firms concentrate in the north (14% in the Red River delta, 25% in the Northern Mountains) and the centre (16% in the Central Coast, 17% in the Central Highlands) of Vietnam, and more foreign firms invest in the South East region at 18% (equivalently to 5,252 out of 28,418 total regional firms). In the South East region, the number of foreign firms increased at a factor of approximately 3 after six years. Furthermore, contrary to the decreasing number of state firms in all regions, private and foreign firms increase their number in all regions.

Regarding industrial groups, private firms again showed their overwhelming share of 89%, 76%, 75% and 55% in the resource-based, low-tech, medium-tech and high-tech industries. Compared with foreign firms, the share of state firms is 3% higher in the resource-based industry, but it is 1% and 2% lower in the low-tech and medium-tech industries and 22% lower in the high-tech industry, implying a heavier (i.e., biased) foreign investment in industries which require higher technology levels. Impacts of such high-level production technologies of foreign firms on productivity enhancement of domestic firms via spillover effects will be one of the factors examined in our empirical analyses of the Chapters 3 and 4.

Table 2.1. Number of Observations and Their Percentage Shares for Various Types of Firms in the Survey

Year	2000	2001	2002	2003	2004	2005	Total
Original data							
All firms	42,307	56,551	62,908	72,010	91,755	113,235	438,766
State firms	5,764	5,389	5,363	4,843	4,596	4,086	30,041
Share (%)	14	10	9	7	5	4	7
Private firms	35,014	49,040	55,237	64,526	84,003	105,452	393,272
Share (%)	83	87	88	90	92	93	90
Foreign firms	1,529	2,122	2,308	2,641	3,156	3,697	15,453
Share (%)	4	4	4	4	3	3	4
Manufacturing firms	10,405	13,237	14,794	16,915	20,531	24,043	99,925
Share in all firms (%)	25	23	24	23	22	21	21
State firms	1,572	1,426	1,413	1,317	1,247	1,082	8,057
Share in manufacturing (%)	15	11	10	8	6	5	8
Private firms	7,787	10,298	11,700	13,612	16,958	20,307	80,662
Share in manufacturing (%)	75	78	79	80	83	85	81
Foreign firms	1,046	1,513	1,681	1,986	2,326	2,654	11,206
Share in manufacturing (%)	10	11	11	12	11	11	11
After dropping observations with missing values and duplication							
Total manufacturing firms	9,262	10,375	9,615	11,684	14,147	17,326	72,409
State firms	1,306	1,196	1,200	1,076	1,020	897	6,695
Share in manufacturing (%)	14	12	12	9	7	5	9
Private firms	7,314	8,350	7,337	9,265	11,564	14,655	58,485
Share in manufacturing (%)	79	80	76	79	82	85	81
Foreign firms	642	829	1,078	1,343	1,563	1,774	7,229
Share in manufacturing (%)	7	9	13	13	12	11	11

Table 2.2. Number of Manufacturing Firms by Region, Ownership, and Industry

Year		2000	2001	2002	2003	2004	2005	Total
Total manufacturing firms		9,203	10,360	9,615	10,203	12,099	16,595	68,075
State firms		1,301	1,193	1,200	1,043	975	885	6,597
Private firms		7,261	8,338	7,337	7,943	9,741	14,024	54,644
Foreign firms		641	829	1,078	1,217	1,383	1,686	6,834
By regions								
Red River delta	State firms	508	455	437	380	353	296	2,429
	Private firms	1,592	2,096	1,718	2,050	2,510	3,820	13,786
	Foreign firms	92	129	131	153	181	238	924
Northern Mountains	State firms	137	130	120	103	101	90	681
	Private firms	217	300	233	284	356	514	1,904
	Foreign firms	10	12	16	19	23	38	118
Central Coast	State firms	220	198	210	167	165	147	1,107
	Private firms	766	939	731	809	1,054	1,438	5,737
	Foreign firms	21	34	32	44	53	54	238
Central Highlands	State firms	35	33	42	34	30	31	205
	Private firms	135	149	125	132	151	225	917
	Foreign firms	7	10	12	9	9	17	64
South East	State firms	298	270	278	264	239	234	1,583
	Private firms	2,173	2,711	3,219	3,283	4,119	6,078	21,583
	Foreign firms	480	612	847	951	1,074	1,288	5,252
Mekong River delta	State firms	103	107	113	96	88	87	594
	Private firms	2,378	2,143	1,311	1,385	1,551	1,949	10,717
	Foreign firms	31	32	40	41	43	51	238
By industries								
Resource-based	State firms	326	297	306	236	238	221	1,624
	Private firms	3,717	3,786	2,859	2,986	3,458	4,658	21,464
	Foreign firms	111	132	169	204	214	265	1,095
Low-tech	State firms	618	571	581	524	488	426	3,208
	Private firms	2,415	3,027	2,933	3,201	4,038	5,922	21,536
	Foreign firms	304	409	548	608	712	876	3,457
Medium-tech	State firms	332	308	294	265	235	223	1,657
	Private firms	1,076	1,471	1,477	1,675	2,135	3,278	11,112
	Foreign firms	190	245	312	348	394	476	1,965
High-tech	State firms	25	17	19	19	15	15	110
	Private firms	53	54	68	81	110	166	532
	Foreign firms	36	43	49	57	63	69	317

Chapter 3: Small Privately-Owned and Large State-Owned Manufacturing Firms in Vietnam: A Productivity Comparison for 2000-2005

3.1. Motivation for the Analysis and Related Literature

In Vietnam’s manufacturing sector, most privately-owned firms are substantially smaller than state-owned firms; however, they occupy a large share of the manufacturing sector. Data from the General Statistics Office (GSO) of Vietnam show that in 2008, private and state firms hired 4.7 and 1.6 million employees, respectively, and had turnovers of 2,973 and 1,349 trillion Vietnam dongs (VND), respectively. Thus, private firms had 2.9 and 2.2 times higher employment and turnover than state firms. With such large production shares, small private firms substantially contribute to the productivity level of Vietnam’s manufacturing sector. Therefore, it is important to examine the productivity of private firms in comparison with that of state firms, a common research focus in socialist economies. Furthermore, it is important to explain why these firms have different productivity levels.

Firm ownership is a natural point of comparison between private and state firms’ productivity. The literature commonly argues that private firms are more productive than state firms. In developing countries, this is likely the case partly because private firms are often managed by a family member working for a family firm. As the manager is the firm’s only residual claimant, he or she puts a great deal of effort into its management to increase profits (Bottasso and Sembenelli, 2004). Furthermore, state firms are likely to be less productive partly because they are free of competitive pressure. They also lack a scheme for transferring residual claims, which reduces incentives for both managers and workers. Moreover, rather than pursuing higher productivity, state firms in the developing countries are expected to play a key role in stabilizing the economy.

Another point of comparison between Vietnam’s private and state manufacturing firms is from firm size. This is because their sizes differ greatly and because productivity studies often address the relationship between firm size and productivity. Large firms are more efficient because of their greater product differentiation, their ability to access specialized resources (labor or capital), their greater market power, the cost advantages of scale economies, their higher prestige, and their perquisites to attract more competent managers and workers (Jovanovic, 1982; Ahuja and Majumdar, 1998). On the other hand, small firms might have higher production efficiency because their small size enables flexibility when responding to changes in the economic environment (e.g., instantaneous adjustments in labor) as well as lower supervision costs (Chapelle and Plain, 2005; Yang and Chen, 2009). Consequently, the two points of comparison might predict contrasting answers to the following question: are private or state firms more productive in the Vietnamese manufacturing sector?

An effective means of comparing private and state firms' productivity is by estimating their stochastic production frontiers (SPF). SPF estimation allows us to examine the difference not only in their technology levels but also in their technical efficiency (TE), both of which are important components of productivity. Technology level represents the best production technology potentially available for all firms. On the other hand, TE represents how efficiently each firm actually produces outputs in comparison with the outputs that could be produced using the best technology.

Despite its importance, most studies that estimate SPF for different groups focus only on TE and not on production frontiers. For Vietnamese manufacturing firms, no study presents SPF estimates for both private and state firms to compare their productivity levels. For example, Vu (2003) estimates SPF only for state firms, while Tran, Grafton, and Kompas (2008) do so only for private firms. Nguyen, Giang, and Bach (2007) and Pham, Dao, and Reilly (2010) estimate SPF for the entire manufacturing sector, which differs only in the intercepts for private and state firms in the equation for TE. If we compare TE indexes of private and state firms assuming identical production technology, we might reach a misleading conclusion about their productivity differences.

This study utilizes data on individual manufacturing firms (Vietnamese Enterprise Survey) for 2000–2005 to estimate separate SPF for private and state firms. Specifically, we estimate the Cobb–Douglas SPF with a half-normal inefficiency term, which is assumed to be heteroskedastic to absorb factors that affect TE. To identify the more productive firms, we use the estimation results to compare production frontiers and TE indexes of private and state firms. Furthermore, to determine why they have different production frontiers and TE levels, we decompose the ratio of the predicted outputs (production frontiers) into the relevant factors and regress TE indexes on the selected variables.

The results indicate that private firms have a considerably lower production frontier than state firms do, whereas they tend to have slightly higher TE indexes. Combining these opposite effects on productivity, private firms are found to have much lower productivity due to their much lower production frontier. Important explanations for the difference between the production frontiers include policies that benefit only state firms in resource-based manufacturing industries and those that led to only profitable state firms remaining when state firms were restructured at the end of the 1990s.

Section 3.2 briefly describes the economic environment surrounding private manufacturing firms in Vietnam. Furthermore, it compares the variables appearing in production frontiers and those affecting the TE of private and state firms. Section 3.3 explains the specifications and estimation methods of the Cobb–Douglas SPF and compares production frontiers and the TE of private and state firms using the estimation results. In addition, it finds important factors to explain the productivity differences between private and state firms. Section 3.4 concludes the paper.

3.2. Characteristics of Private and State Firms in the Vietnamese Manufacturing Sector

3.2.1. Economic Environment Surrounding Private Firms

The seventh National Congress of the Communist Party of Vietnam legally approved the establishment of private firms in 1991, five years after the 1986 *Doimoi* reforms began.

Most of these private firms are small and have faced great difficulties, including restricted access to the formal financial system, shortages in the requisite supporting legal institutions and qualified human capital, and limited production technology (Friedman, 2004).

To alleviate these difficulties, the Vietnamese government promulgated the Enterprise Law in 1999, which abolished several administrative procedures and thus lowered various transaction costs, thereby improving the business environment and promoting the development of private firms (Tran, Grafton, and Kompas, 2008; Hansen, Rand, and Tarp, 2009). Since then, private firms have markedly developed and contributed to economic growth. The GSO data show that private firms attained a high growth rate of industrial outputs, 7% on average, during the period of our analysis. The data also show that private firms' employment share increased from 29% to 48% and that their long-run investment share increased from 8% to 21% over the six-year study period. In particular, the manufacturing sector led economic development and produced one-third of total turnover, resulting in 48% of total job creation and 32% of total long-run investment during the period. Although the overall economy was in an upturn, this period also experienced a drastic inflation hike: around 2003, the normal rate was 3%, but it increased to 7.8% and 8.3% in 2004 and 2005, respectively, leading to social instability. Such instability might have negatively influenced production in the leading manufacturing sector.

According to Hansen, Rand, and Tarp (2009), support programs for private firms in their start-up stage (e.g., obtaining licenses and permits, facilitating access to credit and business development services, and temporary tax exemptions) are likely to aid their growth. However, Tran, Grafton, and Kompas (2008) note that some support programs do not systematically improve the productivity of private firms. Furthermore, Nguyen and van Dijk (2012) show that under the present financial system, private firms might face credit constraints. For example, 71% and 37% of private firms are financed through formal and informal sources, respectively, although this is the case for 96% and 22% of state firms, respectively. Furthermore, private firms have access to formal credit for short-term purposes (e.g., day-to-day working capital or trading requirements) rather than for long-term purposes (e.g., capital investment). The subsequent sections investigate how these policies have produced different productivity levels for private and state firms.

3.2.2. Comparison of Selected Variables between Private and State Firms

This subsection introduces the main data for the subsequent analysis and provides a preliminary analysis. The main data are adapted from the Vietnamese Enterprise Survey (GSO) and span 2000–2005. We focus on domestic private and state firms in the manufacturing sector (ISIC15-ISIC37), both of which report positive turnover values, value added, labor compensation, and number of employees.[2] The manufacturing sector can be classified into four industrial groups of similar production technologies: resource-based, low-tech, medium-tech, and high-tech manufacturers (Ministry of Industry and Trade (MoIT) and United Nations Industrial Development Organization (UNIDO), 2011). We can also classify Vietnam's 64 municipalities and provinces into six regions: Red River Delta, Northern Midlands and Mountain areas (henceforth Northern Mountains), North and South Central Coast (henceforth Central Coast), Central Highlands, South East, and Mekong River Delta.

Table 3.1 shows the number of observations for private and state manufacturing firms by firm size for 2000–2005.[3] The number of observations for private firms is 54,644 (89%), while that for state firms is 6,597 (11%), and the shares among all firms are shown in parentheses. Furthermore, the number and share of private firms increased

[2] Many private firms do not report fringe benefits that are included in total labor compensation defined in this study. We replace missing values of fringe benefits with zero for private firms because most of them are unlikely to pay fringe benefits. Furthermore, some private firms report fixed assets to be zero. For these firms, fixed assets are replaced with one tenth of the smallest positive value of fixed assets to estimate a Cobb-Douglas production frontier.

[3] Firms of "large scale" are defined as those with turnover greater than the 75th centile of turnover for all sample firms. Although it might be natural to define them as those with turnover greater than the median, this definition results in too small number of state firms of "small scale".

from 7,261 (85%) in 2000 to 14,024 (94%) in 2005, whereas that of state firms declined from 1,301 (15%) in 2000 to 885 (6%) in 2005. Among state firms, the number of small firms decreased much more rapidly than that of large firms over the six-year study period. Over the same period, among private firms, small firms increased from 6,300 to 11,109, and large firms also increased from 961 to 2,915. The total number of small firms was 45,929, 75% of the total sample. These observations reflect the overwhelming share of private firms in the manufacturing sector.

Now, we introduce the production function variables. We use value added Y for output because data for production materials are unavailable for some years. It is computed as the sum of total profit and labor compensation (including fringe benefits). Labor L is the number of total employees at the end of the survey year. Capital K is the value of fixed assets at the beginning of the survey year. The value added and capital are deflated by the distinct producer price indexes proposed by Javorcik (2004).

Table 3.2 reports the means of value added, labor, and capital. The means of L, K, and Y for private firms are 87.9, 21.2, and 11.2, respectively, whereas those of state firms are 562.8, 221.6, and 126.8, respectively. Therefore, state firms use 6.4 times more labor and 10.5 times more capital to produce 11.3 times more output. Furthermore, the capital/labor ratio K/L is 0.39 and 0.24 for state and private firms, respectively, implying that state firms adopt more capital-intensive technology. These results suggest that state firms are likely to have higher productivity. In such socialist developing countries as Vietnam, state firms can be more productive partly because they are designated as national economic stabilizers and can benefit from such policies as preferential investment policies, fund raising from state credit, and market protection (Friedman, 2004). We confirm the plausibility of this prediction by estimating separate SPFs for private and state firms.

Next, in view of the related literature, we introduce six variables ($dsize$, age, $debt$, $percap\_income$, $Herfindhal$, and $spillover$), which potentially affect TE. The dummy variable $dsize$ takes the value 1 if the firm is classified as large scale, as defined in Table 3.1. The dummy variable can positively or negatively affect TE, as we examined in the Section 1. The variable age is defined as the difference between the current year and the registration year.[4] It, too, can positively or negatively impact TE. Older firms may be technically more efficient due to their greater experience (Jovanovic, 1982), but they may be outdated in their organizational modes of thoughts and actions (Ahuja and Majumdar, 1998). The variable $debt$ is defined as the ratio of total liabilities to total assets. Higher $debt$ is expected to negatively influence TE. An increase in $debt$ is associated with higher interest payments and an increase in the possibility of default (bankruptcy), which forces a greater input adjustment (Paul, Johnston, and Frengley, 2000). The variable $percap\_income$ is defined as total labor compensation divided by labor input, and it is expected to positively affect TE. Yang and Chen (2009) mention that higher incomes stimulate employees to increase effort, thereby increasing TE. Industrial concentration (or competition) is proxied by the index $Herfindahl_j = \sum_i S_{ji}^2$, where S_{ji} denotes the market share of firm i in industry j in terms of turnover. Sari (2003) finds a positive effect of the Herfindahl index on TE at two extremes of highly concentrated or highly competitive markets. Suyanto, Salim, and Bloch (2009) also interpret a negative effect of the Herfindahl index on TE as static competition and its positive effect as dynamic competition, depending on market conditions. Finally, the variable $spillover_j$ (j: industry name) is defined as the sum of the turnover of foreign firms in industry j divided by the sum of the turnover of all firms in the same industry. It is expected to positively affect TE because domestic firms can imitate the better products of foreign firms and because they try to devote more effort to prevent falling behind these foreign firms (Caves, 1974; Javorcik, 2004).

Table 3.2 reports the means of the six variables. The mean of $dsize$ shows that most private firms are classified as small scale, while most state firms are classified as large scale. The mean age for private firms is only 6.1, while that for state firms is 21.7.

[4] We dropped from our sample firms which report the registration year to be zero, smaller than 1945, or larger than the current year.

This large difference reflects Vietnam's social and economic background, which is examined in the Section 2.1. The mean of $debt$ is 0.34 for private firms and 0.65 for state firms. Private firms' lower $debt$ possibly implies that they do not finance from formal sources as state firms do. The mean of $percap\_income$ shows that private-firm employees are paid lower wages than state-firm employees are. The Herfindahl index, in terms of turnover, is smaller for private firms (0.0043) than for state firms (0.0060), implying that private firms face greater market competition. Both these values are small because there are many small firms in Vietnam's manufacturing sector. Finally, the means of $spillover$ for private and state firms are similar, suggesting that both types of firms are similarly exposed to foreign products and technology.

3.3. Empirical Analysis

3.3.1. Empirical Methods

To compare production frontiers of private and state firms, we specify and estimate two Cobb–Douglas SPFs separately for these firms. Specifically, the SPF has two inputs (labor L_{it} and capital K_{it}) and one output (value added Y_{it}) for firm $i\ (= 1, \dots, \mathrm{n})$ and year $t\ (= 2000, \dots, 2005)$:

$$lnY_{it} = \beta_0 + \beta_1 lnL_{it} + \beta_2 lnK_{it} + \beta_3 dsize_{it} + \sum_s \beta_s dyear_s$$

$$+ \sum_{r \in R} \beta_r dregion_{ir} + \sum_{g \in G} \beta_g dindustry_{ig} + v_{it} - u_{it}, \qquad (1)$$

where $dyear_s$ denotes time dummy variables for year $s = 2001, \cdots, 2005$, with 2000 chosen as the base year; $dregion_{ir}$ denotes regional dummy variables for firm i in region r with R denoting a regional set which includes five out of the six regions introduced in the Section 3.2.2 (Red River delta is chosen as the base group); $dindustry_{ig}$ denotes industrial dummy variables for firm i in industrial group g with G denoting an industrial set which includes three out of four industrial groups introduced in the Section 3.2.2 (medium-tech is chosen as the base group). Note that subscript j for industries is omitted from variables (except for $dindustry_{ig}$) to simplify notations, which means that their coefficients are common to all industries. We assume that v_{it} is a normal random variable with a mean zero and a constant variance σ_v^2 and that non-negative technical inefficiency u_{it} follows a half normal distribution with variance σ_u^2.

The coefficients of labor and capital in the SPF (1) can be interpreted in two ways. On the one hand, higher coefficients of labor and capital can be regarded as higher quality or efforts related to these inputs because increases in the inputs make a higher contribution to output. On the other hand, a higher coefficient of labor, for example, can be regarded as a higher share or intensity of labor input because β_1 is equal to the ratio of wage payment to output under a competitive labor market.

Caudill, Ford, and Gropper (1995) emphasize that the heteroskedasticity of inefficiency u can substantially affect the estimated TE index. Recalling the six variables introduced in the Section 3.2.2, we specify the variance σ_u^2 for firm i in industry j in year t as[5]

$$ln\sigma_u^2 = \delta_0 + \sum_s \delta_s dyear_s + \delta_1 dsize_{it} + \delta_2 age_{it} + \delta_3 debt_{it} + \delta_4 percap\_income_{it} + \delta_5 Herfindahl_{jt} + \delta_6 spillover_{jt}. \quad (2)$$

We jointly estimate the SPF (1) and the variance function (2) using the maximum likelihood method. After separately estimating these functions for private and state firms, we follow Battese and Coelli (1988) to compute the TE index as

$$TE = \mathrm{E}[\exp(-u)\,|Y] = \{\Phi[(u^*/\sigma_*) - \sigma_*]/\Phi(u^*/\sigma_*)\}\exp\,[(\sigma_*^2/2) - u^*], \quad (3)$$

where $u^* = -(v-u)\sigma_u^2/\sigma^2$, $\sigma_*^2 = \sigma_u^2\sigma_v^2/\sigma^2$, and $\sigma^2 = \sigma_u^2 + \sigma_v^2$. Φ denotes the cumulative distribution function of the standard normal variable. If the TE indexes differ between private and state firms, we adopt a popular method to explain the difference by regressing the estimated TE indexes on the six variables and year dummies in equation (2).

To compare production frontiers for private and state firms, we compute an index of the predicted output in a manner similar to Kumbhakar, Tsionas, and Sipiläinen (2009).

[5] Note that $Herfindahl$ and $spillover$ are industry-level variables.

Let $\hat{Y}_p$ and $\hat{Y}_s$ denote outputs predicted by using deterministic frontiers (the right hand side of equation (1) excluding the terms u and v) of private and state firms, respectively. It should be noted that each firm (private or state) has two predicted outputs $\hat{Y}_p$ and $\hat{Y}_s$ after substituting its actual value of labor, capital, and other dummy variables into the two deterministic frontiers. In other words, computing $\hat{Y}_p$ and $\hat{Y}_s$ for each firm allows us to compare the two production frontiers by controlling for the input levels.

If the production frontiers differ between private and state firms, we decompose the geometric means of $\hat{Y}_p$ and $\hat{Y}_s$ as follows to explain the difference. By their definition and equation (1), we can write $\hat{Y}_p$ and $\hat{Y}_s$ for (private or state) firm i as

$$\hat{Y}_{m,i} = \exp(\hat{\beta}_{0,m}) \prod_{k=1}^{16} X_{k,i}^{\hat{\beta}_{k,m}} \quad (m = p, s), \tag{4}$$

where $X_{k,i}$ $(k = 1, \cdots, 16)$ denote L, K, $\exp(dsize)$, $\exp(dyear_s)$ ($s = 2001, \cdots, 2005$), $\exp(dregion_{ir})$ (r: index of the five regions), and $\exp(dindustry_{ig})$ (g: index of the three industrial groups). $\hat{\beta}_{0,m}$ and $\hat{\beta}_{k,m}$ $(m = p, s)$ are maximum likelihood estimates of the parameters β_0 and β_k for type m (private or state) firms. Taking the geometric means $\tilde{Y}_p$ and $\tilde{Y}_s$ of $\hat{Y}_{p,i}$ and $\hat{Y}_{s,i}$ in equation (4) for all firms (including private and state firms), we obtain

$$\tilde{Y}_p / \tilde{Y}_s = \exp(\hat{\beta}_{0,p} - \hat{\beta}_{0,s}) \prod_{k=1}^{16} \tilde{X}_k^{\hat{\beta}_{k,p} - \hat{\beta}_{k,s}}, \tag{5}$$

where $\tilde{X}_k$ $(k = 1, \cdots, 16)$ denote the geometric mean of $X_{k,i}$ for all firms. Equation (5) shows that the ratio $\tilde{Y}_p / \tilde{Y}_s$ is decomposed into the difference in the intercept of the production frontier, $\exp(\hat{\beta}_{0,p} - \hat{\beta}_{0,s})$, and the difference in the contribution of factor k $(= 1, \cdots, 16)$ to the production frontier, $\tilde{X}_k^{\hat{\beta}_{k,p} - \hat{\beta}_{k,s}}$. Each of these contributions is greater than 1 if $\hat{\beta}_{k,p} > \hat{\beta}_{k,s}$, lower than 1 if $\hat{\beta}_{k,p} < \hat{\beta}_{k,s}$, and equal to 1 if $\hat{\beta}_{k,p} = \hat{\beta}_{k,s}$.

3.3.2. Estimated Parameters

Table 3.3 presents estimated parameters of the SPF (1) and the variance function (2) for private and state firms. Most parameters are statistically significant at the 5% level. Production elasticity of labor is estimated at 0.90 for private firms and 0.83 for state firms. Production elasticity of capital is estimated at 0.04 for private firms and 0.09 for state firms. As explained in the previous section, the higher coefficient of labor for private firms shows that their workers seem to devote more efforts to producing output or that they use labor more intensively than capital. The lower coefficient of capital for private firms shows that they cannot maintain their machinery and equipment as well as state firms do or that they use capital less intensively than labor.

We are not aware of any Vietnamese studies suitable for comparison that use value added to estimate the Cobb–Douglas production function. However, Söderbom and Teal (2004) use value added to estimate production elasticities of labor and capital for manufacturing firms in Ghana. Their results are 0.89 and 0.18, respectively, and are consistent with ours in that the production elasticity of labor is very high in the manufacturing sector of the developing countries, in which most firms are small and use labor-intensive technology.[6]

An examination of the coefficients of the regional dummy variables indicates that both private and state firms produce less in the Northern Mountains and more in the South East and the Mekong Delta than do firms in the Red River Delta. This result seems consistent with the actual economic situation in Vietnam. The Northern Mountains region is far less developed in terms of infrastructure and is not favorable for manufacturing production. On the other hand, the South East (including Ho Chi Minh City) and the Mekong River delta have been more exposed to the market economy for a long time because of their experience in the pre-unification period and access to better market-supporting institutions (Vu, 2003; Pham, Dao, and Reilly, 2010). For the other two regions, we find statistically significant positive coefficients only for private firms, implying that local authorities support and/or contribute to the development of the region’s private sector.

The positive coefficients of the year dummy variables show that both types of

[6] If we test constant returns to scale using a likelihood ratio statistic, which has a chi-square distribution with one degree of freedom, the test statistic is 632.46 (0.00) for private firms and 101.92 (0.00) for state firms, where p-values are shown in parentheses. Therefore, the hypothesis of constant returns to scale is rejected for both types of firms.

firms experience technological progress (i.e., upward shifts in the production frontiers) throughout 2000–2005. Specifically, private firms' production frontier steadily shifted upward since 2000 to record 10% growth over the six-year study period, after reaching the peak growth rate at 17% in 2003. State firms recorded considerably faster growth, particularly in the last two years. State firms' faster growth since 2004 can be attributed to various policies for intensified restructuring and dissolution of state firms at the end of the 1990s, which led to the dissolution or privatization of incapable firms (especially local firms), leaving only capable firms as completely or partially state-owned ones. As a result, restructured state firms are considered key in stabilizing the economy, and hence can benefit more from governmental support to fulfill their socioeconomic role.

The estimated coefficients of the industrial group dummies are plausible for both private and state firms because the production frontiers of the low-tech (although insignificant for the low-tech manufacturing state firms) and the resource-based manufacturers are lower, while the production frontiers of the high-tech manufacturers are higher than those of the medium-tech manufacturers (the base group). The low-tech and resource-based manufacturers utilize relatively simple technologies and low-skilled labor and are more labor- or resource-intensive (MoIT and UNIDO, 2011), which suggests their lower production frontiers. On the other hand, the medium- and high-tech manufacturing require much more sophisticated technologies, a skilled workforce, investment in and development of new products (MoIT and UNIDO, 2011), which suggests their higher production frontiers.

Table 3.3 also presents the estimated parameters of the variance function (2). Most parameters are statistically significant at the 5% level. Because these coefficients are more easily interpreted using the related partial effects, this topic will be further discussed in the Section 3.3.4.

3.3.3. Comparison of Production Frontiers

The estimated production frontiers of private and state firms are compared in two ways.

First, we use a Wald test to compare the parameters of these firms' production frontiers. When only the production elasticities of labor and capital are compared, the test statistic has a chi-square distribution with two degrees of freedom and is computed as 72.99 (0.00), with the p-value in parentheses. When all the parameters in the production frontier are compared, the test statistic has a chi-square distribution with seventeen degrees of freedom and is computed as 398.48 (0.00). Both these tests reject the equivalence of the parameters between private and state firms at the 1% statistical significance level. Therefore, their production frontiers are found to be different, which justifies our assumption in estimating the two SPFs separately.

Second, we compute the predicted outputs (or the deterministic frontiers) $\hat{Y}_p$ and $\hat{Y}_s$ using the estimated production frontiers of both private and state firms. The means of these outputs are shown in Table 3.4, with the measurement unit in million VND. Between 2000 and 2005, private firms' production frontier was always lower than that of state firms. The means of $\hat{Y}_p$ and $\hat{Y}_s$ are 22.0 and 36.2 during this period, implying that the private firms have a 39% lower frontier on average. More specifically, the production frontier $\hat{Y}_p$ of private firms increased from 18.2 in 2000 to 28.5 and then decreased after 2003 to 18.8 in 2005. The production frontier $\hat{Y}_s$ of state firms increased from 25.7 to 43.7 and then decreased to 37.8 for the same years. Because the decrease in $\hat{Y}_p$ was faster (15% and 23% for private firms compared to 3% and 10% for state firms for the last two periods), the difference between $\hat{Y}_p$ and $\hat{Y}_s$ widened over the whole study period.

Why is the production frontier of private firms much lower than that of state firms? To determine this, we decompose the ratio $\tilde{Y}_p/\tilde{Y}_s$ of the geometric means of the predicted outputs $\tilde{Y}_p$ and $\tilde{Y}_s$ using equation (5). Table 3.4 presents results of the decomposition as well as the geometric means of the predicted outputs. The ratio $\tilde{Y}_p/\tilde{Y}_s$ of the geometric means over the six years, 0.63, confirms that private firms had a 37% lower production frontier than did state firms, which is quite close to their predicted output difference (39%) in terms of the arithmetic mean. Furthermore, it confirms that the difference in the production frontiers widened from 27% in 2000 to 48% in 2005.

We can explain the difference in their production frontiers by investigating the contributions to the ratio. Labor input L is the only marked contribution that increases the ratio $\tilde{Y}_p/\tilde{Y}_s$. Labor's positive contribution comes from the higher coefficient of labor in the SPF for private firms, as explained in the Section 3.3.2.

On the other hand, capital K contributes negatively because state firms can use state credits for regular maintenance of their production lines and sustain the superior quality of their machinery and equipment, as expressed by the higher coefficient of capital in the SPF for state firms. The resource-based manufacture dummy negatively affects the ratio $\tilde{Y}_p/\tilde{Y}_s$ probably because private firms in this industrial group (e.g., food and beverages from agricultural products and petroleum refining) have limited rights to utilize natural resources in comparison with state firms in the same group.[7] For the low-tech manufacture dummy, it is impossible to discuss further due to its statistically insignificant estimated coefficient in the SPF for state firms, although its negative contribution is marked. The year dummies for 2004 and 2005 contribute the most in these years. After the intensified restructuring and dissolution of state firms at the end of the 1990s, profitable state firms remained in operation, but unprofitable ones (particularly local ones) were dissolved or privatized. The negative contributions of the year dummies seem to reflect the gradual improvement of production technology of remaining state firms in comparison with that of private firms after the restructuring and dissolution. Furthermore, the negative contribution of the constant term implies that state firms have greater management ability or R&D investment, which is unobserved or unavailable in our analysis.

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[7] Refer to Appendix Table 3.A1 and Table 3.A2, which present the estimation results for private and state firms only in the resource-based industrial group in comparison with those for all private and state firms in the pooled data cases, separately. By these results, we can justify the role of rights and privileges in the natural resource utilization differences favoring state firms that derive their higher production frontier against private firms, although the difference seems more moderate (i.e., 15% vs. 37% difference in the production frontiers of private and state firms respectively for the cases of the resource-based industry and all firms).

Finally, firm size ($dsize$) has negligible effects on the difference (just 1%) between private and state firms' production frontiers. Although $dsize$ actually has large effects on private and state firms' production frontiers, the effects are similar for each type of firms, as seen from the negligible difference between the estimated coefficients of $dsize$ in Table 3.3. In other words, large private firms have an approximately similar production frontier to large state firms, with other things being equal, although the share of large firms is much lower for private firms.

3.3.4. Comparison of Technical Efficiency

Next, we examine the difference in the TE indexes between private and state firms. On the basis of their own production frontiers, the TE indexes are computed using equation (3), and their means are shown in Table 3.5. The average TE is 0.67 for private firms and 0.64 for state firms. Therefore, private firms have a slightly higher TE index during 2000–2005. More specifically, state firms' TE index increased slowly from 0.62 in 2000 to 0.66 in 2005, while that of private firms increased more rapidly and in fact improved from 0.60 in 2000 to 0.72 in 2005. These estimates seem plausible compared with other studies that estimate the TE index for the Vietnamese manufacturing sector. Nguyen, Giang, and Bach (2007) adopt the SPF method to estimate the index at 0.58 for 2000 and 0.52 for 2003, and they cannot find a significant difference between private and state firms. Furthermore, Matsunaga and Vixathep (2012) employ data envelopment analysis to estimate garment firms' TE index at 0.52 for state firms and 0.63 for private firms in Ho Chi Minh City in 2006.

The difference in the TE index (3% on average) is much smaller than the difference in the production frontier (39% on average) between private and state firms. Therefore, we briefly examine why private firms improved their TE more rapidly. For this purpose, we regress the estimated TE index on the variables introduced in the Section 3.3.1. Table 3.6 presents the estimation results by the ordinary least squares method. As discussed in the Section 3.2.2, $percap\_income$ positively influences the TE index and $debt$

negatively affects the TE index for state firms. Only $spillover$ has an unexpected sign, which implies that private and state firms seem discouraged by the entry of foreign firms in the domestic market. The variable age positively affects the TE index for both private and state firms, which supports the hypothesis that the greater experience of the older firms enhances TE. Firm size ($dsize$) positively influences the TE index for both types of firms because larger firms have such advantages as greater product differentiation, as examined in the Section 3.2.2. The Herfindahl index has a significantly positive effect, implying that firms still required compensation (e.g., the agglomeration effects associated with concentrated rights) under a competitive market. Sari (2003) also finds a positive effect of the Herfindahl index on TE in a market where the Herfindahl index is as low as 0.26. Finally, the estimated coefficients of the year dummies show that, after controlling for the other variables, there still exist factors that increased private firms' TE over the six-year study period.

Regarding the size of these effects, most are small when sample means of these variables in Table 3.2 are taken into account.[8] The $dsize$ (for state firms) and the year dummies (for private firms) seem to have moderate effects on the TE index. Furthermore, the $dsize$ has a greater effect of increasing state firms' TE. Consequently, private firms improved their TE slightly faster than did state firms, although the former's production frontier shifted much more slowly than that of state firms during the period.

3.3.5. Robustness of the Results across Years

This subsection examines robustness of the main results by estimating the SPFs of private and state firms for each year in order to check appropriateness of distributional assumptions on the technical inefficiency term. Table 3.7 presents estimated parameters of the SPFs and the variance function, while Table 3.8 presents predicted outputs and TE indexes. The labor elasticity remains high in all years for both private and state firms,

[8] Other studies computing partial effects of continuous variables on TE also show that these effects are generally small (e.g., Lundvall and Battese, 2000; Bhandari and Maiti, 2007).

although its magnitude slightly goes up and down within 5-7%. Regarding the coefficients of determinants to explain TE, we find almost no changes in their signs. Furthermore, the ratios of the predicted outputs for private and state firms are similar to those obtained from results for the pooled data. Finally, the difference in TEs is also unchanged in that private firms have a slightly higher TE than do state firms. These results show the robustness of the previous results based on the pooled data.

3.3.6. Robustness of the Results across Industries

All of our empirical analyses above have shown that state firms have higher productivity than private firms mainly because the former have slightly lower TE but have a considerably higher production frontier. We have found these results by assuming that state firms have a different production frontier from private firms, while state (or private) firms in the different industries share a common production frontier except for the intercept. This subsection verifies the robustness of the main results by estimating the SPFs separately for each of the four industries (resource-based, low-tech, medium-tech, and high-tech industries), assuming that state and private firms share a common production frontier except for the intercept. Specifically, we estimate the SPF (6) separately for these industries:

$$lnY_{it} = \beta_0 + \beta_1 lnL_{it} + \beta_2 lnK_{it} + \beta_3 private_{it} + \beta_4 dsize_{it} + \sum_s \beta_s dyear_s + \sum_{r\in R} \beta_r dregion_{ir} + v_{it} - u_{it}, \quad (6)$$

Note that the subscript j for industries is omitted from variables to simplify the notations and that the SPF for each industry is estimated using the data for both private and state firms.

Table 3.9 presents the estimated parameters of the SPF and the variance function. Similarly to the results in Table 3.3, the coefficient of labor is very high (between 0.87 and 0.98) and that of capital is very low (between 0.03 and 0.05) for all the industries. The year and regional dummies have similar coefficients to those for private firms in

Table 3.3 because the number of these firms is much larger than that of state firms in all the industries.

The coefficients of firm size dummy vary with industries, but they are estimated between 0.50 and 0.84, which includes the estimates 0.60 and 0.63 in Table 3.3. Finally, the dummy variable for private firms has a statistically negative coefficient for all industries, which implies higher production frontiers for state firms in all the industries.

Table 3.10 presents the predicted production frontiers and TE index, which are comparable to Table 3.4. The predicted outputs show that the production frontier of state firms is much higher than that of private firms in the four industries. In particular, it is substantially higher in the resource-based and low-tech industries. The growth rate of the predicted output also changes very similarly in all the industries: it increases from 2000 to 2002 or 2003 and decreases after then. Furthermore, the TE index is slightly lower for state firms in three out of the four industries. Although it is higher for state firms in the medium-tech industry, the percentage difference in TE (5%) is still lower than that in the predicted output (7%). Finally, the TE index tends to increase over the study period for both state and private firms in all the industries, which is similar to the results in Table 3.4.

The results seem to show that our results obtained in the previous subsections are robust to the different specification examined in this subsection. Therefore, we suggest our discussions in the Section 3.3 are robust and reasonable for our conclusions in the Section 3.4.

3.4. Summary and Conclusions

This chapter used data on individual manufacturing firms (Vietnamese Enterprise Survey) for 2000–2005 and estimated two separate SPFs for private and state firms in Vietnam. The primary objective was to compare the productivity of the two types of firms in terms of their production frontiers and TE.

The empirical results show that the average private firm has a 39% lower production frontier (the maximum predicted output based on their production technology) and a 3% higher TE than the average state firm. Consequently, state firms are inferred to have a much higher productivity than private firms in the Vietnamese manufacturing sector. It is worth noting that the higher production frontier of state firms is not due to a considerably higher share of large firms in this sector. Instead, large private firms have a production frontier similar to that of large state firms, with other things being equal. Therefore, large state firms have a further higher production frontier than small private firms. This is because they can use flexible state credit to maintain their machinery and equipment and because they have priority rights to utilize natural resources, advantages that private firms lack. Furthermore, only the profitable state firms remained in operation after the restructuring and dissolution of some of these firms, implying that they are likely to have had greater management ability or R&D investment.

These results imply that the Vietnamese government employed policies favoring state firms. It also introduced several policies to encourage private firms to enter the market; consequently, the number of private firms has increased. However, these policies were insufficient for increasing these firms' productivity (particularly through production technology), as pointed out by Tran, Grafton, and Kompas (2008) and Nguyen and van Dijk (2012). To increase the productivity of private firms in the manufacturing sector, the government should give them similar rights and privileges to those of state firms, including rights to utilize natural resources or more access to credit for long-term capital investment. Otherwise, the manufacturing sector, which is largely occupied by small private firms, will face serious stagnation and will not achieve the productivity needed to facilitate Vietnam's further economic development.

Table 3.1. Number of Observations for Private and State Manufacturing Firms by Firm Size

Firm Ownership	Private			State			Total
Firm Size	Total	Small	Large	Total	Small	Large	
2000	7,261	6,300	961	1,301	542	759	8,562
2001	8,338	7,099	1,239	1,193	424	769	9,531
2002	7,337	5,848	1,489	1,200	376	824	8,537
2003	7,943	6,164	1,779	1,043	251	792	8,986
2004	9,741	7,478	2,263	975	185	790	10,716
2005	14,024	11,109	2,915	885	153	732	14,909
Total	54,644	43,998	10,646	6,597	1,931	4,666	61,241

Note: "Large" firms are defined as firms with turnover greater than the 75th centile of the turnover for all sample firms.

Table 3.2. Means of Variables Used for Empirical Analysis

Firm Ownership		Private		State	
Number of Observations		54,644		6,597	
Variables in Production Frontier					
Value-added	[mill.VND]	11.18	(46.72)	126.83	(398.21)
Labor	[person]	87.86	(290.14)	562.76	(900.29)
Capital	[mill.VND]	21.19	(98.94)	221.63	(842.91)
Regional dummies					
Red River delta		0.252	(0.434)	0.368	(0.482)
Northern Mountains		0.035	(0.183)	0.103	(0.304)
Central Coast		0.105	(0.307)	0.168	(0.374)
Central Highlands		0.017	(0.128)	0.031	(0.174)
South East		0.395	(0.489)	0.240	(0.427)
Mekong River delta		0.196	(0.397)	0.090	(0.286)
Industrial group dummies					
Resource-based		0.393	(0.488)	0.246	(0.431)
Low-tech		0.394	(0.489)	0.486	(0.500)
Medium-tech		0.203	(0.402)	0.251	(0.434)
High-tech		0.010	(0.098)	0.017	(0.128)
Variables to Explain Technical Efficiency					
dsize		0.19	(0.40)	0.71	(0.46)
age		6.1	(7.5)	21.7	(13.4)
debt		0.34	(7.23)	0.65	(0.37)
percap_income	[mill.VND]	10.53	(12.18)	16.33	(19.10)
Herfindahl		0.0043	(0.0058)	0.0060	(0.0050)
spillover		0.3373	(0.1497)	0.3271	(0.1992)

Note: Standard deviations are shown in parentheses and units are shown in brackets. VND represents Vietnam dong, which is approximately equal to US 0.00007 dollar on average for 2000-2005. The variable *dsize* is included in both “variables in production frontier” and “variables to explain technical efficiency” in the empirical analysis.

Table 3.3. Estimated Parameters of Stochastic Production Frontiers and Variance Functions by Firm Ownership

Firm Ownership	Private		State	
Number of Observations	54,644		6,597	
Production Frontier				
ln *L*	0.8997	(0.0027)***	0.8251	(0.0102)***
ln *K*	0.0365	(0.0010)***	0.0902	(0.0065)***
dsize	0.5993	(0.0100)***	0.6337	(0.0298)***
dyear2001	0.0243	(0.0143)*	0.0605	(0.0355)*
dyear2002	0.0817	(0.0145)***	0.1270	(0.0354)***
dyear2003	0.1656	(0.0141)***	0.2344	(0.0364)***
dyear2004	0.1063	(0.0135)***	0.2967	(0.0369)***
dyear2005	0.1029	(0.0126)***	0.4351	(0.0377)***
Northern Mountains	-0.0553	(0.0168)***	-0.1170	(0.0321)***
Central Coast	0.0339	(0.0103)***	-0.0507	(0.0261)*
Central Highlands	0.0957	(0.0221)***	-0.0500	(0.0520)
South East	0.2038	(0.0070)***	0.3349	(0.0205)***
Mekong River delta	0.3528	(0.0094)***	0.2329	(0.0310)***
Resource-based	-0.3182	(0.0083)***	-0.0965	(0.0262)***
Low-tech	-0.1970	(0.0074)***	-0.0002	(0.0205)
High-tech	0.0937	(0.0263)***	0.2109	(0.0588)***
constant	-1.8670	(0.0156)***	-1.5094	(0.0508)***
Variance Function				
dyear2001	0.1777	(0.0457)***	0.1395	(0.1170)
dyear2002	0.3299	(0.0504)***	0.3907	(0.1197)***
dyear2003	0.5214	(0.0514)***	0.8385	(0.1268)***
dyear2004	0.6488	(0.0503)***	1.2927	(0.1333)***
dyear2005	0.8514	(0.0470)***	2.0132	(0.1459)***
dsize	1.0683	(0.0419)***	0.6721	(0.0848)***
age	-0.0145	(0.0014)***	0.0008	(0.0021)
debt	0.0003	(0.0009)	0.6680	(0.0772)***
percap_income	-0.4089	(0.0053)***	-0.2629	(0.0080)***
Herfindahl	1.0723	(2.4982)	-32.2211	(8.4160)***
spillover	0.7252	(0.0883)***	0.6103	(0.2124)***
constant	1.3618	(0.0444)***	0.8639	(0.1384)***
σ_v	0.5107	(0.0024)***	0.5078	(0.0063)***
log-likelihood	-50748.16		-6292.58	

Note: Standard errors are shown in parentheses. *, **, and *** represent the statistical significance at 10%, 5%, and 1% levels, respectively.

Table 3.4. Predicted Outputs Based on Production Technologies of Private and State Firms and Their Decomposition into Contributions

	2000	2001	2002	2003	2004	2005	Total
$\bar{Y}_p$	18.2	18.9	25.3	28.5	24.3	18.8	22.0
$\bar{Y}_s$	25.7	27.6	37.8	43.7	42.2	37.8	36.2
$\tilde{Y}_p$	3.55	3.82	5.52	6.09	5.18	3.97	4.54
$\tilde{Y}_s$	4.87	5.38	8.11	9.24	8.81	7.67	7.23
$\tilde{Y}_p/\tilde{Y}_s$	0.73	0.71	0.68	0.66	0.59	0.52	0.63
Contributions to $\tilde{Y}_p/\tilde{Y}_s$							
L	1.29	1.29	1.32	1.32	1.31	1.29	1.30
K	0.96	0.97	0.94	0.92	0.94	0.97	0.95
dsize	0.99	0.99	0.99	0.99	0.99	0.99	0.99
dyear2001		0.96					0.99
dyear2002			0.96				0.99
dyear2003				0.93			0.99
dyear2004					0.83		0.97
dyear2005						0.72	0.92
Northern Mountains	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Central Coast	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Central Highlands	1.00	1.00	1.00	1.00	1.00	1.00	1.00
South East	0.96	0.96	0.95	0.95	0.95	0.95	0.95
Mekong River delta	1.04	1.03	1.02	1.02	1.02	1.02	1.02
Resource-based	0.90	0.91	0.92	0.92	0.93	0.93	0.92
Low-tech	0.93	0.93	0.92	0.92	0.92	0.92	0.92
High-tech	1.00	1.00	1.00	1.00	1.00	1.00	1.00
constant	0.70	0.70	0.70	0.70	0.70	0.70	0.70

Note: $\bar{Y}_m$ and $\tilde{Y}_m$ $(m = p, s)$ respectively denote arithmetic and geometric means of output $\hat{Y}_m$ which are predicted using production technologies of type m (private or state) firms. Unit of the predicted output is million VND. Decomposition of the ratio $\tilde{Y}_p/\tilde{Y}_s$ to its contributions is done for each year from 2000 to 2005, where the explanatory variables are also averaged for each year. Note that the product of all the contributions is equal to $\tilde{Y}_p/\tilde{Y}_s$.

Table 3.5. Estimated Technical Efficiency Index of Private and State Firms

	2000	2001	2002	2003	2004	2005	Total
Private Firms	0.60	0.62	0.66	0.69	0.70	0.72	0.67
State Firms	0.62	0.63	0.63	0.64	0.64	0.66	0.64

Table 3.6. Ordinary Least Squares Regression of TE index on Selected Variables

Firm Ownership	Private		State	
Number of Observations	54,644		6,597	
dyear2001	0.0057	(0.0032)*	0.0084	(0.0077)
dyear2002	0.0378	(0.0033)***	0.0069	(0.0077)
dyear2003	0.0483	(0.0032)***	-0.0025	(0.0081)
dyear2004	0.0555	(0.0031)***	-0.0123	(0.0083)
dyear2005	0.0623	(0.0029)***	-0.0227	(0.0086) ***
dsize	0.0085	(0.0022)***	0.0499	(0.0055)***
age	0.0003	(0.0001)**	0.0008	(0.0002)***
debt	-0.0002	(0.0001)	-0.1671	(0.0066)***
percap_income	0.0085	(0.0001)***	0.0049	(0.0001)***
Herfindahl	1.1521	(0.1590) ***	10.9470	(0.5070)***
spillover	-0.0426	(0.0061)***	-0.2298	(0.0129)***
constant	0.5508	(0.0031)***	0.6230	(0.0090)***
Adjusted R^2	0.2427		0.3584	

Note: Standard errors are shown in parentheses. *, **, and *** represent the statistical significance at 10%, 5%, and 1% levels, respectively.

Table 3.7. Estimated Parameters of Stochastic Production Frontiers and Variance Functions by Years

Year	Whole Firms				2000				2001			
Firm Ownership	Private		State		Private		State		Private		State	
Number of Obs.	54,644		6,597		7,261		1,301		8,338		1,193	
Production Frontier												
ln *L*	0.90	(0.00)***	0.83	(0.01)***	0.88	(0.01)***	0.80	(0.02)***	0.87	(0.01)***	0.82	(0.02)***
ln *K*	0.04	(0.00)***	0.09	(0.01)***	0.03	(0.00)***	0.11	(0.02)***	0.03	(0.00)***	0.07	(0.01)***
dsize	0.60	(0.01)***	0.63	(0.03)***	0.72	(0.03)***	0.67	(0.06)***	0.71	(0.03)***	0.65	(0.06)***
dyear2001	0.02	(0.01)*	0.06	(0.04)*								
dyear2002	0.08	(0.01)***	0.13	(0.04)***								
dyear2003	0.17	(0.01)***	0.23	(0.04)***								
dyear2004	0.11	(0.01)***	0.30	(0.04)***								
dyear2005	0.10	(0.01)***	0.44	(0.04)***								
Northern Mountains	-0.06	(0.02)***	-0.12	(0.03)***	-0.09	(0.05)*	-0.02	(0.07)	-0.01	(0.04)	-0.00	(0.07)
Central Coast	0.03	(0.01)***	-0.05	(0.03)*	0.07	(0.03)**	0.00	(0.05)	0.05	(0.03)**	-0.00	(0.06)
Central Highlands	0.10	(0.02)***	-0.05	(0.05)	0.01	(0.06)	0.15	(0.11)	0.04	(0.06)	0.08	(0.12)
South East	0.20	(0.01)***	0.33	(0.02)***	0.22	(0.02)***	0.42	(0.04)***	0.24	(0.02)***	0.38	(0.05)***
Mekong River delta	0.35	(0.01)***	0.23	(0.03)***	0.34	(0.03)***	0.23	(0.07)***	0.28	(0.02)***	0.25	(0.07)***
Resource-based	-0.32	(0.01)***	-0.10	(0.03)***	-0.19	(0.03)***	-0.05	(0.05)	-0.26	(0.02)***	-0.07	(0.06)
Low-tech	-0.20	(0.01)***	-0.00	(0.02)	-0.13	(0.02)***	0.07	(0.04)	-0.22	(0.02)***	-0.00	(0.04)
High-tech	0.09	(0.03)***	0.21	(0.06)***	0.06	(0.08)	0.22	(0.12)*	0.06	(0.08)	0.20	(0.13)
constant	-1.87	(0.02)***	-1.51	(0.05)***	-2.07	(0.04)***	-1.66	(0.10)***	-1.88	(0.03)***	-1.44	(0.10)***
Variance Function												
dyear2001	0.18	(0.05)***	0.14	(0.12)								
dyear2002	0.33	(0.05)***	0.39	(0.12)***								
dyear2003	0.52	(0.05)***	0.84	(0.13)***								
dyear2004	0.65	(0.05)***	1.29	(0.13)***								
dyear2005	0.85	(0.05)***	2.01	(0.15)***								
dsize	1.07	(0.04)***	0.67	(0.08)***	1.37	(0.17)***	0.99	(0.20)***	1.33	(0.13)***	0.91	(0.19)***
age	-0.01	(0.00)***	0.00	(0.00)	-0.01	(0.00)**	-0.00	(0.01)	-0.01	(0.00)***	-0.01	(0.01)**
debt	0.00	(0.00)	0.67	(0.08)***	0.46	(0.15)***	0.52	(0.19)**	0.23	(0.12)*	0.34	(0.19)*
percap_income	-0.41	(0.01)***	-0.26	(0.01)***	-0.72	(0.02)***	-0.41	(0.03)***	-0.55	(0.02)***	-0.37	(0.03)***
Herfindahl	1.07	(2.50)	-32.22	(8.42)***	-20.54	(10.20)**	-38.85	(22.17)*	-22.46	(9.11)**	-39.34	(21.53)*
spillover	0.72	(0.09)***	0.61	(0.21)**	0.74	(0.28)**	0.76	(0.53)	0.40	(0.26)	0.65	(0.52)
constant	1.36	(0.04)***	0.86	(0.14)***	2.06	(0.10)***	1.62	(0.31)***	2.02	(0.09)***	2.17	(0.31)***
σ_v	0.51	(0.00)***	0.51	(0.01)***	0.54	(0.01)***	0.50	(0.01)***	0.54	(0.01)***	0.48	(0.01)***
log-likelihood	-50748.16		-6292.58		-6987.88		-1170.37		-8116.80		-1048.14	

Note: Standard errors are shown in parentheses. *, **, and *** represent the statistical significance at 10%, 5%, and 1% levels, respectively.

Table 3.7. --- cont.

Year	2002				2003			
Firm Ownership	Private		State		Private		State	
Number of Obs.	7,337		1,200		7,943		1,043	
Production Frontier								
ln *L*	0.87	(0.01)***	0.78	(0.02)***	0.90	(0.01)***	0.82	(0.03)***
ln *K*	0.05	(0.00)***	0.13	(0.02)***	0.04	(0.00)***	0.09	(0.02)***
dsize	0.71	(0.03)***	0.66	(0.07)***	0.56	(0.03)***	0.61	(0.08)***
Northern Mountains	-0.08	(0.05)	-0.15	(0.07)**	-0.08	(0.04)*	-0.21	(0.08)**
Central Coast	0.03	(0.03)	-0.08	(0.06)	0.02	(0.03)	-0.11	(0.07)*
Central Highlands	0.14	(0.06)**	-0.07	(0.11)	0.07	(0.06)	-0.26	(0.13)**
South East	0.21	(0.02)***	0.30	(0.05)***	0.21	(0.02)***	0.31	(0.05)***
Mekong River delta	0.39	(0.03)***	0.29	(0.07)***	0.47	(0.03)***	0.19	(0.08)**
Resource-based	-0.36	(0.02)***	-0.20	(0.06)***	-0.33	(0.02)***	-0.10	(0.07)
Low-tech	-0.24	(0.02)***	-0.04	(0.05)	-0.16	(0.02)***	0.04	(0.05)
High-tech	0.10	(0.08)	0.19	(0.14)	0.10	(0.07)	0.27	(0.14)*
constant	-1.72	(0.03)***	-1.28	(0.10)***	-1.71	(0.03)***	-1.23	(0.12)***
Variance Function								
dsize	1.18	(0.11)***	0.81	(0.21)***	0.87	(0.11)***	0.58	(0.22)**
age	-0.02	(0.00)***	-0.00	(0.01)	-0.01	(0.00)**	0.00	(0.01)
debt	0.00	(0.00)	1.31	(0.18)***	0.38	(0.10)***	0.63	(0.21)***
percap_income	-0.43	(0.02)***	-0.30	(0.02)***	-0.38	(0.01)***	-0.24	(0.02)***
Herfindahl	0.02	(8.33)	-23.31	(22.51)	-5.55	(7.79)	-11.94	(20.19)
spillover	1.18	(0.26)***	0.88	(0.56)	0.65	(0.24)**	0.22	(0.54)
constant	1.56	(0.10)***	0.77	(0.31)***	1.68	(0.10)***	1.63	(0.34)***
σ_v	0.53	(0.01)***	0.51	(0.01)***	0.52	(0.01)***	0.49	(0.02)***
log-likelihood	-6931.40		-1112.61		-7376.75		-976.83	

Note: Standard errors are shown in parentheses. *, **, and *** represent the statistical significance at 10%, 5%, and 1% levels, respectively.

Table 3.7. --- cont.

Year	2004				2005			
Firm Ownership	Private		State		Private		State	
Number of Obs.	9,741		975		14,024		885	
Production Frontier								
ln *L*	0.92	(0.01)***	0.90	(0.03)***	0.94	(0.01)***	0.82	(0.03)***
ln *K*	0.05	(0.00)***	0.05	(0.01)***	0.03	(0.00)***	0.10	(0.02)***
dsize	0.51	(0.02)***	0.64	(0.08)***	0.50	(0.02)***	0.48	(0.10)***
Northern Mountains	-0.05	(0.04)	-0.24	(0.08)***	-0.05	(0.03)	-0.11	(0.10)
Central Coast	0.03	(0.02)	-0.08	(0.07)	0.01	(0.02)	-0.10	(0.08)
Central Highlands	0.21	(0.05)***	-0.25	(0.13)*	0.09	(0.04)**	-0.03	(0.15)
South East	0.23	(0.02)***	0.25	(0.05)***	0.16	(0.01)***	0.28	(0.06)***
Mekong River delta	0.31	(0.02)***	0.15	(0.08)*	0.29	(0.02)***	0.18	(0.09)**
Resource-based	-0.38	(0.02)***	-0.05	(0.07)	-0.32	(0.01)***	-0.09	(0.08)
Low-tech	-0.22	(0.02)***	0.03	(0.05)	-0.19	(0.01)***	-0.09	(0.06)
High-tech	0.08	(0.06)	0.05	(0.16)	0.13	(0.05)**	0.27	(0.17)
constant	-1.73	(0.03)***	-1.40	(0.12)***	-1.75	(0.02)***	-0.81	(0.14)***
Variance Function								
dsize	0.75	(0.09)***	1.12	(0.23)***	1.02	(0.08)***	0.15	(0.24)
age	-0.02	(0.00)***	0.01	(0.01)**	-0.02	(0.00)***	0.00	(0.01)
debt	0.34	(0.09)***	0.04	(0.12)	0.20	(0.08)**	1.12	(0.24)***
percap_income	-0.33	(0.01)***	-0.21	(0.02)***	-0.32	(0.01)***	-0.18	(0.01)***
Herfindahl	9.32	(4.93)*	-63.32	(21.28)***	6.40	(3.53)*	4.74	(21.57)
spillover	1.02	(0.19)***	1.05	(0.52)**	0.60	(0.16)***	-0.52	(0.53)
constant	1.46	(0.09)***	1.56	(0.30)***	1.83	(0.07)***	1.94	(0.37)***
σ_v	0.49	(0.01)***	0.48	(0.02)***	0.47	(0.00)***	0.54	(0.02)***
log-likelihood	-8674.54		-940.13		-12052.47		-905.00	

Note: Standard errors are shown in parentheses. *, **, and *** represent the statistical significance at 10%, 5%, and 1% levels, respectively.

Table 3.8. Predicted Outputs and Estimated Technical Efficiency of Private and State Firms Compared with the Results of Pooled Cross-Section Estimation

	2000	2001	2002	2003	2004	2005
Predicted Outputs						
Pooled Cross-Section Estimation Result						
$\overline{\hat{Y}}_p$	18.2	18.9	25.3	28.5	24.3	18.8
$\overline{\hat{Y}}_s$	25.7	27.6	37.8	43.7	42.2	37.8
$\tilde{Y}_p$	3.55	3.82	5.52	6.09	5.18	3.97
$\tilde{Y}_s$	4.87	5.38	8.11	9.24	8.81	7.67
$\tilde{Y}_p/\tilde{Y}_s$	0.73	0.71	0.68	0.66	0.59	0.52
Estimation Result by Year						
$\overline{\hat{Y}}_p$	15.6	17.0	25.2	28.8	26.8	20.8
$\overline{\hat{Y}}_s$	24.2	26.1	34.7	45.2	47.9	39.0
$\tilde{Y}_p$	3.05	3.47	5.39	6.19	5.47	4.31
$\tilde{Y}_s$	4.32	5.52	7.39	9.50	9.06	8.78
$\tilde{Y}_p/\tilde{Y}_s$	0.70	0.63	0.73	0.65	0.60	0.49
Estimated Technical Efficiency						
Pooled Cross-Section Estimation Result						
Private firms	0.60	0.62	0.66	0.69	0.70	0.72
State firms	0.62	0.63	0.63	0.64	0.64	0.66
Estimation Result by Year						
Private firms	0.69	0.67	0.68	0.67	0.67	0.67
State firms	0.67	0.66	0.66	0.63	0.60	0.63

Note: $\overline{\hat{Y}}_m$ and $\tilde{Y}_m$ $(m = p, s)$ respectively denote arithmetic and geometric means of output $\hat{Y}_m$ which are predicted using production technologies of type m (private or state) firms. Unit of predicted output is million VND.

Table 3.9. Estimated Parameters of Stochastic Production Frontiers and Variance Functions by Groups of Industries

Industries	Resource-based		Low-tech		Medium-tech		High-tech	
Number of Obs.	23,088		24,744		12,767		642	
Production Frontier								
ln *L*	0.87	(188.80)	0.90	(244.43)	0.98	(147.70)	0.94	(32.63)
ln *K*	0.05	(22.59)	0.04	(24.71)	0.03	(17.00)	0.05	(5.26)
private	-0.40	(14.78)	-0.50	(30.15)	-0.07	(2.75)	-0.21	(1.97)
dsize	0.73	(43.55)	0.50	(34.99)	0.53	(25.83)	0.84	(9.16)
dyear2001	0.03	(1.24)	-0.01	(0.33)	0.11	(3.57)	0.12	(0.86)
dyear2002	0.04	(2.20)	0.08	(3.85)	0.17	(5.81)	0.23	(1.74)
dyear2003	0.12	(5.37)	0.21	(10.00)	0.25	(8.53)	0.22	(1.70)
dyear2004	-0.00	(0.04)	0.18	(9.15)	0.24	(8.57)	0.19	(1.53)
dyear2005	0.05	(2.44)	0.16	(8.77)	0.21	(8.15)	0.22	(1.91)
Northern Mountains	-0.02	(0.89)	-0.10	(4.53)	-0.04	(1.24)	-0.39	(2.22)
Central Coast	0.04	(2.60)	0.02	(1.47)	0.02	(0.86)	-0.07	(0.63)
Central Highlands	0.09	(2.95)	0.08	(2.15)	0.07	(1.45)	n.a.	
South East	0.22	(15.82)	0.21	(22.55)	0.23	(18.61)	0.26	(4.69)
Mekong River delta	0.34	(23.47)	0.25	(13.83)	0.26	(10.54)	0.04	(0.07)
constant	-1.75	(46.52)	-1.55	(57.46)	-2.05	(49.21)	-1.66	(9.37)
Variance Function								
dyear2001	0.27	(4.05)	0.06	(0.94)	0.12	(1.19)	0.22	(0.46)
dyear2002	0.22	(2.83)	0.32	(4.48)	0.34	(3.23)	0.73	(1.58)
dyear2003	0.47	(5.85)	0.55	(7.37)	0.69	(6.52)	0.37	(0.74)
dyear2004	0.34	(4.22)	0.84	(11.55)	0.86	(8.30)	0.91	(2.17)
dyear2005	0.86	(11.08)	0.95	(13.85)	0.82	(8.34)	0.56	(1.35)
private	-1.20	(11.81)	-1.38	(19.99)	-0.59	(5.20)	-0.69	(1.43)
dsize	1.28	(19.95)	0.79	(13.19)	1.19	(14.04)	1.43	(4.07)
age	-0.01	(2.78)	-0.01	(8.13)	-0.01	(3.45)	-0.02	(1.19)
debt	0.33	(5.28)	0.00	(0.31)	0.10	(1.15)	0.53	(1.71)
percap_income	-0.45	(45.01)	-0.38	(54.55)	-0.34	(42.72)	-0.26	(10.52)
Herfindahl	12.43	(1.07)	-3.65	(0.77)	3.03	(0.24)	-14.29	(2.16)
spillover	-3.56	(4.58)	0.73	(7.14)	-0.81	(1.62)	12.47	(2.75)
constant	3.50	(13.84)	2.64	(27.18)	2.48	(12.06)	-7.56	(2.13)
σ_v	0.56	(139.80)	0.49	(143.36)	0.48	(109.27)	0.44	(22.68)
log-likelihood	-23037.36		-22120.88		-11089.40		-553.76	

Note: Absolute values of *t*-statistic are shown in parentheses. "n.a." means the value is not available.

Table 3.10. Means of Predicted Outputs and of Estimated Technical Efficiency of Private and State Firms Compared with the Results for Pooled Sample

	2000	2001	2002	2003	2004	2005	Total
Predicted Outputs							
Pooled Sample							
Private Firms	18.2	18.9	25.3	28.5	24.3	18.8	22.0
State Firms	25.7	27.6	37.8	43.8	42.2	37.8	36.2
Resource-Based							
Private Firms	9.6	11.1	16.4	17.5	15.5	13.5	13.7
State Firms	14.4	16.5	24.5	26.1	23.1	20.1	20.4
Low-Tech							
Private Firms	27.4	25.7	32.5	38.8	32.8	24.4	29.8
State Firms	45.2	42.3	53.5	63.9	54.0	40.1	49.1
Medium-Tech							
Private Firms	20.7	21.0	25.7	27.9	25.1	18.9	22.8
State Firms	22.1	22.4	27.4	29.8	26.8	20.2	24.4
High-Tech							
Private Firms	37.2	46.3	50.8	46.6	36.4	23.0	37.3
State Firms	46.0	57.4	62.9	57.6	45.0	28.4	46.2
Estimated Technical Efficiency							
Pooled Sample							
Private Firms	0.60	0.62	0.66	0.69	0.70	0.72	0.67
State Firms	0.62	0.63	0.63	0.64	0.64	0.66	0.64
Resource-Based							
Private Firms	0.63	0.62	0.68	0.68	0.72	0.72	0.68
State Firms	0.57	0.58	0.60	0.63	0.68	0.75	0.63
Low-Tech							
Private Firms	0.59	0.62	0.66	0.69	0.69	0.70	0.67
State Firms	0.59	0.61	0.63	0.67	0.71	0.77	0.66
Medium-Tech							
Private Firms	0.59	0.63	0.66	0.66	0.68	0.71	0.67
State Firms	0.65	0.69	0.71	0.73	0.76	0.84	0.72
High-Tech							
Private Firms	0.59	0.61	0.60	0.69	0.62	0.69	0.65
State Firms	0.61	0.66	0.59	0.67	0.62	0.73	0.64

Note: Unit of the predicted output is million VND. The predicted outputs of private and state firms in the four industries are evaluated with respect to the based Hong River delta in all cases and additionally with respect to the based year 2000 for the total case.

Table 3.A1. Estimated Parameters of Stochastic Production Frontiers and Variance Functions for the Resource-Based Industry

	Whole Firms				Resource-based Firms			
Firm Ownership	Private		State		Private		State	
Number of Obs.	54,644		6,597		21,464		1,624	
Production Frontier								
ln *L*	0.90	(0.00)***	0.83	(0.01)***	0.86	(0.00)***	0.90	(0.02)***
ln *K*	0.04	(0.00)***	0.09	(0.01)***	0.04	(0.00)***	0.13	(0.02)***
dsize	0.60	(0.01)***	0.63	(0.03)***	0.72	(0.02)***	0.64	(0.08)***
dyear2001	0.02	(0.01)*	0.06	(0.04)*	0.03	(0.02)	0.03	(0.09)
dyear2002	0.08	(0.01)***	0.13	(0.04)***	0.05	(0.02)**	0.09	(0.09)
dyear2003	0.17	(0.01)***	0.23	(0.04)***	0.11	(0.02)***	0.14	(0.10)
dyear2004	0.11	(0.01)***	0.30	(0.04)***	-0.01	(0.02)	0.19	(0.10)**
dyear2005	0.10	(0.01)***	0.44	(0.04)***	0.03	(0.02)	0.43	(0.09)***
Northern Mountains	-0.06	(0.02)***	-0.12	(0.03)***	-0.01	(0.03)	-0.16	(0.08)**
Central Coast	0.03	(0.01)***	-0.05	(0.03)*	0.04	(0.02)**	-0.04	(0.06)
Central Highlands	0.10	(0.02)***	-0.05	(0.05)	0.12	(0.03)***	-0.10	(0.10)
South East	0.20	(0.01)***	0.33	(0.02)***	0.21	(0.01)***	0.28	(0.06)***
Mekong River delta	0.35	(0.01)***	0.23	(0.03)***	0.33	(0.01)***	0.22	(0.07)***
Resource-based	-0.32	(0.01)***	-0.10	(0.03)***				
Low-tech	-0.20	(0.01)***	-0.00	(0.02)				
High-tech	0.09	(0.03)***	0.21	(0.06)***				
constant	-1.87	(0.02)***	-1.51	(0.05)***	-2.14	(0.02)***	-2.23	(0.13)***
Variance Function								
dyear2001	0.18	(0.05)***	0.14	(0.12)	0.31	(0.07)***	-0.00	(0.28)
dyear2002	0.33	(0.05)***	0.39	(0.12)***	0.27	(0.08)***	0.46	(0.26)*
dyear2003	0.52	(0.05)***	0.84	(0.13)***	0.48	(0.09)***	0.70	(0.29)**
dyear2004	0.65	(0.05)***	1.29	(0.13)***	0.36	(0.09)***	0.88	(0.29)***
dyear2005	0.85	(0.05)***	2.01	(0.15)***	0.86	(0.08)***	1.80	(0.29)***
dsize	1.07	(0.04)***	0.67	(0.08)***	1.29	(0.07)***	1.09	(0.20)***
age	-0.01	(0.00)***	0.00	(0.00)	-0.01	(0.00)***	0.01	(0.00)***
debt	0.00	(0.00)	0.67	(0.08)***	0.18	(0.08)**	0.82	(0.14)***
percap_income	-0.41	(0.01)***	-0.26	(0.01)***	-0.49	(0.01)***	-0.25	(0.02)***
Herfindahl	1.07	(2.50)	-32.22	(8.42)***	30.32	(11.80)**	-57.52	(67.93)
spillover	0.72	(0.09)***	0.61	(0.21)**	-4.20	(0.76)***	0.19	(4.85)
constant	1.36	(0.04)***	0.86	(0.14)***	2.64	(0.22)***	0.11	(1.42)
σ_v	0.51	(0.00)***	0.51	(0.01)***	0.55	(0.00)***	0.63	(0.02)***
log-likelihood	-50748.16		-6292.58		-20959.02		-1847.10	

Note: Standard errors are shown in parentheses. *, **, and *** represent the statistical significance at 10%, 5%, and 1% levels, respectively.

Table 3.A2. Predicted Outputs and Estimated Technical Efficiency of Private and State Firms in the Resource-Based Industry Compared with the Results of Pooled Cross-Section Estimation

	2000	2001	2002	2003	2004	2005	Total
Predicted Outputs							
Pooled Cross-Section Estimation Result							
$\overline{\hat{Y}}_p$	18.2	18.9	25.3	28.5	24.3	18.8	22.0
$\overline{\hat{Y}}_s$	25.7	27.6	37.8	43.7	42.2	37.8	36.2
$\tilde{Y}_p$	3.55	3.82	5.52	6.09	5.18	3.97	4.54
$\tilde{Y}_s$	4.87	5.38	8.11	9.24	8.81	7.67	7.23
$\tilde{Y}_p/\tilde{Y}_s$	0.73	0.71	0.68	0.66	0.59	0.52	0.63
Resource-based Contribution to $\tilde{Y}_p/\tilde{Y}_s$	0.90	0.91	0.92	0.92	0.93	0.93	0.92
Estimation Result for Firms in the Resource-Based Industry							
$\overline{\hat{Y}}_p$	9.2	10.6	15.8	16.6	14.7	12.6	13.0
$\overline{\hat{Y}}_s$	13.6	15.6	24.9	26.2	27.5	28.8	22.7
$\tilde{Y}_p$	1.92	2.19	3.24	3.51	3.03	2.66	2.65
$\tilde{Y}_s$	1.87	2.16	3.61	3.92	3.96	4.13	3.10
$\tilde{Y}_p/\tilde{Y}_s$	1.03	1.01	0.90	0.89	0.77	0.64	0.85
Estimated Technical Efficiency							
Pooled Cross-Section Estimation Result							
Private firms	0.60	0.62	0.66	0.69	0.70	0.72	0.67
State firms	0.62	0.63	0.63	0.64	0.64	0.66	0.64
Estimation Result for Firms in the Resource-Based Industry							
Private firms	0.64	0.63	0.68	0.70	0.73	0.74	0.69
State firms	0.61	0.62	0.60	0.61	0.60	0.61	0.61

Note: $\overline{\hat{Y}}_m$ and $\tilde{Y}_m$ $(m = p, s)$ respectively denote arithmetic and geometric means of output $\hat{Y}_m$ which are predicted using production technologies of type m (private or state) firms. Unit of predicted output is million VND.

Chapter 4: Exiting Firms and Their Productivity: A Stochastic Frontier Analysis of Vietnamese Manufacturing Firms

4.1. Motivation for the Analysis and Related Literature

Theoretically, once firms have entered the market, they operate under continuous but varying levels of exit risk (Shiferaw, 2009). These firms decide to stay in or close their business depending importantly on their productivity which is known only by the decision makers. Actually, a number of studies have found a negative relationship between the unobserved productivity and exit decision of firms. Firms with lower productivity are more likely to exit the market (Söderbom, Teal, and Harding, 2006; Frazer, 2005). However, dysfunctional markets in the developing countries tend to allow inefficient large firms to stay in business while stifling the entry and growth of small firms (Shiferaw, 2009; Frazer, 2005). This is partly because there is difference in production technology (production frontier) between driven-out and remaining firms. That is, there might be a reverse impact of exit decision of firms on their production frontier, or firms exiting from the market might have lower production technology. If this is the case, exit decision will raise an endogeneity problem when estimating production functions separately for exiting and staying firms (Kumbhakar, Tsionas and Sipiläinen, 2009; Mayen, Balagtas and Alexander, 2010).

To examine impacts of firms' exit decision on their technology adoption, we specify an SPF with a different intercept for exiting and staying firms by introducing a dummy variable of firm exit. We estimate this SPF for Vietnamese manufacturing firms in two ways. First, we estimate it using data on all firms by ignoring endogeneity of the exit dummy. Second, we estimate it for exiting and matched staying firms by following Mayen, Balagtas and Alexander (2010). Specifically, we use a propensity score matching (PSM) method to find a matched staying firm for each exiting firm. Then, we estimate the SPF using data on exiting and matched staying firms. Comparison of the two SPF and outputs predicted from them should reveal impacts of endogenous exit decision on productivity.

For this analysis, we use data on Vietnamese manufacturing firms for 2000-2004 by taking two adjacent years during the period 2000-2005 to define firm exit. To allow for different production technology shown in the previous chapter, we conduct the analysis separately for private and state firms. The results indicate some estimation bias from endogeneity of exit decision. Specifically, when we use data on all firms to estimate SPF, exiting private firms have a 5% lower production frontier and exiting state firms have a 15% lower production frontier. On the other hand, when we use data on exiting and matched staying firms, only exiting state firms show a significantly lower frontier (9%). Furthermore, exiting private (state) firms have 8% (8%) lower TE using the full sample, while they have 2% (3%) lower TE using the matched sample, Consequently, exiting firms are likely to have lower productivity for the Vietnamese manufacturing sector between 2000 and 2004.

Section 4.2 describes the economic environment underlying productivity and firm exit in Vietnam. It also compares the variables explaining the production frontiers and exit probability of private and state firms. Section 4.3 explains specification and estimation of a probit model for exit, PSM method used in this study, and specification and estimation method of Cobb-Douglas SPF. Furthermore, it interprets the empirical results. Section 4.4 concludes the chapter.

4.2. Characteristics of Productivity and Firm Exit in Vietnamese Manufacturing Sector

4.2.1. Economic Environment underlying Productivity and Firm Exit

The seventh National Congress of the Communist Party of Vietnam, following the open economy policy initiated by the 1986 *Doimoi* reform, created a new business ownership of private firms. Since then, private firms, even small in production scale, have been rapidly increasing their share in the number of firms (from 85 % in 2000 to 94% in 2005 in the manufacturing sector) as well as their role in the high growth rate of industrial outputs (7% for 2000-2005, GSO). Such contribution of private firms is particularly impressive because they have done their business under lacking market information, excessive regulations, unequal treatment favoring state firms that are needed to raise productivity (Nguyen, Le, and Bryant, 2013; Steer and Sen, 2010).

To foster and stimulate the development of this private sector, there are a number of legal innovations aiming at equalizing treatments between state and private firms (e.g., 1999 Enterprise Law revised in 2005, Decree No.90/2001/ND-CP on “Support for development of small and medium-sized firms”) (Leung, 2010) and government supporting programs in terms of both financial assistance (e.g., temporary tax exemption/reductions, soft policy loans) and technical assistance (e.g., human resource training, export promotion initiatives, quality and technology programs) (Hansen, Rand, and Tarp, 2009). These circumstances are suggested to bring about changes (i.e., new entries and exit) in the structure that may derive low productivity of the existing manufacturing sector. On the one hand, this industrial evolution might be attributed to bankrupt of private firms with low profits and new entries under the competitive market condition. The business inefficiency in terms of profits of private firms is affected by difficulties such as limited access to formal credit for long-term capital investment, weak technical and management capacity, policies favoring state firms at the expense of private firms, lacking preferential networks between the government and firms, and so on (Nguyen and van Dijk, 2012; Hansen, Rand, and Tarp, 2009). On the other hand, the intensified restructuring and dissolution of unprofitable state firms that began at the end of the 1990s could decrease only a small fraction of unprofitable firms at the provincial level: 95 out of 5,759 state firms in 2000 and 180 out of 4,086 state firms in 2005 (GSO, 2006, 2010). This implies that there still remain state firms at the central level which have low productivity because their debts are usually ignored and cancelled by the state banking system. Such state credit in cancelling debts allowed a significant number of state firms to stay in business after 20 years of transition from a planned economy to a socialist-oriented market economy (Nguyen and van Dijk, 2012).

Although the government introduced several policies to encourage private firms in balance with maintaining the leading role of state firms, its preferential treatments of state firms (e.g., easy access to bank loans and land-use, concentrated rights in certain profitable industries) might have caused both low productivity and firm exit in the economy. Productivity difference between private and state firms seems to depend on whether the government favors state or private firms, especially in term of disparities in policy implementation at the provincial level (Nguyen, Le, and Bryant, 2013). Private firms that manage to survive and grow under the circumstances dominated by state firms are often not given sufficient access to resources to develop independently from state firms. As a result, those private firms might be less productive than state firms. Because they could neither effectively utilize the limited resources (e.g., dependence on resource allocation relative to state firms' production plans) nor do business flexibly (e.g., flexibility in choosing business partners) in a perfectly competitive market. Moreover, if such low productivity increases transaction costs, those private firms might choose to exit from business. On the contrary, policies favoring private firms will create more chances for them to continue business as equal partners/competitors with state firms and hence survive longer in the market. When private firms are given sufficient access to resources to develop independently from state firms, they will be capable of utilizing the resources more effectively and raise profits. The subsequent sections use a data sample for 2000-2004 and investigate the relationship between firm productivity and exit decision of Vietnamese private and state manufacturing firms.

4.2.2. Comparison of Selected Variables between Exiters and Stayers

This subsection introduces the main data for the subsequent analysis and provides a preliminary analysis. The main data are adapted from the Vietnamese Enterprise Survey (GSO) and span 2000-2005. We focus on domestic private and state firms in the manufacturing sector (ISIC15-ISIC37), both of which report positive turnover, value added, labor compensation, and the number of employees as we discussed in the previous chapters. The manufacturing sector can be classified into four industrial groups of similar production technologies: resource-based, low-tech, medium-tech, and high-tech manufactures (MoIT and UNIDO, 2011). We can also classify Vietnam's 64 municipalities and provinces into six regions: Red River delta, Northern Midlands and Mountain areas (henceforth Northern Mountains), North and South Central Coast (henceforth Central Coast), Central Highlands, South East, and Mekong River delta.

To define if a firm exits the market or not, we construct a dummy variable, *exit*, for each pair of two adjacent years, e.g., 2000-2001, … , 2004-2005. Variable *exit* takes the value 1 if a firm is observed in the former year (e.g., 2000) and is not present in the latter year (e.g., 2001) of each pair. Consequently, the empirical analysis uses five periods between 2000 and 2004.

Table 4.1 reports the number of total and exit firms and the exit rate for various categories of firms. The number of observations for total, private, and state firms over five years is 46,332, 40,620, and 5,712 firms, respectively. The number of total firms increased 25% from 8,562 in 2000 to 10,716 in 2004. The number of private firms increased 34% from 7,261 to 9,741, whereas that of state firms decreased 25% from 1,301 to 975 in the same period. The number of total exiting firms (exit rate in % is shown in parentheses) is 10,964 (24%), whereas that for private and state firms is respectively 9,920 (21%) and 1,044 (2%) for the whole period. Furthermore, the exit rate decreased from 32% in 2000 to 10% in 2004 for the whole sample. Exit rate for private-firm decreased from 28% in 2000 to 10% in 2004. This reflects the fact that private firms started their business in the 1990s and their exit rate was still high at the beginning of the 2000s. Over the same period, exit rate for state firms was much lower. Overall, these observations show that most exited firms were private firms in the manufacturing sector.

Now, we introduce main variables in the production frontier. Value added Y is computed as the sum of total profit and total labor compensation (including fringe benefits). Labor L is the number of total employees at the end of the survey year. Capital K is the value of fixed assets at the beginning of the survey year. The value added and capital are deflated by the distinct producer price indexes proposed by Javorcik (2004).

The left panel of Table 4.2 and Table 4.3 report the means of value added, labor, and capital for exiters, stayers, and all firms separately for private and state firms. Table 4.2 shows for private firms that the means of L, K, and Y for exiters are 42, 11, and 4, whereas those of stayers are 105, 23, and 13, where unit of capital and value added is million VND. Therefore, exiters use 40% and 48% of labor and capital to produce 31% of output compared with stayers. Table 4.3 shows for state firms that means of L, K, and Y for exiters are 363, 114, 50, whereas those for stayers are 596, 217, 133. Therefore, exiters use 61% and 53% of labor and capital to produce 38% of output compared with stayers. These simple comparisons suggest that exiters are substantially smaller in production scale and seem to have lower productivity than stayers.

Next, we introduce variables which explain exit probability. They include five firm-specific variables (turnover, age, debt, wage income, capital labor ratio), two industry-specific variables (competition or concentration level, the presence of foreign firms within the industry), and four types of dummy variables (ownership, industries, regions, and years). Turnover in logarithm is used to represent firm size[9] and it is expected to reduce exit probability. Variable age is defined as the difference between the current and registration years[10] and it can also reduce exit probability. Consequently, large and old firms are less likely to exit due to the advantage of scale economies and their accumulated experiences (Jovanovic, 1982). Variable $debt$ is defined as the ratio of total liabilities to total assets. While higher $debt$ is likely to raise exit probability due to higher interest payments and likely bankruptcy (Tsionas and Papadogonas, 2006; Paul, Johnston, and Frengley, 2000), it might lower exit probability if $debt$ is regarded as

[9] This measurement in terms of turnover is used only in the probit model for firm exit probability. In the SPF and the variance function of technical inefficiency, we use the dummy variable $dsize$ for firm size consistently with the Chapter 3 to categorize “large scale” and “small scale” firms.
[10] Refer to the footnote 4 of the Chapter 3.

proxy for easier access to formal financial system (Hansen, Rand, and Tarp, 2009). Variable $percap\_income$ is defined as total labor compensation divided by labor input, and it is used in logarithm in the exit probability function. This variable might raise exit probability due to burdensome wage payments, while it might lower exit probability due to higher effort of employees, as discussed in Yang and Chen (2009). Capital labor ratio, KLR, can have a negative effect on exit probability because firms with more capital often have higher profitability, while it can have a negative effect as a result of factor intensity in the standard trade model (Frazer, 2005).

Industrial concentration (or competition) is proxied by the index $Herfindahl_j = \sum_i S_{ji}^2$, where S_{ji} denotes the market share of firm *i* in the industry *j* in terms of turnover. $Herfindahl$ is expected to reduce exit probability because its higher value means weaker market competition. Finally, $spillover_j$ is defined as the sum of the turnover of foreign firms in industry j divided by the sum of the turnover of all firms in the same industry. It may raise exit probability if domestic firms lose their market shares to competing foreign firms due to the "market stealing" effect (Aitken and Harrison, 1999). On the contrary, it may lower exit probability if domestic firms can imitate the better products of foreign firms and they devote more efforts to prevent falling behind these foreign firms (Caves, 1974; Javorcik, 2004).

The left panel of Table 4.2 and Table 4.3 also report the means of variables explaining exit probability for exiters, stayers, and all firms separately for private and state firms. In Table 4.2 (private firms), comparison of the two types of firms using the full sample shows that exiters have much smaller turnover, are younger, incur fewer liabilities, and pay lower wages, although they have similar characteristics for the other three variables (KLR, $Herfindahl$, $spillover$). However, if we use the matched sample, these differences almost disappear. We can find a similar result for state firms by comparing means of those variables based on the full sample and the matched sample.

4.3. Empirical Analysis

4.3.1. Methods

Assuming private and state firms possess different production technology, we specify and estimate two Cobb-Douglas SPFs separately for these firms. Specifically, the SPF has two inputs (labor L_{it} and capital K_{it}) and one output (value added Y_{it}) for firm i $(= 1, \cdots, \mathrm{n})$ and year t $(= 2000, \cdots, 2004)$:

$$lnY_{it} = \beta_0 + \beta_1 lnL_{it} + \beta_2 lnK_{it} + \alpha exit_{it} + \beta_3 dsize_{it} + \sum_{g \in G} \beta_g dindustry_{ig}$$
$$+ \sum_{r \in R} \beta_r dregion_{ir} + \sum_s \beta_s dyear_s + v_{it} - u_{it}, \quad (1)$$

where $dsize_{it}$, $dindustry_{ig}$, $dregion_{ir}$, and $dyear_s$ are dummy variables defined in the previous chapter. In equation (1), production technology between exiting and staying firms differs only in the intercept, as the dummy variable $exit_{it}$ shows. A negative coefficient α of $exit_{it}$ means that exiting firms have a lower production frontier than staying firms do, with other things being equal. We assume that v_{it} is a normal random variable with mean zero and constant variance σ_v^2 and that non-negative technical inefficiency u_{it} follows a half normal distribution with variance σ_u^2.

As specified in the previous chapter, we again assume that inefficiency u has the following heteroskedastic function:

$$ln\sigma_u^2 = \delta_0 + \sum_s \delta_s dyear_s + \delta_1 dsize_{it} + \delta_2 age_{it} + \delta_3 debt_{it}$$
$$+ \delta_4 percap\_income_{it} + \delta_5 Herfindahl_{jt} + \delta_6 spillover_{jt}. \quad (2)$$

where $u^* = -(v-u)\sigma_u^2/\sigma^2$, $\sigma_*^2 = \sigma_u^2\sigma_v^2/\sigma^2$, and $\sigma^2 = \sigma_u^2 + \sigma_v^2$. Φ denotes the cumulative distribution function of the standard normal variable.

To obtain a matched stayer for each exiter, we specify the following probit model:

$$exit_{it} = \begin{cases} 1 & for\ exiting\ firms \quad if \quad I_{it}^* > 0 \\ 0 & for\ continuing\ firms \quad if \quad I_{it}^* \leq 0 \end{cases}$$

$$I_{it}^* = \gamma_0 + \gamma_1 ln(turnover)_{it} + \gamma_2 age_{it} + \gamma_3 debt_{it} + \gamma_4 ln(percap\_income_{it})$$
$$+ \gamma_5 ln(KLR)_{it} + \gamma_6 Herfindahl_{jt} + \gamma_7 spillover_{jt}$$
$$+ \sum_{g \in G} \gamma_g dindustry_{ig} + \sum_{r \in R} \gamma_r dregion_{ir} + \sum_s \gamma_s dyear_s + e_{it}, \quad (3)$$

where e_{it} is a standard normal variable. Matched sample is constructed by propensity score matching (PSM) method of Mayen, Balagtas and Alexander (2010). First, we estimate the probit model (3) using data for all firms and predict probability $\Pr(exit = 1)$ to exit for each firm. Next, we apply single-nearest-neighbor matching with pre-defined caliper and with replacement[11] to reduce the bias. After this procedure, each exiter is matched with a stayer with similar (i.e., closest) propensity score. Other unmatched stayers are dropped for the sample (Dehejia and Wahba, 2002).

For private and state firms separately, we jointly estimate the SPF (1) and the variance function (2) using the maximum likelihood method in two ways. First, we estimate them using data on all exiters and stayers by ignoring endogeneity of $exit_{it}$. Second, we estimate them using data on all exiters and their matched stayers to allow for the endogeneity of $exit_{it}$. After estimating the SPF and variance function, we follow Battese and Coelli (1988) to compute the TE index as

$$TE = \mathrm{E}[\exp(-u)\,|Y] = \{\Phi[(u^*/\sigma_*) - \sigma_*]/\Phi(u^*/\sigma_*)\}\exp\,[(\sigma_*^2/2) - u^*], \quad (4)$$

where $u^* = -(v-u)\sigma_u^2/\sigma^2$, $\sigma_*^2 = \sigma_u^2\sigma_v^2/\sigma^2$, and $\sigma^2 = \sigma_u^2 + \sigma_v^2$. Φ denotes the cumulative distribution function of the standard normal variable.

4.3.2. Estimated Parameters of Exit Probability and Characteristics of Matched Samples

Estimation results of the probit model (3) for private and state firms are presented in Table 4.4. For private firms, the probit model has pseudo R^2 at 0.089 and correctly predicts exit decision for 98% of stayers and for 11% of exiters. Similarly, for state firms, the probit model has pseudo R^2 of 0.083 and correctly predicts exit decision for 99% of stayers and 3% for exiters. Most coefficients are estimated significantly at the 5% level, which justifies our hypotheses in the subsection 4.2.2.

Private firms tend to exit the market if they have higher values of capital intensity

[11] Refer to Dehejia and Wahba (2002) for detailed matching with and without replacement, and Rosenbaum and Rubin (1985) for how to define the caliper width. We, in the preliminary analysis, construct the matched sample in two ways with and without pre-defined caliper and the two give the same estimation results. Therefore, we decide to report the results of the matched sample with pre-defined caliper in the body of the paper.

(KLR), they face more presence of foreign firms ($spillover$), or they have the resource-based industry membership (resource-based dummy). Conversely, they tend to stay in the market if they have larger production scale ($turnover$), they are older (age), they have more liabilities ($debt$), or they pay higher wage ($percap\_income$). Furthermore, private firms in the Northern Mountains, Central Coast, and South East regions are less likely to exit, and exit probability of private firms started decreasing since 2002. Results for state firms are very similar to those for private firms.

We use these parameter estimates to compute the propensity score or the predicted probability of being an exiter for each firm. We then select for each exiter a stayer which has the propensity score closest to that of the exiter. Figure 4.1 shows the kernel densities of propensity scores for exiters, stayers, and matched stayers. As expected, for both private and state firms, the distribution of stayers is skewed towards zero, while that of matched stayers gets very close to the distribution of exiters.

Before estimating the SPF and variance function using matched sample, we briefly examine characteristics of this sample, which are shown in the right panel of Table 4.2 and Table 4.3. The resulting matched sample, which is composed of exiters and matched stayers, includes 17,092 (1,874) firms for private (state) firms. The matched stayers have similar characteristics to exiters for all variables in Tables 4.2 and 4.3. In Table 4.2, for example, the means of L, K, and Y are 65, 14, and 7 for matched stayers, which are much closer to those for exiters (42, 11, and 4) than those for stayers (105, 23, 13). Similar results are shown in Table 4.3. Other variables, age, $debt$, and $percap\_income$ for matched stayers are also closer to those of exiters, as shown in the two tables.

4.3.3. Estimated Parameters of the SPF and the Variance Function

Table 4.5 presents estimated parameters of the SPF (1) and the variance function (2) over full sample of and matched sample separately for private and state firms. For private firms, the coefficient of $exit_{it}$, which represents technology difference between exiters and stayers, is negative for both full and matched samples. However, this difference is found to be statistically insignificant once we control for endogeneity of exit decision, which suggests the importance of the use of PSM method. On the other hand, for state firms, the coefficient of $exit_{it}$ is statistically negative for both full and matched samples and the difference is statistically significant even after controlling for the endogeneity.

For private firms, estimated production elasticities of labor and capital are similar between the full and matched samples. For state firms, estimated production elasticity of labor is similar between these samples, while that of capital is different (0.09 and 0.05). For other coefficients, most of them are similar between the full and matched samples both for private and state firms if we focus on statistically significant coefficients. The only difference can be found for the coefficient of high-tech industry dummy for private firms and 2003 and 2004 year dummies for state firms.

4.3.4. Comparison of Production Frontiers and Technical Efficiency

The upper panel of Table 4.6 presents predicted outputs (i.e., deterministic production frontiers) for exiters and stayers over the full and matched samples, where unit is million VND. The average production frontiers of exiters and stayers over the full sample are higher than those over the matched sample for both private and state firms. The difference is 100% for private exiters, 110% for private stayers, 72% for state exiters, and 84% for state stayers. The difference between the two types of samples is the highest in 2002 for private exiters and stayers (100% and 107%), in 2004 for state exiters and stayers (144% and 161%). These higher predicted outputs over the full sample come from overestimation by ignoring endogenous firm exit in the estimation of the SPFs.

Focusing on the result over the matched sample, the predicted output shows the same production frontiers between private exiters and stayers and slightly different production frontiers between state exiters and stayers, reflecting the estimated coefficients of the dummy variable, $exit_{it}$, for private and state firms. Furthermore, private exiters and stayers are found to upgrade their production technology annually, e.g., 100% (from

4.6 to 9.2) for exiters and 102% (from 4.6 to 9.3) for stayers from 2000 to 2004. On the other hand, state exiters and stayers reached their peak in 2003 (from 65.5 in 2000 to 90.4 in 2003, and 72.2 to 99.8 for the same years) and turned back to the level in 2000 (65.5 and 72.3) after a slight decrease in 2001-2002.

The lower panel of Table 4.6 presents predicted TEs for exiters and stayers over the full and matched samples. Average TE of exiters is lower than that of stayers for both these samples and the difference is larger over the full sample. For example, the difference for private firms is 0.08 and 0.02 over the full and matched samples, and that for state firms is 0.08 and 0.03 over these samples. TEs for private and state exiters over the full samples are smaller than those over the matched sample, whereas there is almost no TE difference for private and state stayers over the two samples. Focusing on the matched sample, the estimated TEs show an increasing trend for all types of firms by ownership (private or state) and by exit status (exiters or stayers). Private exiters and stayers respectively gained 10% and 12% of their TE between 2000 and 2004, whereas both state exiters and stayers gained 5% of their TE for the same period.

4.4. Summary and Conclusions

This chapter uses data on individual manufacturing firms for 2000–2004 to examine the effect of endogeneity of firms' exit decision on their production frontiers. For this purpose, it estimates Cobb-Douglas production frontiers with different intercepts for exiting and staying firms separately for private and state firms.

The empirical results indicate some estimation bias from endogenous exit decision of firms. When we use data on all private firms to estimate the SPF, exiting firms have a 5% lower production frontier and exiting state firms have a 15% lower production frontier. On the other hand, when we use data on exiting and matched staying private firms, only exiting state firms show a significantly lower frontier (9%). Furthermore, estimation with the full sample overestimates some parameters of the SPF than that with the matched sample, especially for state firms. In terms of TE, the difference is larger for the full sample than for the matched sample: Exiting private firms are less technically efficient by 0.08 (0.02), and exiting state firms are less technically efficient by 0.08 (0.03) over the full (matched) sample.

Comparison of the results over the full and matched samples in terms of the SPF parameters, predicted outputs, and TEs shows that the PSM method can correct the bias from endogenous firm exit more effectively for private firms than for state firms. Such different results between the two types of samples imply the importance to consider the firm exit endogeneity in estimating the SPF, although the PSM method seems to correct this endogeneity only partially.

Our model does not capture the effect of the unobservable productivity on the exit decision and their interactions in the SPF specification. In the future study, we should reconsider this effect by employing different methods, which include a simultaneous estimation of the SPF and firm exit probit model.

Table 4.1. Number of Total and Exiting Firms and Exit Rate

Firm Ownership	Whole Sample Firms Total	Private	State	Exit Total	Private	State	Exit Rate (%) Total	Private in total	State in	Private itself	State itself
2000	8,562	7,261	1,301	2,767	2,397	370	0.32	0.28	0.04	0.33	0.28
2001	9,531	8,338	1,193	3,301	3,130	171	0.35	0.33	0.02	0.38	0.14
2002	8,537	7,337	1,200	2,107	1,858	249	0.25	0.22	0.03	0.25	0.21
2003	8,986	7,943	1,043	1,672	1,499	173	0.19	0.17	0.02	0.19	0.17
2004	10,716	9,741	975	1,117	1,036	81	0.10	0.10	0.01	0.11	0.08
Total	46,332	40,620	5,712	10,964	9,920	1,044	0.24	0.21	0.02	0.24	0.18

Table 4.2. Means of Variables over Full and Matched Samples: Private Firms

	Full Private Sample			Matched Private Sample		
	All Firms	Exiters	Stayers	All Firms	Exiters	Stayers
Number of Obs.	40,620	9,920	30,700	17,092	9,911	7,181
Variables in Production Frontier						
Value added	11.01	4.32	13.18	5.36	4.32	6.80
[Mill.VND]	(45.65)	(19.84)	(51.10)	(23.65)	(19.85)	(27.99)
Labor	89.64	42.42	104.90	51.80	42.46	64.70
[persons]	(296.61)	(115.57)	(333.38)	(153.48)	(115.62)	(193.22)
Capital	20.44	11.11	23.46	12.43	11.11	14.26
[Mill.VND]	(98.44)	(63.32)	(107.19)	(73.50)	(63.35)	(85.51)
dsize	0.19	0.10	0.22	0.11	0.10	0.12
	(0.39)	(0.30)	(0.41)	(0.31)	(0.30)	(0.33)
Resource-based	0.41	0.49	0.39	0.48	0.49	0.46
	(0.49)	(0.50)	(0.49)	(0.50)	(0.50)	(0.50)
Low-tech	0.38	0.33	0.40	0.34	0.33	0.36
	(0.49)	(0.47)	(0.49)	(0.47)	(0.47)	(0.48)
Medium-tech	0.19	0.17	0.20	0.17	0.17	0.17
	(0.39)	(0.37)	(0.40)	(0.37)	(0.37)	(0.38)
High-tech	0.01	0.01	0.01	0.01	0.01	0.01
	(0.09)	(0.09)	(0.10)	(0.09)	(0.09)	(0.09)
Red River delta	0.25	0.24	0.25	0.24	0.24	0.24
	(0.43)	(0.43)	(0.43)	(0.43)	(0.43)	(0.43)
Northern Mountains	0.03	0.03	0.03	0.03	0.03	0.03
	(0.18)	(0.18)	(0.18)	(0.18)	(0.18)	(0.18)
Central Coast	0.11	0.10	0.11	0.10	0.10	0.10
	(0.31)	(0.31)	(0.31)	(0.31)	(0.31)	(0.30)
Central Highlands	0.02	0.02	0.02	0.02	0.02	0.02
	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
South East	0.38	0.31	0.41	0.32	0.31	0.34
	(0.49)	(0.46)	(0.49)	(0.47)	(0.46)	(0.47)
Mekong River delta	0.22	0.29	0.19	0.28	0.29	0.27
	(0.41)	(0.46)	(0.39)	(0.45)	(0.46)	(0.44)
Variables to Explain Technical Efficiency and Propensity Score						
turnover	11.76	5.99	13.62	6.29	6.00	6.69
[Bill.VND]	(70.85)	(30.67)	(79.53)	(28.88)	(30.69)	(26.17)
age	6.23	5.79	6.37	5.88	5.80	5.99
	(7.61)	(7.04)	(7.78)	(7.13)	(7.04)	(7.26)
debt	0.33	0.21	0.37	0.22	0.21	0.24
	(8.39)	(0.28)	(9.65)	(0.28)	(0.28)	(0.28)
percap income	9.61	8.36	10.01	8.31	8.36	8.24
	(12.01)	(19.09)	(8.51)	(15.10)	(19.10)	(6.29)
KLR	0.34	0.36	0.33	0.34	0.36	0.32
	(1.22)	(1.09)	(1.26)	(0.92)	(1.09)	(0.63)
Herfindahl	0.0043	0.0040	0.0044	0.0041	0.0040	0.0041
	(0.0056)	(0.0057)	(0.0056)	(0.0053)	(0.0057)	(0.0048)
spillover	0.3363	0.3288	0.3388	0.3299	0.3289	0.3313
	(0.1471)	(0.1395)	(0.1494)	(0.1412)	(0.1396)	(0.1435)

Note: Standard deviations are shown in parentheses and units are shown in brackets.

Table 4.3. Means of Variables over Full and Matched Samples: State Firms

	Full State Sample			Matched State Sample		
	All Firms	Exiters	Stayers	All Firms	Exiters	Stayers
Number of Obs.	5,712	1,044	4,668	1,874	1,044	830
Variables in Production Frontier						
Value added	117.71	50.09	132.85	54.73	50.14	60.50
[Mill.VND]	(374.44)	(116.91)	(409.00)	(123.70)	(116.96)	(131.54)
Labor	553.35	363.32	595.88	385.31	363.64	412.57
[persons]	(887.60)	(543.74)	(942.44)	(564.88)	(543.90)	(589.41)
Capital	197.68	113.52	216.52	116.23	113.63	119.50
[Mill.VND]	(620.52)	(230.94)	(676.30)	(236.77)	(231.02)	(243.90)
dsize	0.69	0.54	0.72	0.56	0.54	0.58
	(0.46)	(0.50)	(0.45)	(0.50)	(0.50)	(0.49)
Resource-based	0.25	0.31	0.23	0.30	0.31	0.30
	(0.43)	(0.46)	(0.42)	(0.46)	(0.46)	(0.46)
Low-tech	0.49	0.44	0.50	0.44	0.44	0.45
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Medium-tech	0.25	0.24	0.25	0.24	0.24	0.24
	(0.43)	(0.42)	(0.44)	(0.42)	(0.42)	(0.43)
High-tech	0.02	0.02	0.02	0.02	0.02	0.01
	(0.13)	(0.13)	(0.13)	(0.12)	(0.13)	(0.11)
Red River delta	0.37	0.40	0.37	0.39	0.40	0.38
	(0.48)	(0.49)	(0.48)	(0.49)	(0.49)	(0.48)
Northern Mountains	0.10	0.11	0.10	0.11	0.11	0.12
	(0.30)	(0.32)	(0.30)	(0.32)	(0.32)	(0.32)
Central Coast	0.17	0.18	0.17	0.18	0.18	0.18
	(0.37)	(0.38)	(0.37)	(0.38)	(0.38)	(0.39)
Central Highlands	0.03	0.04	0.03	0.04	0.04	0.04
	(0.17)	(0.20)	(0.16)	(0.20)	(0.20)	(0.21)
South East	0.24	0.18	0.25	0.18	0.18	0.19
	(0.42)	(0.38)	(0.43)	(0.38)	(0.38)	(0.39)
Mekong River delta	0.09	0.10	0.09	0.09	0.10	0.09
	(0.28)	(0.29)	(0.28)	(0.29)	(0.29)	(0.29)
Variables to Explain Technical Efficiency and Propensity Score						
turnover	101.04	53.83	111.60	50.39	53.89	46.00
[Bill.VND]	(282.72)	(160.03)	(302.47)	(137.13)	(160.10)	(101.00)
age	21.62	19.21	22.16	19.65	19.21	20.19
	(13.19)	(13.06)	(13.16)	(13.13)	(13.07)	(13.20)
debt	0.65	0.67	0.64	0.67	0.67	0.67
	(0.37)	(0.46)	(0.35)	(0.46)	(0.46)	(0.46)
percap income	15.16	11.68	15.94	11.76	11.69	11.84
	(19.41)	(8.22)	(21.04)	(8.04)	(8.21)	(7.83)
KLR	0.41	0.40	0.41	0.40	0.40	0.39
	(0.71)	(0.66)	(0.72)	(0.69)	(0.66)	(0.72)
Herfindahl	0.0060	0.0056	0.0061	0.0056	0.0056	0.0057
	(0.0050)	(0.0047)	(0.0051)	(0.0047)	(0.0047)	(0.0047)
spillover	0.3283	0.3397	0.3257	0.3400	0.3398	0.3402
	(0.1983)	(0.1853)	(0.2010)	(0.1921)	(0.1854)	(0.2002)

Note: Standard deviations are shown in parentheses and units are shown in brackets.

Table 4.4. Estimated Coefficients of Probit Model of Firm Exit

Type of Firms	Private Firms		State Firms	
Number of Observations	40,620		5,712	
ln(*turnover*)	-0.118	(25.05)	-0.161	(10.36)
age	-0.008	(7.64)	-0.009	(5.23)
debt	-0.147	(5.05)	0.159	(2.99)
ln(*percap_income*)	-0.059	(4.88)	-0.017	(0.37)
ln(*KLR*)	0.015	(5.24)	0.017	(1.00)
Herfindahl	-0.061	(0.04)	-3.095	(0.64)
spillover	0.262	(4.04)	0.515	(3.45)
Resource-based	0.161	(6.19)	0.309	(4.10)
Low-tech	0.013	(0.60)	0.004	(0.06)
High-tech	-0.009	(0.11)	-0.053	(0.32)
Northern Mountains	-0.104	(2.52)	-0.177	(2.45)
Central Coast	-0.075	(2.82)	-0.149	(2.46)
Central Highlands	-0.089	(1.59)	-0.042	(0.36)
South East	-0.060	(3.04)	-0.186	(3.05)
Mekong River delta	0.036	(1.56)	-0.024	(0.31)
dyear2001	0.174	(8.21)	-0.477	(7.99)
dyear2002	-0.079	(3.45)	-0.195	(3.40)
dyear2003	-0.274	(11.70)	-0.271	(4.34)
dyear2004	-0.623	(25.78)	-0.678	(9.25)
constant	0.416	(8.26)	0.968	(5.63)
log-likelihood	-20561.8		-2493.4	
pseudo R^2	0.0894		0.0828	
Correctly predicted portion for exiters	10.62%		2.87%	
Correctly predicted portion for	97.92%		99.29%	
Predicted propensity score				
All firms	0.2447	[0.1330]	0.1829	[0.1096]
Exiters	0.3198	[0.1375]	0.2488	[0.1228]
Stayers	0.2204	[0.1220]	0.1681	[0.1007]

Note: Absolute values of *t*-statistic are shown in parentheses and standard deviations are shown in brackets.

Table 4.5. Estimated Parameters of Stochastic Production Frontiers over Full and Matched Samples

Type of Firms	Private Firms				State Firms			
Type of Samples	Full Sample		Matched Sample		Full Sample		Matched Sample	
Number of Obs.	40,620		17,092		5,712		1,874	
Production Frontier								
ln L	0.887	(0.003)***	0.874	(0.005)***	0.822	(0.011)***	0.827	(0.019)***
ln K	0.041	(0.001)***	0.042	(0.002)***	0.086	(0.007)***	0.046	(0.012)***
exit	-0.050	(0.008)***	-0.012	(0.010)	-0.166	(0.023)***	-0.098	(0.030)***
dsize	0.626	(0.012)***	0.686	(0.022)***	0.656	(0.031)***	0.666	(0.050)***
Resource-based	-0.314	(0.010)***	-0.283	(0.017)***	-0.080	(0.028)**	-0.104	(0.046)**
Low-tech	-0.200	(0.009)***	-0.195	(0.015)***	0.015	(0.022)	0.042	(0.039)
High-tech	0.075	(0.032)**	0.135	(0.054)**	0.194	(0.062)***	0.021	(0.108)
Northern Mountains	-0.056	(0.020)**	-0.032	(0.033)	-0.123	(0.034)***	-0.024	(0.057)
Central Coast	0.045	(0.012)***	0.030	(0.020)	-0.050	(0.027)*	-0.024	(0.046)
Central Highlands	0.098	(0.026)***	0.061	(0.042)	-0.045	(0.055)	0.047	(0.076)
South East	0.221	(0.008)***	0.224	(0.014)***	0.330	(0.022)***	0.278	(0.040)***
Mekong River delta	0.368	(0.011)***	0.347	(0.017)***	0.229	(0.033)***	0.239	(0.054)***
dyear2001	0.026	(0.014)*	-0.015	(0.019)	0.037	(0.035)	0.020	(0.057)
dyear2002	0.079	(0.014)***	0.066	(0.021)***	0.109	(0.034)***	-0.021	(0.051)
dyear2003	0.160	(0.014)***	0.146	(0.022)***	0.212	(0.035)***	0.165	(0.057)***
dyear2004	0.100	(0.014)***	0.126	(0.024)***	0.258	(0.036)***	-0.115	(0.077)
constant	-1.866	(0.018)***	-1.944	(0.028)***	-1.462	(0.054)***	-1.407	(0.093)***
Variance Function								
dyear2001	0.187	(0.048)***	0.062	(0.065)	0.151	(0.118)	0.104	(0.186)
dyear2002	0.367	(0.053)***	0.369	(0.079)***	0.415	(0.121)***	0.041	(0.180)
dyear2003	0.575	(0.054)***	0.628	(0.088)***	0.885	(0.129)***	0.974	(0.214)***
dyear2004	0.731	(0.054)***	0.924	(0.108)***	1.373	(0.136)***	0.836	(0.305)***
dsize	1.095	(0.051)***	1.297	(0.109)***	0.848	(0.090)***	0.722	(0.145)***
age	-0.013	(0.002)***	-0.011	(0.003)***	0.001	(0.002)	0.000	(0.004)
debt	0.000	(0.001)	0.216	(0.087)**	0.609	(0.082)***	0.489	(0.121)***
percap_income	-0.454	(0.007)***	-0.561	(0.014)***	-0.287	(0.009)***	-0.373	(0.021)***
Herfindahl	-2.363	(3.376)	-11.243	(6.864)	-38.819	(9.386)***	-24.399	(15.880)
spillover	0.788	(0.109)***	0.942	(0.190)***	0.739	(0.233)***	0.230	(0.392)
constant	1.432	(0.050)***	1.590	(0.076)***	0.946	(0.147)***	1.836	(0.232)***
σ_v	0.526	(0.003)***	0.554	(0.004)***	0.497	(0.007)***	0.482	(0.013)***
log-likelihood	-38470.9		-16982.3		-5321.4		-1767.9	
LR test	39.64	[0.00]	1.42	[0.23]	49.34	[0.00]	10.98	[0.00]

Note: Standard errors appear in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively. LR test represents a likelihood ratio statistic for identical production technology between exiters and stayers, which follows a chi-squared distribution with one degree of freedom. Its p-value is shown in brackets.

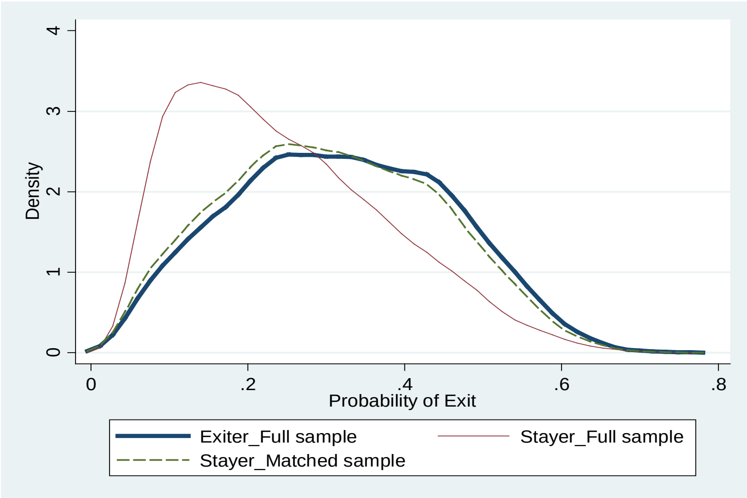
Table 4.6. Predicted Outputs and Technical Efficiency over Full and Matched Samples

Type of Samples	Full Sample						Matched Sample					
	2000	2001	2002	2003	2004	Total	2000	2001	2002	2003	2004	Total
Predicted Outputs												
Private-Firm Sample												
Exiters	8.4	9.8	13.6	16.1	14.5	12.6	4.6	4.9	6.8	8.5	9.2	6.3
Stayers	8.8	10.3	14.3	16.9	15.3	13.2	4.6	5.0	6.9	8.6	9.3	6.3
State-Firm Sample												
Exiters	85.9	95.0	113.3	145.6	159.8	117.1	65.5	64.1	60.9	90.4	65.5	68.2
Stayers	101.5	112.2	133.8	172.0	188.6	138.3	72.2	70.7	67.2	99.8	72.3	75.3
Predicted Technical Efficiency												
Private-Firm Sample												
Exiters	0.59	0.58	0.65	0.67	0.69	0.62	0.63	0.64	0.69	0.72	0.73	0.67
Stayers	0.64	0.67	0.70	0.72	0.73	0.70	0.62	0.68	0.71	0.72	0.74	0.69
State-Firm Sample												
Exiters	0.58	0.57	0.56	0.58	0.52	0.57	0.60	0.59	0.63	0.63	0.65	0.61
Stayers	0.64	0.65	0.66	0.66	0.66	0.65	0.60	0.62	0.67	0.67	0.65	0.64

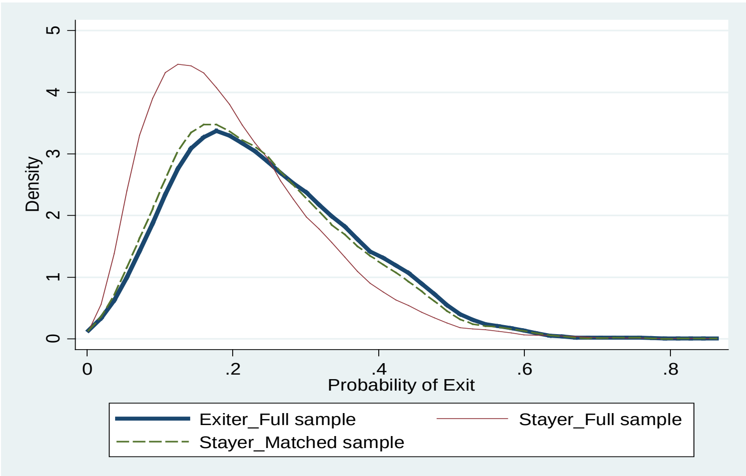
Note: Full sample is the original sample for all firms. Matched sample is that with Stayers repeatedly used in matching. Caliper width is defined as one-quarter of the standard deviation of the predicted propensity score (exit probability) for all firms in each of the corresponding full samples. Unit of predicted output is million VND.

Figure 4.1. Kernel Densities of Exit Probability for Exiters and Stayers

Private Firms



State Firms



Source: The author's calculation based on the microdata of the GSO for 2000-2004

Chapter 5: Summary of the Dissertation and Concluding Remarks

This dissertation uses individual firm-level data on the Vietnamese manufacturing sector for 2000-2005 and applies the SPF method to study productivity and firm exit of the manufacturing firms. The data constructed in the Chapter 2 actually show plausible results when we estimate the SPFs for private and state firms in the Chapter 3 and when we investigate the effects of endogenous firm exit in the SPF estimation for private and state firms in the Chapter 4.

Assuming the difference in the production technology between private and state firms, the empirical analysis in the Chapters 3 and 4 estimate separate SPFs for the two types of firms. The production elasticity of labor is very high, while that of capital is quite low for the Vietnamese manufacturing sector. The high elasticity of labor reflects a common feature of the manufacturing sector in developing countries such as Vietnam, in which most firms are small and use the labor-intensive technology. It also reflects the fact that workers in private firms put more efforts to produce output. On the other hand, the low elasticity of capital particularly for private firms reflects their difficult in maintaining machinery and equipment.

In terms of firm size, large production scale is found to be an important factor to shift the production frontiers of private and state firms upward, as expected. In other words, large private firms, as well as large state firms, have a much higher production frontier, with other things being equal. Therefore, the higher production frontier of state firms is not because they have a considerably higher share of large firms but because large state firms have a much higher production frontier than small private firms. Also, firm size positively influences the TE index for both types of firms because larger firms have such advantages as greater product differentiation.

In terms of firm ownership, the empirical analysis in the Chapters 3 and 4 shows that private firms have much lower productivity than state firms. Comparing their productivity by decomposing it into two factors, we find that production technology is much more important factor to explain the productivity difference. These private firms have lower production frontiers probably because these they face greater difficulties such as limited access to the formal financial system and few rights to utilize natural resources.

Focusing on firm exit behavior, the empirical analysis in the Chapter 4 finds that firms exiting from the market tend to have lower productivity. It actually shows that exiting firms have both a lower production frontier and lower TE than staying firms. It also finds that the importance to consider endogeneity of firm exit behavior. When we compare estimation results of the SPF models over the full and matched samples, parameters, predicted outputs, and TE index all detect some estimation bias. Therefore, the PSM method seems to effectively correct sample bias for the full sample in estimating all these measures.

These empirical results help us examine how to raise productivity of firms for further development of the Vietnamese manufacturing sector, especially productivity of private firms that capture a substantially large share in the economy. Our analyses find that current policies in Vietnam tend to favor state firms. The government introduced several policies to encourage private firms to enter the market, but these policies were insufficient for increasing their productivity, particularly in terms of their production technology. Therefore, our empirical results suggest that the government should give private firms similar rights and privileges to those of state firms, including more rights to utilize natural resources and more access to credit for long-term capital investment. These policy changes will help many small private firms in the economy and prevent the Vietnamese economy from stagnated economic development.

Finally, the empirical analysis in this dissertation still includes potential issues for future research. For example, it did not make full use of panel data information in our estimation methods, did not make a jointly estimation of the production frontier and firm exit decision, and did not provide detailed policy analysis of the effect of more foreign firms on the Vietnamese economy. These are left for the future study, which will make the empirical results in the Chapters 3 and 4 more persuasive and more robust.

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