An Empirical Analysis of the Manufacturing Sector in Vietnam during the Period 2000-2006 with a Particular Emphasis on Technical Efficiency, Trade Reforms and Workplace Injuries

LE THANH, DAO

Thesis submitted for the Degree of Doctor of Philosophy

April 2013

Department of Economics

University of Sussex

WORK NOT SUBMITTED ELSEWHERE FOR EXAMINATION

I hereby declare that this thesis has not been, and will not be, submitted in whole or in part to another University for the award of any other degree.

Signature:

UNIVERSITY OF SUSSEX

DAO LE THANH
DEGREE OF DOCTOR OF PHILOSOPHY

AN EMPIRICAL ANALYSIS OF THE MANUFACTURING SECTOR IN VIETNAM DURING THE PERIOD 2000-2006 WITH A PARTICULAR EMPHASIS ON TECHNICAL EFFICIENCY, TRADE REFORMS AND WORKPLACE INJURIES

SUMMARY

This thesis investigates empirically the manufacturing sector in Vietnam during the period 2000-2006. The main objective is to provide a comprehensive analysis on the technical performance, and workplace safety of this sector. The analysis uses the sub-dataset for the manufacturing sector extracted from the annual Vietnam Enterprise Surveys for the period under consideration.

Chapter one provides an overview of the economic renovation (commonly called *Doi moi*). The chapter reviews milestones in the *Doi moi* process and its consequences in terms of economic structural changes, trade, and investment. Chapter two describes the dataset used in the thesis and the construction of the key variables adopted in the subsequent chapters.

Chapter three estimates technical efficiency in the Vietnam's manufacturing sector. The chapter explores if, among other things, the estimates of technical efficiency obtained using the stochastic frontier approach are sensitive to the different distributional and econometric assumptions. Based on several test results, the chapter concludes that average manufacturing sector operated at 62 percent of its technical efficiency.

Chapter four investigates empirically the determinants of technical efficiency in the Vietnam's manufacturing sector using both mean and quantile regression approaches. Results suggested that types of ownership, feminization, and compliance of firms to labour market regulation are among important determinants of technical efficiency. Notably, there is a positive, albeit modest impact of trade liberalization on technical performance of the manufacturing sector and this impact is most pronounced for the least technically efficient firms.

Chapter five focuses attention on workplace injuries in the manufacturing sector. As data on workplace injuries in Vietnam is very limited, a number of experiments was tried to find the most relevant estimation strategy. The chapter finally adopts a probit model and a simple OLS to inform determinants of workplace injuries. Results suggest that types of ownership and firm size are important factors that exert influences on workplace injuries reported. Interestingly, the foreign-invested sector was found to be the worst performer compared to the domestic counterparts in terms of technical efficiency and workplace safety.

Drawing from these chapters, some policy conclusions, limitations of the current exercise, and outlines of possible agenda for future research in this area are discussed in the conclusion section.

Acknowledgements

Looking back over the time since embarking in this thesis, I'm surprised by the large number people who have offered me countless advice, suggestions, and encouragement for its completion. My biggest gratitude is to my first supervisor – Prof. Barry Reilly. He has been a remarkable academic, who has taught me more than I could imagine since I first received his email indicating that he would be interested in my research proposal. Discussions and advice from Barry have been useful at all the stages of this thesis. Secondly, I would like to express my gratitude to Prof. Andy McKay, my second supervisor, for his suggestions on a number of issues related to Vietnam. Thank you for giving of your time so freely to me, patiently reading all my drafts – of which I cannot even remember the number of versions that I have submitted to you, and your encouragement from the beginning to the end.

For the revised version of this thesis, I would like to thank for two examiners, Dr. Mike Barrow and Dr. Remco Oostendorp for their insightful comments on the issues that need further discussions and/or examination. This revision has been clearly a useful learning process for the author to complete the current study.

I would like to thank the Department of Economics at Sussex for allocating office space and facilities. I would especially like to express my gratitude to other fellow D.Phil students at the Department: Hung Pham, Jonathan Pycroft, Anirudh Shingal, Saki Tapsell, Mateo Cominetta and Malgorzata Sulimierska for sharing the office and joining me in numerous events both inside and outside the Department's corridor. Being an international student, having your presence and encouragement is really important for me to overcome my homesickness. I have also learnt a lot from your knowledge and from your own countries. This is truly an international and stimulating research environment that I expected before coming to Sussex.

Outside the Department of Economics at Sussex, there are a number of people who have also offered invaluable comments and suggestions. Particularly, I would like to thank Mr. Nguyen Bich Lam, Mr. Nguyen Duc Thuy and his staff at the Department for Industrial Statistics of the General Statistics Office who have provided a lot of useful discussions on the dataset used for the current research. This is extremely helpful given the surveys are not well documented. I am grateful to the National Economics University in Hanoi for allowing me to take leave for my D.Phil study, and my colleagues at the International School for Economics and Management who have shared my workload during the period I have pursued my research. Particularly, I would like to thank Prof. Bui Anh Tuan and Dr. Nguyen Thi Thanh Huong and the team for their constant encouragement for me to complete my research. This research is supported by the Ministry of Education and Training and Ministry of Finance in Vietnam. Special thanks go to the General Statistics Office and the Ministry of Trade and Industry for the access to the enterprise database and tariff data used in this thesis.

Finally, pursuing my D.Phil research for such a long time is really tough for me as an international student. Fortunately, my mother and my family were always behind me to keep me focused and strong. I would like to dedicate this thesis to all of them for their constant and tireless support and encouragement.

Le Thanh DAO

Table of Contents

List of Figures

Introduction

During the economic renovation process, which is commonly called *Doi moi*, Vietnam has transformed dramatically from a largely agrarian economy with an agricultural sector accounting for nearly 40 percent of GDP in the early 1990s to an economy with the manufacturing sector assuming a more significant role. The sector has registered an annual growth of around ten percent in the period 1990-2007. This sector now accounts for nearly 42 percent of GDP and a half of total exports. The rapid growth of manufacturing output and exports is associated with an impressive growth in the number of establishments at 16 percent per annum since 2000. Since that year, employment in the manufacturing sector has grown at an annual rate of 14 percent. Though the sector has become an increasingly important component of the economy, there is limited, albeit growing, research on the country's manufacturing sector. The purpose of this thesis is to partly fill this gap by examining empirically technical efficiency and, and as a secondary theme, workplace injuries in Vietnam's manufacturing sector.

The thesis draws mainly on three strands of the literature. The first strand relates to technical efficiency. Following the pioneering work of Farrell (1957), a number of techniques have been developed to measure technical efficiency, including both parametric (Aigner and Chu, 1968; Aigner, Lovell and Schmidt, 1977; Meeusen and van den Broeck, 1977) and non-parametric approaches (Charnes *et al.* 1978). Murillo-Zamarano (2004) argues that "[…] neither goal programming models (i.e. DEA) nor deterministic econometric approaches provide accurate measures of the productive structure" (p. 48). In this regard, the stochastic frontier models are preferred and indeed this approach has become the most popular and widely used parametric approach in the measurement of technical efficiency in the applied economics literature (Kalirajan and Shand, 1999; Coelli *et al.* 2005). In this context, the thesis adopts the stochastic frontier approach – as one of the parametric techniques – to estimate the technical efficiency for enterprises in the manufacturing sector of Vietnam.

The second strand of the literature adopted on this thesis is linked to sub-strand of the literature on trade reforms and economic performance. Under this sub-strand, the proponents of free trade argue that trade liberalization can increase overall domestic productivity (Epifani, 2003; Topalova, 2004; Melitz, 2003; Aghion *et al.* 2003). However, whether domestic producers can take advantage of increased access to foreign know-how remains questionable. Trade liberalization has certainly its own costs. Some even argue that trade liberalization in developing economies may have a detrimental effect on growth (Young, 1991; Rodrik, 1992; Stiglitz, 2002; Baldwin and Robert-Nicoud, 2006). Given this ambiguous picture of the impact of trade liberalization on firm performance, both theoretically and empirically, there is an obvious need for further country-specific studies (Hahn, 2004). In this regard, this thesis provides a empirical analysis on the potential impacts of the trade reforms and technical efficiency of the manufacturing sector in Vietnam.

The third and final strand concerns the literature on workplace injuries. Workplace safety represents a growing issue in business operation management (Kaminski, 2001). Brown (1996) notes "[…] in spite of the increasing importance of this topic, and in spite of its relevance to research issues in our field, it (workplace safety) has been almost completely absent from the literature" (p.157). Most of the recent push towards improved workplace safety has been motivated by cost reduction goals, regulatory pressures, and a growing acceptance of social responsibility or corporate codes of conduct that incorporates the responsibility of creating decent working conditions for employees. This thesis takes the view that workplace injuries are associated with both the characteristics of the work environment and work practices (Harell, 1990; Sherry, 1991; Brown, 1996) and certain characteristics of the individuals (Dahlback, 1991; Sutherland and Cooper, 1991). Based on this literature, the thesis examines empirically the determinants of workplace injuries reported in the manufacturing sector of Vietnam.

Drawing from on these strands of the economics literature, this thesis represents a number of novel contributions. Firstly, compared to the previous studies on technical efficiency in Vietnam (Nguyen *et al.* 2002; Vu, 2003; Hoang *et al.* 2008), this is the first comprehensive and nationally representative study on technical efficiency of Vietnam's manufacturing sector. Being well aware of the fact that technical efficiency estimates could be sensitive to different assumptions regarding the structure of production, the distributions of the technical efficiency and the presence of heteroscedasticity, the current research is among a limited number of studies that performed a set of several statistical tests to verify the most appropriate assumptions governing empirical estimation. Based on the analysis, the thesis reported that the manufacturing sector is operating at 62 percent of its technical efficiency. The estimated technical efficiency is compatible with those reported for some other transitional economies such as Bulgaria (Jones et al., 1998), Czechoslovakia and Hungary (Brada et al., 1997), and the former Soviet Union (Brock, 1999). The average technical efficiency level of 62 percent obtained from the cross-sectional analysis is considerably lower than the level of nearly 84 percent obtained from the limited panel of 5880 firms across the period 2001-2006. In addition, it is also found that the SOEs have outperformed private (both domestic and foreign) manufacturing firms and this could be considered as supportive evidence for the SOE reform process. It challenges the common understanding that foreign-invested firms are the efficiency flagships in the business sector of Vietnam.

Secondly, the thesis reports a positive, albeit modest, impact of trade liberalization on technical performance of the Vietnam's manufacturing sector. This effect proved to be generally insensitive to the use of some other measures for trade openness adopted in this research. The finding represents additional evidence to support a positive linkage between trade liberalization and firm performance to the current literature on the impact of trade liberalization on firm performance in a developing country. More interestingly, the trade effect of technical performance tends to decrease with the movement up the conditional distribution of technical efficiency and the same tendency is found for the effect of export orientation. It suggests that trade liberalization could be most beneficial for the least technically efficient firm. In addition, it is also found a relative advantage of SOEs and domestic private firms over foreign-invested counterparts in terms of technical efficiency. Interestingly, these relative advantages decrease with a movement along the conditional technical efficiency distribution. This suggests that firms at the top end of the distribution tend to converge in technical efficiency regardless of the type of ownership structure.

Finally, the thesis is arguably the first empirical study on workplace injuries in the manufacturing sector of Vietnam. Using limited data available on workplace injuries, the research shows an increasing tendency, albeit unstable across time, of workplace injuries in the manufacturing sector over the period under consideration. Notably, foreign-invested firms are reported to perform worse in terms of ensuring workplace safety. Combined with the earlier results, this could be taken to suggest these foreign-invested forms are the poorest performers in terms of technical efficiency and workplace safety. The study also finds a strong and positive relationship between firm size and workplace injuries. In addition, being in the Southeast of Vietnam, especially in Ho Chi Minh City (HCMC), exerts a negative *ceteris paribus* impact on workplace injuries reported in the manufacturing sector.

The thesis is structured into five chapters. The first two chapters provide a background for the empirical analysis of the thesis. Chapter one reviews the *Doi moi* process and major outcomes in the period 1990-2007. After reviewing the milestones of the *Doi moi*, the chapter focuses on some important structural changes that have occurred in the economy. It emphasizes the increasingly important role of manufacturing activities and the development of the vibrant private sector. Chapter two describes the dataset employed for the empirical analysis. This thesis exploits the data available from the annual Vietnam Enterprise Survey (VES) conducted by General Statistics Office (GSO) between 2001 and 2007. As each VES was conducted to collect information on firm performance one year prior to the survey time, these VESs provide information on the firm surveyed in the period 2000-2006. This thesis is amongst a few research projects that have been granted a partial access to the manufacturing sector of the VES database. Nonetheless, this access is sufficient to pursue empirical investigation of the current research.

Chapter three estimates technical efficiency in Vietnam's manufacturing sector. The chapter explores if, among other things, the estimates of technical efficiency obtained using the stochastic frontier approach are sensitive to the different distributional and econometric assumptions made regarding the errors governing the underlying production process. Before estimating technical efficiency, a set of statistical tests is performed to verify the most appropriate assumptions for empirical estimation. The thesis finally elects to use a translog production function assuming error terms for both the production and efficiency equations are heteroscedastic. For the distribution of technical efficiency terms, an exponential distribution is found to be most appropriate for the data in 2000-02 and 2004, while the truncated normal distribution is favoured for the remaining three years. Based on these test results, the chapter provides estimates of technical efficiency in the manufacturing sector for the period 2000-2006.

Using the estimates of technical efficiency obtained from chapter three, chapter four investigates empirically the determinants of technical efficiency in Vietnam's manufacturing sector. Acknowledging the non-normality of the technical efficiency estimation, the thesis pursues both mean and quantile regression to examine empirically the determinants of technical efficiency. To provide better inferences to differences in technical efficiency of firms across regions and sub-sectors, the chapter also adopts the approach introduced by Haisken-DeNew and Schmidt (1997), which generalizes the conventional method developed by Krueger and Summers (1988). While examining the determinants of technical efficiency, a focus of this chapter is placed on examining how the trade reform process has affected the technical performance of the manufacturing sector. Taking the advice of Edwards (1997) and Winters *et al.* (2002), all data available was explored to construct different proxies for trade openness in order to test whether the estimated results on the potential trade impact are robust to different trade measures. As a result, tariff is first adopted to capture the trade reform. It is then replaced by export ratio and import penetration calculated from the only SAM available for the period under consideration, which is the SAM 2000.

Chapter five focuses on workplace injuries in the manufacturing sector. As data on workplace injuries in Vietnam are very limited, a number of experiments was tried to find the most relevant estimation strategy. While it is not unreasonable to suspect the selection bias or the excess-zero generating mechanism is important processes at work here, these potential problems were not tackled satisfactorily in this chapter due to data constraints. As we could not find appropriate instruments to control for the above potential problems, the chapter adopts a probit model to examine the determinants of the probability of having injuries reported and a simple OLS to investigate the determinants of workplace injuries. The adaptation of these two methods might not be entirely satisfactory but given data constraints encountered in the current research, these are probably the only likely approaches to inform, for the first time, workplace injuries in the manufacturing of Vietnam. A secondary focus of this chapter is to examine where there is any link between the country’s trade reforms and workplace injuries but the estimated results, however, proved inconclusive.

Given this, the thesis provides a number of conclusions. (i) The increasingly important manufacturing sector of Vietnam in the post *Doi moi* era operated at 62 percent of its technical efficiency. (ii) Types of ownership, feminization, and compliance of firms to labour market regulations (proxied by proportion of workers with a contract) are among the important determinants of technical efficiency in the Vietnamese manufacturing sector. (iii) There is a positive, though modest, impact of trade liberalization on technical performance of Vietnam's manufacturing sector and this impact is most pronounced for the least technically efficient firms. (iv) Types of ownership and firm size are important factors that exert influences on workplace injuries reported in the manufacturing sector. (v) The foreign-invested sector was found to be the worst performer compared to the domestic counterparts in terms of both technical efficiency and workplace safety.

The current study also signals a future research agenda. First, other measures of efficiency should be explored to provide a complete story on efficiency of the manufacturing sector of Vietnam. In pursuing this direction, other approaches, in addition to the stochastic frontier approach, should be considered. Second, further research on efficiency in the panel framework will be useful to inform the movement of efficiency frontier over time – which is potentially an important issue in the recent economic reform process of Vietnam. Third, the relationship between trade reforms and technical performance of the manufacturing sector is also an area of future study. Finally, though the current thesis provides some interesting findings on workplace injuries in Vietnam over the period governing the country's recent impressive industrial growth, this area of research is largely under-documented. However, it should be noted that feasibility of this research agenda largely depends on future improvements in data availability for the manufacturing sector. This study suggests a necessity to improve the quality of the VES in general and particularly in regard to workplace injuries.

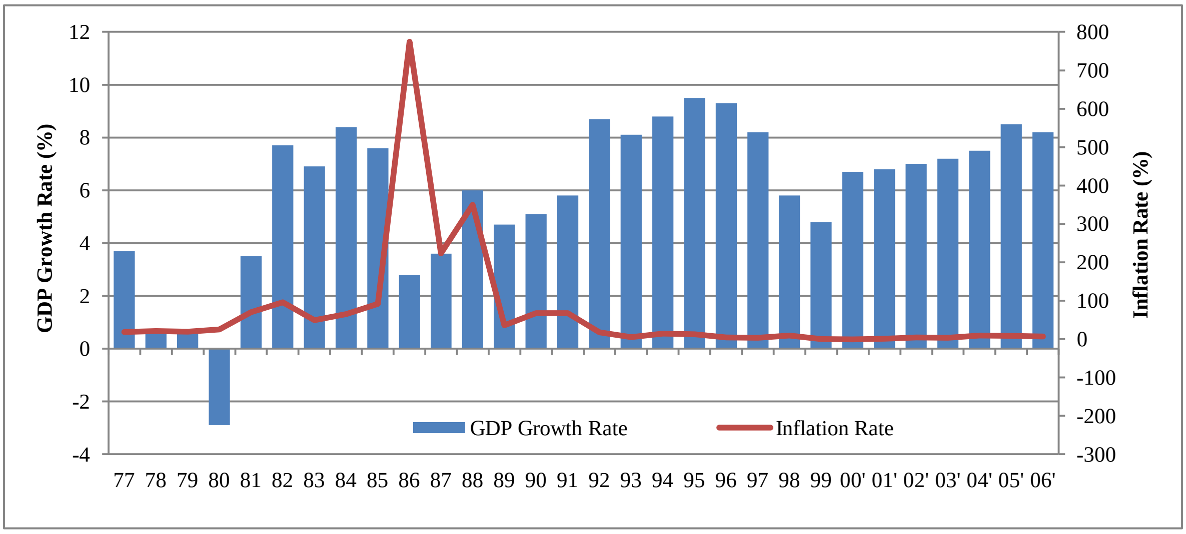
Chapter 1: Vietnam Country Background

After the reunification in 1975, Vietnam shifted its focus to reconstruction and socio-economic development. The subsequent failure in terms of achieving even modest economic growth was assumed attributable to the centrally planning model. This failure forced Vietnam to undertake certain reforms in the early 1980s. However, only the *Doi moi* (i.e. Renovation) in 1986 and especially the radical market-oriented reforms of 1989 marked a turning point in Vietnam's economic history (World Bank, 1998). Success in managing that transition process has put Vietnam into the top two or three performers in the developing world (Glewwe, Agrawal and Dollar, 2004). To contextualize the empirical analysis of this thesis, the first chapter summarizes the *Doi moi* process in Vietnam in the first section. The second section outlines some key consequences of the *Doi moi*. The scope of data covered in this chapter will be mainly between 1990 and 2007, which is the period subject to the empirical analysis in the subsequent chapters.

1.1 Overview of the Doi moi

The economic development in Vietnam after the reunification in 1975 can be characterized by three major periods (Figure 1.1). Prior to the 1980s, Vietnam's economy was essentially a centrally planned economy. Between 1980 and 1988, the failure of the centrally planned system had become apparent. The Government of Vietnam tried to create incentives in agriculture and state-owned enterprises (SOEs) through some microeconomic reforms. These initiatives, usually described as the so-called 'fence-breaking' and 'bottom-up measures', had some success in the early 1980s. But the initial measures were not sufficient to address the fundamental problem of resource misallocation. The resultant economic recession was so severe that the official launch of the *Doi moi* was sometimes referred as a 'survival' strategy (CPV, 2001). From 1989 onwards, the economy has been an economy in transition, striving for industrialization and international integration.

Figure 1.1 Main Stages of the *Doi Moi* in Vietnam



Before the 1980s: Centrally planning economy	**During 1980-88:** Crisis of centrally planning mechanisms; 'fence-breaking' initiatives	**Since 1989: Market-oriented reforms**		
		Up to 1996: Strong market reforms	**In 1997-99**: Asian crisis; Reform slowdown	**Since 2000**: Further commitments to reforms

Source: GSO Statistical Yearbook (various years)

Before the 1980s: Centrally planned economy

The economy was essentially a centrally planned one at a low development level. Major characteristics of the economy included: (i) state or collective ownership of the means of production; (ii) the Government administered supply of input and distribution of output; (iii) lack of autonomy for enterprises, absence of factor markets, highly regulated goods and services markets; and (iv) investment biases toward heavy industries, which were overwhelmingly dependent on external resources (CIEM, 2002). Vietnam was relatively autarkic with trade relationships mostly with the other former socialist countries. As a result, the economy was heavily distorted in resource allocation with poor incentives and restricted information flows. By the end of the 1970s, the failure of the centrally planned system started to become increasingly apparent. Economic recession was evident and the economy suffered from a serious shortage of consumer goods as well as input for centrally planned production, and thus pressure for economic management changes increased substantially.

During the period 1980-88: 'fence-breaking' measures

The centrally planned economy was steadily modified to respond to the depletion of the economy. Some microeconomic reforms were introduced in the early 1980s to recognize 'spontaneous' and bottom-up measures. 'Illicit contracting' in agriculture is an example where farmers were not necessarily selling all their output to collectives. Instead, they were assigned output targets and as long as these targets were completed, the households were free to decide the usage of the remaining output. 'Fence breaking' in the manufacturing sector is another example where enterprises were allowed to decide on what they were going to do after completing the plans imposed by the authorities and use the revenue from these extra activities to compensate for their workers. These micro-level reforms enhanced voluntary and decentralized interactions between economic agents and created new incentives for producers and farmers in raising outputs during the period 1982-85. The economy became more dynamic and, as a result, Vietnam enjoyed a relatively high rate of economic growth in the first half of the 1980s.

However, that resultant growth was not sustainable and tended to decline quickly as the consequences of macroeconomic imbalances such as excessive demand for consumption goods and large fiscal deficits emerged, and more importantly misallocation of resources. In attempts to reverse the situation, the financial reforms implemented in 1985 changed the currency to new Vietnam Dong notes which appreciated tenfold. But this 'price-wage-money' reform failed as it was introduced without addressing the fundamental problems of resource misallocation and macroeconomic imbalances. As a result, the inflation rate accelerated to several hundred percent (see figure 1.1) and the economy was in crisis by the mid-1980s. This provided an important push for the *Doi moi*.

Since 1989: market-oriented reforms

The year of 1986 marked the Vietnam Communist Party's Sixth Plenum that recognized the existence and the essential role of a multi-ownership economic structure in Vietnam's economy. However, significant changes in this direction occurred only sometimes after the approval of the *Doi moi*. In March of 1989, Vietnam adopted a radical and comprehensive reform package aimed at stabilizing and opening the economy, and enhancing freedom of choice for economic agents and competition so as to change fundamentally its economic management system. The reform package included:

- Almost complete price liberalization with state control retained on some important and strategic goods;
- Devaluation and unification (i.e. between the official and black market rates) of the exchange rates;
- Increases in nominal interest rates to ensure positive real interests;
- Substantial reduction in subsidies to the SOE sector, which signaled the end of subsidies and 'cheap' credit for SOEs, and increased the autonomy for SOEs;
- Agricultural reforms through the replacement of collectives by households as the basic decision-making unit in agricultural production and security of land tenure for farmers;
- Encouragement of the private sector and promulgation of the Law in Foreign Investment;
- Removal of domestic trade barriers and diversifying trade relation to other countries rather than only focusing on the (former) socialist countries.

The economy responded positively to the reforms, which motivated creativeness and entrepreneurship in generating job and income for individuals and their families. Macroeconomic stabilization was successful in conjunction with price liberalization, changes in interest rate and exchange rate policies and at the same time, the relief of the fiscal deficit burden. Inflation was put under control at the beginning of the 1990s. This economic stabilization laid important background for further reforms to take place during the 1990s. To further strengthen the private sector, the Law on Private Enterprises and Company Law was approved in 1991. The private sector, including both domestic private firms and household businesses, became a major source for employment in the economy. Rapid growth in services and construction during the 1990s mainly came from the quick response of private entrepreneurs. Nearly two million newly established household businesses in urban areas helped to enhance the performance of the economy and considerably improve the retail sales and service network (CIEM, 2002).

The Order No. 100 in early 1981 and the Resolutions No.10 in 1988 of the Politics Bureau are the two cornerstones of the widespread agricultural evolution in Vietnam. These two Resolutions recognized and legalized agricultural activities that take place outside the scope of collectives in rural Vietnam. Land as the most important physical assets in the rural areas were subject to important reforms. Long-term land use right provided by a new Land Law in 1987 and Amended Land Law in 1993 created strong incentives for about ten million farming households to make long-term investment and expand agricultural production (Ravallion and Van De Walle, 2006). By the middle of the 1990s, there were very few co-operatives left from the high-tide of decollectivization (Fforde and Huan, 2001). Those surviving co-operatives were transformed from agricultural production activities into agriculture-related services. Rural households became major economic units in rural Vietnam. The most significant outcome of these reforms was to 'convert' Vietnam from a country that constantly suffered from a lack of food into one of the world's leading rice exporters with food security ensured.

In attempts to make the SOE sector viable, the Government substantially reduced subsidies, diminished "cheap" credit to these enterprises and given them greater autonomy.

Inefficient and money-losing enterprises were liquidated or equitized. In the first half of the 1990s, the number of SOEs fell from more than 12,000 to 6,300 enterprises, with 1.5 million SOE workers (out of about four millions SOE workers) made redundant (World Bank, 1998). To facilitate the business sector, the Government also introduced reforms in the banking system. The mono-banking system was replaced by a two-tier one, which functioned from1990, when the Law on Banking authorized the State Bank of Viet Nam to assume traditional central bank functions (i.e. the conduct of the monetary policy and supervision of the financial system). Sectoral restrictions on the specialized banking activities and entry barriers were also abolished. In addition to the five state-owned commercial banks (SOCBs), a number of joint-stock banks, credit co-operatives/funds, joint-venture banks and representative offices of foreign banks became in operation.

The collapse of the socialist block in the former Soviet Union and Eastern Europe in the late 1980 transmitted into the loss of traditional trade partners of Vietnam. In response, Vietnam substantially liberalized its trade and investment policies in the early 1990s. Vietnam’s first tariff law, the Law on Import and Export Duties, was issued in December 1991 and became effective in March 1992. Since 1990, state monopoly on foreign trade was removed and participation of other business entities of other ownership types was allowed. The Decree 57 dated July 1998 was a cornerstone that removed licensing requirements for participation in international trade transactions. In addition, the country has become a member of the Association of South East Asian Nations (ASEAN) since June 1995 and the Asia Pacific Economic Co-operation (APEC) since 1998, which were important milestones in Vietnam’s integration process.

Despite broad and fast liberalization, certain restrictions remained, for instance in the areas of foreign trade and market entry. The reforms of SOEs and the financial sector have been limited and/or not implemented as quickly as expected to keep pace with economic development. There were concerns on an unlevel playing field for different economic actors with the private sector seen as being at a disadvantage. The 1997-98 Asian financial crisis represented a serious (and possibly the first) challenge to the 'open door' policy of the *Doi moi*. Though Vietnam was not hit as seriously as the other neighboring countries such as Thailand or Indonesia, this did raise a concern as to the degree of liberalized reforms in terms of their effects on trade and investment. As a consequence, Vietnam was reluctant to undertake further reforms during this crisis period. There was doubt that the *Doi moi* had lost its momentum created by the earlier one-off measures and further reforms would be needed to sustain economic growth (World Bank, 1998).

Since the year 2000, the *Doi moi* gained new momentum with a number of bold policy reforms started by the promulgation of the Enterprise Law, which brought all laws for different types of enterprises together for the first time. During the period 2000 – 2004, about 90,000 private enterprises were registered under the new Law with a total capital equivalent to about USD 13 billion. This figure was much higher than foreign direct investment (FDI) during the same period and five times higher than that of the private enterprises established during 1991-99. The pace of reforms of SOEs was also subject to further moves. In the period 2003-2005, 3000 SOEs from a total of about 5,000 SOEs were scheduled to restructure, of which 1459 SOEs were restructured in 2003 (World Bank, 2005). The Government explicitly informed further commitments to adapt a 'new round' of the reform process. This was reflected in Socio-Economic Development Strategy 2001-2010 (CPV, 2001), and the Comprehensive Growth and Poverty Reduction Strategy (CGPRS) (SRV, 2003), and also in the Five Year Plan for Socio-Economic Development 2001-2005 (MPI, 2003).

A trade policy roadmap for the period 2001-05 (Decision 46/2001/QD-TTg in April 2001) was announced in replacement for the earlier practice of announcing one-year management regimes, making a more transparent and predictable export-import environment. The international economic integration process has been stepped up. Vietnam has mostly fulfilled its commitments under ASEAN Free Trade Area (AFTA) (Athukorala, 2005). The Vietnam - US Bilateral Trade Agreement (BTA) signed in July 2000 and came into effect in December 2001 covers commitments across a wide range of issues which are in conformity with WTO norms such as trading rights, tariffs, quantitative restrictions, intellectual property rights, liberalization in some service sectors, trade-related investment measures, and transparency. More importantly, the Government decided to speed up the process of WTO accession with the aim to join WTO by the end of 2005.

The *Doi moi* launched in 1986 and especially the market-oriented reforms of 1989 marked a turning point in the history of Vietnam's economic development. Vietnam escaped from the crisis in the mid-1980s and the face of Vietnam's economy and society has changed significantly. Successful economic development has resulted in an overall improvement of people's welfare and significant poverty reduction irrespective of measurement methods. Between 1993 and 2006, Vietnam's national poverty headcount fell from 58 to 16 percent, while educational enrolment, life expectancy and other measures of human development also increased dramatically (VASS, 2007; World Bank, 2007). There has been a significant increase in Vietnam's human development index (HDI) (from 0.623 in 1994 to 0.688 in 2001, and correspondingly, the Vietnam's rank has been improved from 121 to 109 in the World Human Development Ranks) (UNDP, 2001). The subsequent section will cover major outcomes of the *Doi moi* with a focus on the development of the business sector during this vigorous transformation period.

1.2 Some Major Outcomes of the Doi moi

The *Doi moi* in Vietnam is generally viewed as a great success story in the developing world. Between 1990 and 2007, the economy has experienced an average annual growth rate of 7.4 percent, while other macroeconomic indicators, including inflation and the budget deficit were kept stable (see figure 1.1). High inflation during the 1980 was curbed to two-digit level in the early 1990s and has been under ten percent since 1996. The budget deficit was high in the first half of 1990s but was then controlled to lower than ten percent of GDP since 1998 and has been at a very low level in recent years. This section will focus on the main outcomes of the *Doi moi* in terms of economic structural changes, trade and investment.

1.2.1 Economic Structural Changes

Vietnam has transformed dramatically from a largely agrarian economy (with an agricultural sector accounting for nearly 40 percent of GDP in the early 1990s) to an economy with the manufacturing sector assuming a more significant role (see table 1.1). Particularly, the share of the manufacturing sector in total GDP increased from 23 percent in 1990 to 36.7 percent in 2000 and to nearly 42 percent in 2007. As the share of the services sector in GDP has been stable at around 38 percent, the increase in the contribution of the industry sector was due to the diminishing relative role of agriculture in GDP. Such significant restructuring was obtained through the rapid industrial growth experienced during the *Doi moi.* Over the past 18 years (i.e. from 1990 to 2007), the manufacturing sector has registered an annual growth rate of nearly ten percent, compared to 7.2 and 3.8 percent for the services and agricultural sectors, respectively.

The structural changes in GDP are also associated with changes in the structure of employment. Accounting for 38 percent of GDP, agriculture created 75 percent of the total employment in the early 1990s. The employment share of agriculture has steadily decreased from that to the recent level of 55 percent in 2007. In absolute terms, it is noted that employment in agriculture was stable between 1997 and 2004, and started decreasing since 2005. In contrast, the absolute number of workers employed in industries and services has increased rapidly over time. On average, the manufacturing sector has exhibited an employment growth of 7.4 percent in the period 1995-2007, while the corresponding figure for the services sector was 7.7 percent.

Table 1.1 Macroeconomic Indicators of Vietnam during the *Doi moi*, 1990-2007

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Basic macroeconomic indicators														
GDP (1994 prices, trillion VND)	131.97	195.57	213.83	231.26	244.60	256.27	273.67	292.54	313.25	336.24	362.44	393.03	425.37	461.44
VND/US$ nominal exchange rate [*]	na.	11,029	11,016	11,705	13,393	14,017	14,155	14,786	15,244	15,475	15,704	15,819	15,965	16,076
Inflation rate (%)	67.10	12.70	4.55	3.63	9.20	0.10	-0.60	0.80	4.00	3.00	9.50	8.4	7.0	8.3
Budget deficit (as % of GDP)	-5.95	-12.54	-13.97	-19.09	-9.23	-7.99	-0.29	-2.96	-2.52	-2.41	-2.02	-1.67	-0.6	-0.4
Economic growth (%)														
GDP growth rate, in which:	5.09	9.54	9.34	8.15	5.76	4.77	6.79	6.89	7.08	7.34	7.79	8.44	8.23	8.48
− Agriculture	1.00	4.80	4.40	4.33	3.53	5.23	4.63	2.98	4.17	3.62	4.36	4.02	3.69	3.40
− Manufacturing[**]	2.27	13.60	14.46	12.62	8.33	7.68	10.07	10.39	9.48	10.48	10.22	10.69	10.38	10.60
− Services	10.19	9.83	8.80	7.14	5.08	2.25	5.32	6.10	6.54	6.45	7.26	8.48	8.29	8.68
GDP Structure by Sectors (%)														
− Agriculture	38.74	27.18	27.76	25.77	25.78	25.43	24.53	23.24	23.03	22.54	21.81	20.97	20.40	20.30
− Manufacturing	22.67	28.76	29.73	32.08	32.49	34.49	36.73	38.13	38.49	39.47	40.21	41.02	41.54	41.58
− Services	38.59	44.06	42.51	42.15	41.73	40.07	38.73	38.63	38.48	37.99	37.98	38.01	38.06	38.12
GDP Structure by Ownership (%)[***]														
− State sector	32.50	40.18	39.93	40.48	40.00	38.74	38.52	38.40	38.38	39.08	39.10	38.40	37.39	36.43
− Collectives		10.06	10.02	8.91	8.90	8.84	8.58	8.06	7.99	7.49	7.09	6.82	6.53	6.19
− Private sector	67.50	7.44	7.40	7.21	7.24	7.25	7.31	7.95	8.30	8.23	8.49	8.89	9.41	10.11
− Household sector		36.02	35.25	34.32	33.82	32.93	32.31	31.84	31.57	30.73	30.19	29.91	29.69	29.61
− Foreign investment sector		6.30	7.39	9.07	10.03	12.24	13.27	13.76	13.76	14.47	15.13	15.99	16.98	17.66

Source: calculations from GSO Statistical Yearbook 1996, 2000, 2006 and 2008.

Notes: [*] These are average exchange rates over a 12-month period; [**] Due to statistical aggregation by GSO, "manufacturing" in this table refers to manufacturing, mining and construction.; [***] Before 1995, no disaggregate breakdown was available for the non-state sector and it is thus not possible to separate collectives, private sector, household sector, and foreign-invested sector from the 'umbrella' of a broadly defined non-state sector.

Table 1.2 Structure of Employment in Vietnam, 1990-2006

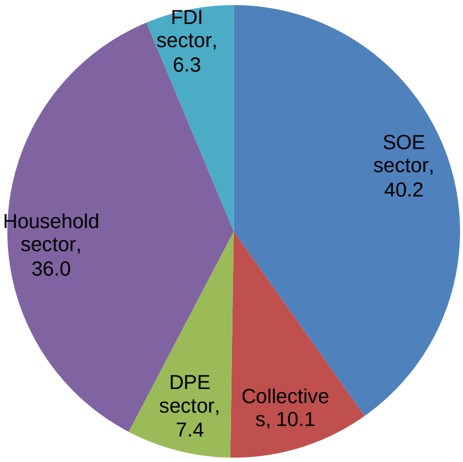
		1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total employment															
Employment:	*- Total (thousand)*	28,623	32,188	32,905	33,622	34,346	35,072	37,610	38,563	39,508	40,574	41,586	42,527	43,339	44,174
Urban unemployment (%)		na.	na.	5.88	6.01	6.85	6.74	6.42	6.28	6.01	5.78	5.60	5.31	4.82	4.64
Employment by sector															
Agriculture:	*- Total (thousand)*	21,476	23,535	23,874	24,196	24,504	24,792	24,481	24,468	24,456	24,443	24,431	24,282	23,994	23,811
	- Proportion (%)	75.03	73.12	72.56	71.97	71.35	70.69	65.09	63.45	61.90	60.24	58.75	57.10	55.36	53.90
Manufacturing:	*- Total (thousand)*	3,306	3,756	3,888	4,021	4,157	4,300	4,930	5,552	6,085	6,671	7,217	7,739	8,334	8,824
	- Proportion (%)	11.55	11.67	11.82	11.96	12.10	12.26	13.11	14.40	15.40	16.44	17.35	18.20	19.23	19.98
Services:	*- Total (thousand)*	3,841	4,898	5,143	5,405	5,685	5,980	8,199	8,542	8,967	9,460	9,939	10,506	11,011	11,539
	- Proportion (%)	13.42	15.22	15.63	16.08	16.55	17.05	21.80	22.15	22.70	23.32	23.90	24.70	25.41	26.12
Employment by ownership															
State sector:	*- Total (thousand)*	2,626	2,211	2,281	2,396	2,496	2,530	3,501	3,604	3,751	4,035	4,142	4,039	3,959	3,985
	- Proportion (%)	9.17	6.87	6.93	7.13	7.27	7.21	9.28	9.34	9.49	9.95	9.96	9.50	9.13	9.02
Non-state:	*- Total (thousand)*	25,997	29,838	30,450	30,976	31,569	32,253	33,882	34,597	35,318	36,019	36,814	37,355	38,057	38,627
	- Proportion (%)	90.83	92.70	92.54	92.13	91.91	91.96	89.80	89.72	89.39	88.77	88.52	87.84	87.81	87.44
FDI sector:	*- Total (thousand)*	-	140	173	250	281	290	349	362	440	520	631	1,133	1,323	1,562
	- Proportion (%)	-	0.43	0.53	0.74	0.82	0.83	0.92	0.94	1.11	1.28	1.52	2.66	3.05	3.54

Source: compiled from GSO Statistical Yearbooks (1995, 2000, 2006, and 2008).

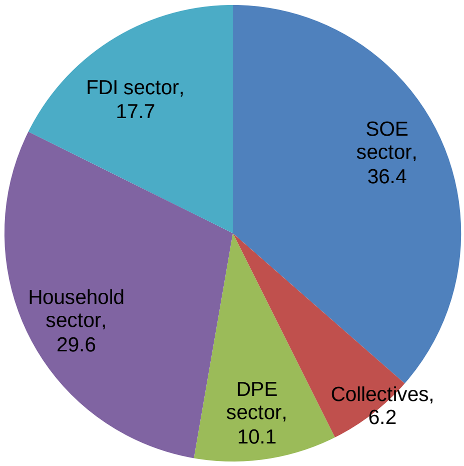
Note: Data on annual unemployment is not available from official statistics of GSO.

Legislative reforms in the business environment during the *Doi moi* have resulted in important changes in terms of economic ownership. Table 1.2 suggests a steady decline in the share of the SOE sector, collectives, and household sector while the shares of the FDI sector and domestic private sector have increased over time. Figure 1.2 describes this structural change by comparing 1995 and 2007 data. Further analysis on the FDI sector will be covered in the subsequent section. The remainder of this section will focus on the economic contribution of the SOE, domestic private sector, and household businesses over time.

Figure 1.2 Economic Structures by Types of Ownership, 1995- 2007



(a) Economic structure in 1995



(a) Economic structure in 2007

The SOE sector has been confirmed by several Party Congresses as the most important sector in Vietnam's economy. This role has a historical root which is based on the belief that developing SOEs (as in the former Soviet Union) was the quickest way of growth after the re-unification. Accordingly, the SOE sector has received investment through the five-year plan mechanism for several years until this trend was re-considered by the *Doi moi*. In 1991, SOEs deemed inefficient or lacking capital and technology or not having sufficient demand for their products were forced to dissolve or merge with other units. As a result, the number of SOEs had been reduced to 6,310 in 1995, or roughly half those in operation in the early 1990 (see figure A1.1 in the Appendix). In 1995, the Law on SOEs was enacted. This Law provided SOEs with the right to do business freely with each other and with nonstate enterprises; to hire and fire employees and set wages, within policy guidelines. The next stage in the transformation of SOEs was organized around the so-called ownership transformation process, the most important part of which is known as 'equitization'.[1] The equitization process started very slowly, with only about 100 SOEs equitized in 1998. It doubled inspeed over subsequent years, and accelerated in 2003. At the present, ownership transformation affects some 500 SOEs every year. Figure A1.1 shows the declining trend in the number of SOEs at the rate of nearly 10 percent per annum in the period 2000-2007.

In association with the SOE reform agenda, the share of the SOE sector has declined from 40 percent to 37 percent in the period 1995-2006 (figure 1.2) but remains the most important business sector in Vietnam. In terms of industrial output, the share of the SOE sector has also decreased from nearly one-half to around 38 percent between 1997 and 2005 (GSO Statistical Yearbook 2000, 2008). Although accounting for more than one-third of the total industrial output, SOEs have however created less than 10 percent of total employment (table 1.2). Because of political patronage, SOEs are frequently exposed to conflicting interests, including those of the authorities, their managers and employees. In many cases, SOEs are supposed to pursue not only profits but also a broader set of social objectives that reflect the interests of their stakeholders. This represents a considerable obstacle to the pursuit of healthy corporate governance. Political patronage inherent in the links to the authorities has allowed SOEs to secure more favourable access to credit or land than enterprises within the private sector. In addition, it has been argued that SOEs are among the major beneficiaries of the protection provided by tariffs and other barriers to international competition. Therefore, the profitability of this sector would be substantially lower if these costs were internalized (World Bank, 2005).

In contrast to the decreasing number of SOEs, the *Doi moi* has created a thriving private sector. A legal framework for private sector development was first established in 1990, with the launch of the Constitution 1992, and Private Enterprise Law, Company Law. The most important milestone for

[1] This process amounts to divesting some of the state capital to the private sector. Until recently, those acquiring the divested capital were mainly workers and directors of the SOEs, making equitization resemble more an "insider privatization" than anything else.

private sector development was the Enterprise Law of 2000, which was a formal conflation of the earlier Company and Private Enterprise Laws. This Law represents a radical change in the approach towards the private sector. Until then, private enterprises were allowed to operate under a series of approvals and controls by the authorities. The Enterprise Law, by contrast, protected the right of citizens to establish and operate private businesses without unnecessary interventions from government officials. The most important innovation introduced by the Enterprise Law was the simplification of registration procedures with the elimination of over one hundred business licenses (CIEM-UNDP, 2005). The business community refers to this innovation as the permission "to register first, then to check" (World Bank, 2005). As a result, it reduced the time and cost needed to register new businesses. It also improved the confidence of the business community in the Government, by reducing the opportunities for corruption derived from such greater transparency.

The private sector responded to this new approach with a sharp increase in the number of new enterprises formed. Figure A1.2 in the Appendix shows a rapid increase in the number of new establishments after the promulgation of the Enterprise Law. On average, the growth rate of new establishments was 43 percent per annum in the period 2000-2006. World Bank (2005) implemented a small scale survey and noted that about 45 percent of the enterprises surveyed were already in existence in 2000, mainly under the form of household businesses. One of the most important reasons for them to register officially was to obtain invoice books for the Value Added Tax (VAT), without which goods and services cannot be sold to the Government and SOEs. Another survey conducted in 2001 by VCCI found that roughly 70 percent of the registered enterprises were truly new.

As of the end of 2006, there were about 210,000 registered private firms, accounting for 33 percent of the manufacturing output. Table 1.1 shows an increase in the private sector's GDP share to over ten percent by 2007. The result has been significant job creation, allowing the absorption of 1.4 to 1.5 million new entrants to the labor market every year (World Bank, 2006). The number employed in the domestic private sector increased from around 800,000 jobs prior to 2000 up to nearly 3.8 million jobs in 2007 (GSO Statistical Yearbook, 2000 and 2008).

In addition to the domestic private sector, household businesses contribute significantly to GDP and especially aid the absorption of the young and fast growing labour force. Assessing exactly how many household businesses are actually in operation is not straightforward. GSO (2008) published a number of nearly 3.7 million non-farm businesses operating in rural Vietnam, creating around 6.6 million jobs. Wim Vijverberg (2005) shows a big gap when estimating the number of household businesses from different survey instruments. For instance, the VHLSS 2004 could be used to determine a number of around 9.3 million non-farm enterprises run by households. On the other hand, the Household Business Survey (HBS) in 2004, also conducted by GSO, reports only about 2.9 million "business households", running at least one business activity. The gap of 6.4 million between these two surveys is very large. Wim Vijverberg (2006) explored measurement differences among these surveys but unable to provide a satisfactory explanation for such a large gap.

Regardless how household businesses are identified, the household sector is found increasingly important in Vietnam's economy. GSO Statistical Yearbook 2008 shows that the household business sector accounted for nearly 29 percent of GDP (table 1.1), creating around 35.2 million jobs in 2007 (out of a total employment of 38.6 million jobs in the non-state domestic sector, and 44.2 million jobs nationwide). World Bank (2005) using the VLSSs and VHLSSs in the period 1998-2004 suggested that household businesses were becoming gradually more "professional". The number of operating days per month, and months per year, increased. The percentage of enterprises with a fixed location increased as well. Also, the share of loss-making household businesses was 0.3 percent in 2004 compared to 4.8 percent in 2002, and 8.2 percent in 1998. The two most popular industries are "commerce" and "processing and manufacturing". The former accounts for more than 40 percent of all household businesses; the latter represents about one-quarter.

1.2.2 Trade and Investment

As the 'open-door' policy under the *Doi moi* has increasingly exposed the Vietnamese economy to international market forces, the country has become remarkably open over the past two decades.

Table 1.3 demonstrates a continuing and impressive growth of both exports and imports. In 2000, per capita export climbed to US$ 184, removing Vietnam from the list of countries with undeveloped foreign trade. This figure increased to US$ 564 in 2007. On average, the growth rate of export turnover between 1990 and 2007 was nearly 20 percent per annum, and the corresponding figure for imports was 22 percent. Compared to the average GDP growth rate, trade grew faster by a factor of 2.7. On average, the trade deficit was kept low at nearly 7.7 percent of GDP, 18 percent of total export, and thus the trade deficit has not been viewed as problematic. If trade openness is defined as the percentage of total export and import over GDP, the economy is already highly open, trade measured this way reached 142 percent of GDP by 2007.

Table 1.3 International Trade and Investment Flows, 1990-2007

	90	92	94	95	96	97	98	99	00	01	02	03	04	05	06	07
International Trade																
Export (US$ mil.)	2,404	2,475	4,054	5,198	7,337	9,145	9,365	11,540	14,449	15,029	16,706	20,149	26,485	32,447	39,826	48,561
Import (US$ mil.)	2,752	2,817	5,827	8,381	11,644	11,592	11,527	11,742	15,200	16,218	19,746	25,256	31,969	34,886	42,602	62,765
Trade deficit																
Trade deficit as % of GDP	-5.95	0.39	-12.54	-13.97	-19.09	-9.23	-7.99	-0.29	-2.96	-3.62	-8.66	-13.03	-12.06	-4.59	-4.55	-0.20
Trade deficit as % of export	-14.49	-13.82	-43.73	-61.24	-58.7	-26.76	-23.09	-1.75	-5.2	-7.91	-18.2	-25.35	-20.71	-7.72	-6.97	-0.29
Exports by sectors (%)																
Heavy industries & mining	25.73	36.98	30	25.28	28.7	28	27.9	31.3	37.2	34.9	31.8	32.2	32.6	36.1	36.2	34.3
Light industries	26.52	13.76	24.09	28.4	29	36.7	36.6	36.7	33.9	35.7	40.6	42.7	41.2	41	41.2	42.6
Agri., Forestry, Aqua.	47.75	49.26	45.9	46.27	42.3	35.3	35.5	32	28.9	29.4	27.6	25.1	26.2	22.9	22.6	23.1
Imports by sectors (%)																
Machinery & equipment	27.36	21.54	29.54	25.71	27.6	30.3	30.6	29.9	30.58	30.52	29.8	31.6	27	25.3	24.6	28.6
Fuel & raw materials	57.74	61.89	52.66	59.11	60	59.6	61	61.7	63.23	61.56	62.3	60.6	68	66.6	67.6	64
Consumer goods	14.9	16.57	17.8	15.18	12.4	10.1	8.5	8.4	6.19	7.94	7.9	7.8	5	8.1	7.8	7.4
Foreign Direct Investment																
Number of projects*	108	197	367	408	387	358	285	311	389	550	802	748	723	970	987	1,544
Total capital committed (US$ mil.)	735	2,209	4,535	7,696	9,735	6,055	4,877	2,264	2,696	3,230	2,963	3,146	4,222	6839	12,004	21,348
% of foreign share	81.5	82.77	76.28	76.94	78.63	76.52	72.47	86.58	84.45	96	91.72	93.84	89.74	91.4	95	93
Actual capital implemented (US$ mil.)	na.	575	2,041	2,556	2,714	3,115	2,367	2,335	2,414	2,451	2,591	2,650	2,852	4100.1	8,030	8,130
% of total commitment	na.	26.03	45	33.21	27.88	51.44	48.54	103.12	89.53	75.87	87.45	84.25	67.56	59.9	66.9	37.6
Official Development Assistance																
Disbursement (US$ mil.)[b]	na.	na.	na.	189	336	550	796	970	1,361	958	1,073	1,258	1,394	1,432	1,380	1,546

Source: (i) trade data are calculated from GSO Statistical Yearbook 1996, 2000, and 2008, using the average exchange rates published by IMF in the same period; (ii) FDI data are calculated from MPI; (iii) ODA data are taken from IMF (2002, 2006, and 2007).

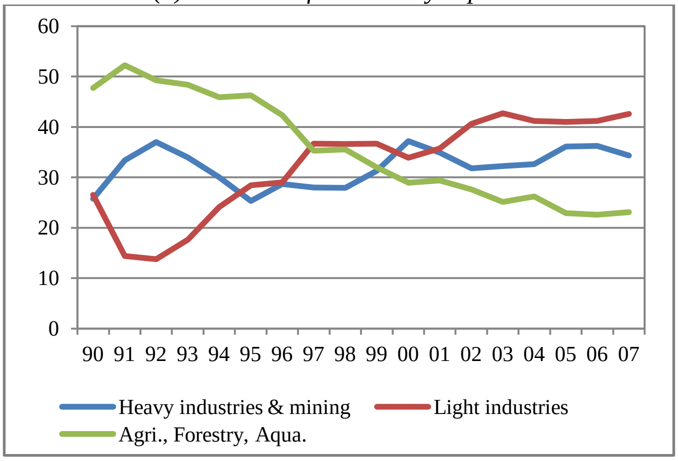
Notes: * These figures are new projects licensed each year and do not take into account numbers of ended or failed projects.

Rapid growth in export and import turnovers is associated with significant changes in the structure of foreign trade. Panel (a) of figure 1.2 shows the dominance of agricultural export in the first half of the 1990s. Of the agriculture export, rice and coffee were the key commodities. During this period, the export of light manufacturing products, including garment, footwear, and seafood started emerging as the main export commodities. Since 1997, the export of these products dominated and surpassed the agricultural export turnover due to rapid growing garment, footwear, and seafood output and the collapse of world prices for Vietnam's major agricultural commodities. It should be noted that the decreasing share of agriculture export does not mean a reduction in absolute terms. Instead, the key agriculture export commodities have experienced unfavorable price fluctuations since the end of 1990s. For instance, the quantity of rice export was almost the same in 1998 and 2003 (at 3.7 million tons), but rice export revenue fell by nearly one-third between these two years (GSO Statistical Yearbook, 2008).

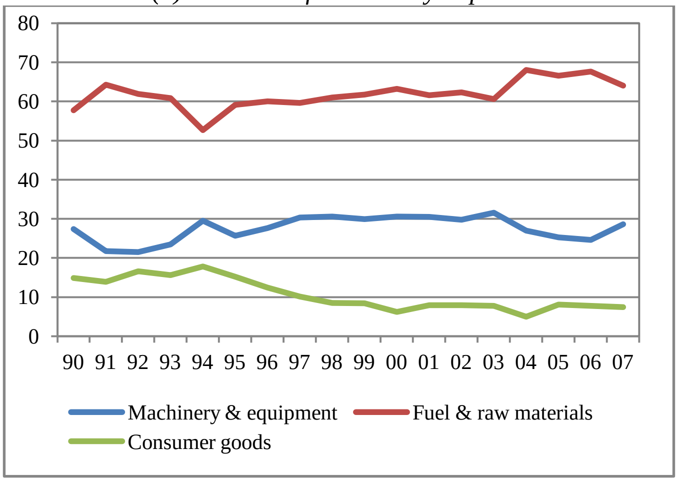
The import structure of Vietnam reflects closely its demand for raw materials, fuel, equipment and machinery for domestic production. As reflected in panel (b) of figure 1.2, the import of these commodities accounts for an average of 90 percent of the import turnover. Import of consumer goods has decreased steadily since 1994. By the end of the period 1990-2007, consumer goods accounted for less than seven percent of the total import. In contrast, fuel (mainly gasoline, diesel) was dominant import item and has slightly increased since 1993. It should be noted that Vietnam largely depends on import for its fertilizer demand for agriculture export growth. In addition to fuel and fertilizer, garment and footwear raw materials constitute a significant proportion of the import turnover. In the total value of US$5.8 billions of garment and footwear export in 2003, imported raw materials for these industries were nearly 40% (IMF, 2006).

Figure 1.2 Structures of Export and Import, 1990-2007

(a) structure of commodity exports



(b) structure of commodity imports



Source: compiled from GSO Statistical Yearbook, 1996, 2000, 2008.

Rapid growth of both exports and imports over the period 1990-2006 was associated with strong shifts in the direction of foreign trade. Vietnam has greatly diversified its export and import markets compared to the early 1990s. The country recovered from the collapse of traditional markets (i.e. the former Soviet Union and other socialist countries) given the emergence of East Asian and ASEAN countries as the major trading partners. Figure A1.3 in the Appendix shows that as of 2006, Japan, Korea, China and ASEAN countries accounted for nearly 64 percent of total imports and around 40 percent of exports. At the same time, EU and North America (USA and Canada) became a growing export market, mainly for garment, footwear, and marine products. EU and North America were the two destinations for more than 20 percent of Vietnam's total export in 2006, representing a big increase from around three percent in 1996. Notably, these markets were identified as the main target markets in Vietnam's Export and Import Strategy 2001-2010 (MoIT, 2000).

In a close association with the trade growth, FDI has become a major investment source during the *Doi moi*. Attracting FDI was one of the first concrete steps towards economic renovation in 1986 through enacting the Law on Foreign Investment. Together with the establishment and gradual improvement of the legal framework for FDI, Vietnam also signed international bilateral and multilateral agreements on investment promotion. Such agreements, which concern 45 countries and territories so far, have a wider scope of application than the regulations stipulated in the Law on Foreign Investment (World Bank, 2005). As a result, the FDI sector became a major source of capital fuelling Vietnam's impressive economic growth in the 1990s. During that decade, it accounted for one-fifth of Vietnam's total investment to GDP ratio, which averaged 25.4 percent. This was almost equivalent to the state investment that originated from the budget with a significant ODA contribution (see Pham *et al.* 2008). Vietnam's FDI/GDP at 5.4 percent was also higher than most countries during that period: for example, in 1991-1999, the FDI/GDP ratio of China, Malaysia, and Mexico were 1.1 percent, 3.2 percent, and 1.2 percent, respectively (World Bank, 1999).

Table 1.3 reveals that Vietnam has attracted 8,823 FDI projects with a total capital committed of nearly US$ 87 billion up to 2007. The flow of FDI capital committed closely mirrors the three phrases of the country's growth experience. It reached its peak in 1996 with US$9,735 millions, then fell sharply during the 1997-98 Asian financial crisis, and has steadily regained the momentum since 2000. The FDI inflow has reached the highest volume of committed capital of more than US$ 21 billion in 2007. So far, Asia is the most important source of foreign capital. The main source economies are Singapore, Taiwan (China), Korea, Hong Kong (China) and Japan. Taken together, these countries account for almost two-thirds of the total FDI to Vietnam. According to World Bank (2005), such predominance of regional investors might be linked to their better ability to operate in an insufficiently developed legal framework, relying more on trust and reputation, compared to Western investors. Outside of Asia, France, the Netherlands, and the United Kingdom are among the most important investors. The United States does not feature prominently in the FDI inflows, however, after the signing of the Vietnam-US Bilateral Trade Agreement, investment from the United States' companies in Vietnam increased steadily. Between 2002 and 2004, United States-related FDI grew by 27 percent per year, compared to just around three percent from 1996 to 2001 (GSO Statistical Yearbook 2000, 2008). In terms of its sectoral distribution, the manufacturing sector has been the destination for nearly 65 percent of the total number of projects and a half of actual disbursements (see table A1.1 of the Appendix). There is also a strong spatial dimension in FDI allocation with the Southeast (including Ho Chi Minh City) and Red River Delta (including Hanoi) accounting for, respectively, 54 percent and 27 percent of the total FDI (see table A1.2 of the Appendix).

Given this, the FDI sector has steadily replaced the dominant role of the SOE sector in terms of its contribution to economic growth. Figure 1.2 shows that the share of the FDI sector in the total output has increased from 6.3 percent in 1995 to 17.7 percent in 2007. The FDI sector's share in the total industrial output increased from 25 percent in 1995 up to 41 percent in 2004. The FDI sector plus the domestic non-state sectors account for more than 50% of the total industrial output (Dao, Pham and Pham, 2006). The FDI sector is also the main exporter with its share in the total export values rose from less than five percent up to 55 percent between 1990 and 2007 (GSO Statistical Yearbook 1996, 2008). It is important to emphasize that as exports by FIEs are mainly manufacturing products, the FDI sector has thus significantly contributed to the share of the manufacturing export in recent years. The remarkable contribution of FDI enterprises in growing manufacturing export is partially offset by the fact that the sector imports around 80% of its total revenue due to its over reliance on importation of raw materials and other intermediate inputs (MUTRAP, 2002).

1.3 Conclusions

The *Doi moi* has been a success story that has put Vietnam among the top two or three performers in the developing world (Glewwe *et al.* 2004). Although the *Doi moi* is an ongoing process, achievements are astonishing. With an average GDP growth rate of nearly 7.4 percent over the whole period 1990-2007, Vietnam was one of the fastest growing economies in the world. Many external shocks such as the 1997-98 regional crisis, the collapse in prices of Vietnam's agricultural exports by the late 1990s, have not halted this outstanding growth.

Despite the SOE restructuring process and improvements in the investment climate toward a level playing field for the private sector during the 1990s, there were almost no changes in the GDP shares of the state sector (dominantly SOEs). Though the SOE reform has transformed this sector from a loss-making situation to a 'not too profitable' outcome, the direction to maintain the 'key' role of SOEs in the economy also implies that this 'not too profitable' sector still control the majority of total capital stock and is subject to certain 'privileges'. In parallel with the SOE reform, Vietnam has been successful in promoting a vibrant private sector, both domestic and foreign-invested. Currently, the private sector contributes 64 percent of GDP, 55 percent of total exports, and more importantly nearly 90 percent of employment. Given this importance, continuing the private sector reform in the current direction is important to ensure that the private sector will be the engine of economic growth for Vietnam in the coming years.

With Vietnam's commitment to increasing the exposure of its economy to international market forces, the country has become increasingly open over the past two decades. On average, the growth rate of export turnover was nearly 20 percent per annum between 1990 and 2007 , and the corresponding figure for imports was 22 percent. Compared to the average GDP growth rate, trade grew faster by some 2.7 times. In association with the rapid growth of foreign trade, Vietnam has attracted a significant FDI inflow since the early 1990s. The FDI sector is currently the dominant in terms of export and industrial output, while contributing to an increasing share of GDP. Such exposure to international trade and investment represents increasing competition for the domestic business sector.

Chapter 2: Data Sources

This chapter describes the data sources used for the empirical analysis in this thesis. The first section focuses on the Vietnam Enterprises Surveys (VES) over the period 2001-2007 as the primary dataset for the thesis. The sub-samples of manufacturing firms extracted from the VESs across these years are summarized in this section. As one focus of the current research is to explore potential effects of trade reforms on technical efficiency (in chapter 4) and on workplace injuries (in chapter 5), the second section describes the data sources used to capture the trade reforms in Vietnam.

2.1 The Vietnam Enterprises Surveys

The Vietnam Enterprises Survey (VES) Series is implemented annually by GSO, within the Department of Industrial Statistics, as the major channel for the statistical authorities to collect information on business performance of enterprises in Vietnam. The history of the VES series started in 1997, when GSO conducted a large-scale survey on enterprises for the first time. Starting from this pilot, GSO embarked on a structured plan to implement the VES on an annual basis. Encouraged by the preliminary findings from these early surveys, GSO has been supported by the World Bank in Vietnam to improve the quality of the VES series since 2000. The surveys are now considered as the most comprehensive database on business performance of enterprises in Vietnam.

2.1.1 Introduction of the Vietnam Enterprises Surveys

The VES series is generally carried out in the first six months of the year and elicits responses on the performances of the firms that were in operation in the year before. The list of firms is provided to GSO from the Taxation Department of the Ministry of Finance (and its provincial departments), with references to the list of firms registered at the database of the Ministry of Planing and Investment (and its provincial departments). Using that list, the VES questionnaires are distributed to all enterprises. As the completed questionnaires are signed and stamped by directors or vice-directors before returning to the provincial divisions of GSO, the data provided are considered as official data from the firms surveyed.

Overall, the VES series aims at collecting information on various aspects of business performance. For instance, the Survey Plan for VES 2006 states the objectives, which are essentially similar to the earlier surveys, as:

> […] To collect basic information in order to analyze business performances, investment climate, firm (human, technical, financial) capacities, distributions of enterprises in all business areas, from all types of ownership in order to provide sound analysis and data for policy-making process, socio-economic development plans of the country and provinces;
>
> To collect necessary information for the statistical routine of GSO, including number of firms, labour, capital, assets, key business performance indicators, and other indicators for the national account system;
>
> To collect necessary information in order to formulate master samples of enterprises which will be then used for other surveys in the same years; and
>
> To update information for the current database of enterprises. […]
>
> GSO (2006), Plan for VES 2006, p.2.

In pursuing these objectives, the VES questionnaires are developed to capture various aspects of business activities. Particularly, the VES series collects firm-level information to identify enterprises and business performances, including:

- Firm identification: name, business address including location, telephone, fax, email, website
- Types of enterprises by ownership
- Areas of operation
- Labour

- Wage bill
- Fixed assets
- Investment
- Revenue
- Major products/services
- Profit (gross and net)
- Taxes and other fees
- IT application (e.g. usage of computers, website…)
- Some other rotating modules which vary across years, including:
    - Workplace injuries
    - Investment climate
    - Research and development activities
    - Cost structures.

The VES series covers a complex set of questionnaires. Given the series is undertaken during the period of rapid economic growth with radical changes in the investment climate legislation, the questionnaires were modified over time to capture these changes in the business environment. Nevertheless, it remains possible to compare across the surveys. In general, the series consists of the following questionnaires:

Questionnaire 1A-DTDN is the main questionnaire that applies to all enterprises listed for the surveys. The questionnaire A1-DTDN covers most of information that is expected to achieve the above objectives. This questionnaire is between 12-18 pages in length and contains nearly 140 questions that are structured into more than 20 sub-sections focusing on several aspects of business activities. Under these sub-sections, there are several specific questions. For the VES 2006 as an example, sub-section one to four elicits information to identify firms (names, year of establishment, address, areas of business, type of ownerships). Sub-section five and six collects information on number of employees and average wage bill. Sub-sections seven to 11 gather data on capital, investment, revenue, profit, taxes. Some basic indicators on environmental performance are provided in sub-sections 12. Section 13 focuses on the list of products/services produced/provided by the enterprise. The remaining sub-sections of the questionnaire are designed to collect further information for certain types of enterprises (such as hotel, tourism, construction). A sample of this Questionnaire is provided in Appendix A2.

Questionnaire 1A.1-DTDN includes an additional set of questions to the questionnaire A1-DTDN in order to collect further information on large enterprises, which are defined as those who have subsidiaries, or affiliate firms.

Questionnaire 1B/CS-DTDN consists of an additional set of questions on the affiliates of the enterprises covered in the Questionnaire A1-DTDN.

Questionnaire 2B-DTDN is used to collect information on financial intermediaries in order to provide additional information to the database operated by the State Bank of Vietnam. In addition to this questionnaire, financial intermediaries are also required to provide information according to the Questionnaire 1A-DTDN.

Questionnaire 2C-DTDN is designed to collect information on insurance companies (in addition to the Questionnaire 1A-DTDN).

Questionnaire 2D-DTDN is a ‘rotating module’ to collect additional information for the Questionnaire 1A-DTDN. This questionnaire is rotated around the focus on (i) workplace injuries; (iii) research and development activities; (iii) investment climate; (iv) environmental performances; and (v) cost structures. It is important to note that there is not a well structured plan for this ‘rotating’ module. The focus is selected on the basis of the policy priorities of GSO at the year of survey and thus more than one ‘rotating’ module could be employed in a survey.

The VES series employs a mix of census and sampling approaches. The census approach applies to all state-owned enterprises (including SOEs with 100% state capital and equitized SOEs in which state ownership account for more than 50 percent), foreign-invested enterprises (FIEs); and domestic private firms (DPEs) with at least 10 employees. The census is also applied to the provinces with less than 1000 enterprises registered. The Questionnaire 1A-DTDN is used for these enterprises.

The sampling approach is adopted for the DPEs that employ less than 10 employees. In this regard, the VES series is not a genuine enterprise census. The sampling frame is formulated using the official list of DPEs reported by the provincial departments of GSO (which is originally provided by the municipal tax authorities). Enterprises in the sampling frame are classified using the four-digit Vietnam Industrial Standards Classification (VNIC), which is essentially the same as the International Standard Industrial Classification (ISIC) of the UN Statistics. From this sampling frame, 15 percent is selected for inclusion in the sample for the VES using the proportional random sampling method with each 4-digit industry treated as a stratum.[2] Hanoi and HCM City are two special cases in this sampling procedure. As the number of DPEs with less than 10 employees in Hanoi and HCMC is very large, the labour size threshold applied for the DPEs in Hanoi is 20 employees while the corresponding figure for HCMC is 30 employees. It is noted that a substantially simplified version of the Questionnaire 1A.1-DTDN is applied to collect basic information on business performances from this sub-sample of small-scaled DPEs. Hence, data available from this sample are not as rich as for the 'census' sample (as above).

Data collection is conducted using two approaches. According to the Survey Plan 2006 (GSO, 2006), visiting enterprises for direct interviews are made for small enterprises. These interviews are carried out by the staff of the GSO provincial departments. Unfortunately, the practice of direct interviews varies from one province to the others as GSO does not issue a uniform guideline on when direct interviews should be made and this

[2] For those DPEs which are not selected in the sample, the GSO consolidates the list and updates it annually in order to provide sufficient information for sampling in the future.

is left to the GSO provincial departments to decide. For the second approach to collect data, the provincial departments hold technical meetings with groups of chief accountants or vice directors of companies to explain the requirements and guidelines to complete the questionnaires distributed. After collecting the questionnaires, the data inputting process is implemented at the GSO provincial departments. If inconsistencies are found in the data provided, the relevant enterprises are re-visited for the purposes of correcting these data errors. After this data inputting process, GSO then centrally analyzes the surveys using the data provided by its provincial departments.

This thesis is among a few research projects that have been granted a partial access to the VES database for empirical analysis. Most of the information available from the Questionnaire 1A.1-DTDN on the manufacturing sector of VESs across the period 2001-2007 was provided for research purposes. As these VESs were implemented to collect data in the latest year (e.g. VES 2007 was to collect data on 2006), data on the manufacturing sector is available in the period 2000-2006 for the empirical analysis undertaken for this thesis.

2.1.2 Samples of the Manufacturing Sector

The focus of this thesis is on the manufacturing sector, which is defined in the VES series in accordance with the definition of the sector using the International Standard Industrial Classification (ISIC) of the UN Statistics. The focus on the manufacturing sector is justified for a number of reasons. Firstly, it can be argued that firm performance, as one of the main interests of the research, in the manufacturing sector should be measured and evaluated differently from the other sectors such as services and agriculture. Secondly, one research interest is to explore the impact of trade reform on some aspects of firm-level performance. Focusing on the manufacturing sector implies that we will only examine the first-round effect of trade reforms on tradable manufacturing activities. In fact, trade reforms are likely to affect the other non-tradable activities (through its effect on the tradable sector) but these impacts are not set as the primary research objective of this thesis. Finally, this focus is justified by the intention to investigate issues related to workplace injuries. Although workplace injuries also matters in other sectors, it is reasonable to argue that the factors affecting workplace injuries in the manufacturing sector are different from those in the services or agriculture sectors. In other words, in addition to the issue of data availability, the focus on the manufacturing sector is a practical option to restrict the scope of the research to a manageable task.[3]

As described above, the VES series employs a mix of census and sampling approaches, with the latter applied to private domestic enterprises having less than 10 employees. Ideally, all observations should be used in the empirical analysis. This is however constrained in the current study. In fact, data on the sub-samples of DPEs having less than 10 employees are provided by GSO only for the VES 2005. GSO has not published secondary data on these 'small' enterprises and efforts to obtain the data files on the 'small' enterprises were not successful and, to the best of our knowledge, access to the data source on enterprises with less than ten employees has not been given in previous studies. In addition, it is noted that the data on these enterprises are generated using a considerably simplified questionnaire. Basically, only information on names, year of establishment, types of ownership, areas of business, number of employees, and asset values were collected from these enterprises. Investigating the data for VES 2005 suggests that there will not be sufficient information to construct the set of variables necessary for the empirical analysis envisaged in the current research.

In this context, the current study will focus on the 'census' observations of the VESs for the period 2001-2007. Given this, the manufacturing sector covers all SOEs and FIEs

[3] It should be noted that the manufacturing sector in Vietnam is somehow referred to as manufacturing, mining, and construction activities. In this current research, mining and construction are not included in the term of "manufacturing sector".

operating in manufacturing activities. For DPEs, the analysis will focus on those enterprises that employ at least 10 employees (for Hanoi and HCMC, these labour size thresholds are set by GSO are 20 and 30 employees, respectively, as already noted above). Table 2.1 reports the sample sizes used in the current research. It should be noted that the sample sizes for the manufacturing sector vary substantially over time as Vietnam experienced a sharp increase in the number of new establishments during this period (see chapter one).

Table 2.1 Sample Sizes of the Manufacturing Sector

Year	Size of manufacturing sector	% increase
2000	7,691	n.a
2001	8,866	13.25
2002	11,029	19.61
2003	12,834	14.06
2004	15,534	17.38
2005	17,731	12.39
2006	19,105	7.19

Source: calculations from the VESs in the period 2001-2007 (for the data on manufacturing firms in the 2000-2006 period)

Notes: 'n.a' stands for 'not applicable' as no information earlier VES is available for the current study.

2.1.3 Remarks on limitations of the VES data source

Though the VESs represent arguably the most comprehensive database on enterprises in Vietnam, and this study is among a few that was granted access to the full sample of the manufacturing sector (e.g. manufacturing firms surveyed using the 'census' approach), the dataset has some limitations.

First, there is no prior dissemination strategy specified in the GSO's plan for this series. Therefore, GSO remains the main authority who publishes some of the results from VESs and provides (parts of) the database for other ministries for their own respective purposes. There is no explicit policy to make VESs available to the research community and wider public. Therefore, the access to VESs is limited. As a result, technical support from GSO for data users is modest. Notably, documentation of the dataset is generally poorly recorded. For instance, it is not entirely clear how GSO and its provincial departments clean the raw data, how the questionnaire was explained to respondents (as there was no survey manual available except some simple training materials). More importantly, reasons underlying modifications from time to time were not documented. For instance, the information for age of establishment was not available in 2003, 2004, and 2006 while this information was recorded in other years. Another example is the information necessary to construct the ratio of female employees with work contracts was not available in 2000, 2001, and 2006. Several consultations between the author and staff at the GSO’s Department for Industrial Statistics were undertaken during the course of this study but the reasons for these inconsistencies remain unclear. This represents a constraint for the empirical analysis, especially when comparing empirical results across time.

Second, as these VESs covered almost all manufacturing enterprises which were registered to the tax authorities, a panel dataset could potentially be constructed. Investigating the data over time, there are two possible ways to identify this panel, including (i) using the identification codes and (ii) using the tax codes. Regarding the former, using these codes however enabled an identification of only 2,400 enterprises across the period 2000-2006. Consultations with responsible officials of GSO’s Department for Industrial Statistics revealed that there have been changes in identification codes across years but documentation on such changes were not filed in a systematic manner. Therefore, further attempts to construct the panel taking into account these changes were constrained.

When using tax codes as an alternative resulted in a panel of 5,880 enterprises between 2001 and 2006. When the 2000 data are included, the number of firms in the panel reduced to around 4,800 firms. It should be noted that the number of firms that appeared in a year and then disappeared in a consecutive year is very large (see table 2.2 below). It is not clear how such large numbers of firms were lost from the panel over time but it is unlikely that all of them liquidated. First, this period 2000-2006 represents a period of impressive economic growth in Vietnam (see chapter 1). Second, there could be a certain level of manufacturing firms that did not survive over time but these firms are likely to be only a small proportion of the number of firms that were 'lost' from the panel as in table 2.1. For instance, it is not plausible to argue that, for instance, of the total of 17,731 firms in 2005, 11,851 firms were not observed in the following year of 2006. Attempts to construct a better panel were made through face-to-face discussions between the author and staff from GSO's Department for Industrial Statistics in 2008. It was found that even the GSO staff has not been able to construct a panel of more enterprises than that reported here. If this 'attrition' problem is due to measurement errors, analysis using the panel will be misleading. This warrants caution in using the panel for the analysis of this study.

Table 2.2: Number of firms that are 'lost' from the panel between 2001 and 2006.

	2001	2002	2003	2004	2005	2006
Number of firms	8,866	11,029	12,834	15,534	17,731	19,105
Number of firms that are 'lost' from the panel	2,986	5,149	6,954	9,654	11,851	13,225

Source: calculations from the VESs in the period 2001-2007 (for the data on manufacturing firms in the 2000-2006 period)

Notes: firms that are 'lost' from the panel refers to those who appeared in the survey of one year but disappeared in the survey in the consecutive year.

Third, VESs cover only the registered enterprises (i.e. those with business licenses registered at the provincial departments of the Ministry of Planning and Investment). Therefore, the surveys do not include information on unregistered enterprises. Given this, the informal manufacturing activities are not subject to the analysis in the current study. In addition, it is also noted that the data available from VESs are largely 'reporting' data. As discussed earlier, direct interviews were supposed to include small enterprises but it was for the GSO provincial departments to decide which enterprises were interviewed and how these interviews should be implemented. For other enterprises, the information provided was based on reporting data.[4] This might present a data issue problem when ‘sensitive’ information such as taxes, work contracts, workplace injuries, environmental performance was asked. This data issue becomes more pronounced when investigating the determinants of workplace injuries in chapter 5 of the current study (and hence it will be discussed in that chapter).

In addition, it is noted that there is a cost module, which was considered as a rotating module in the VES series but there is very little information about these data. Publications of the GSO on the results of VESs do not report information on cost structures (see GSO, 2004, 2005, 2006, 2008). For the current research, the cost module was provided as part of the VES 2003, where information on 1,455 manufacturing enterprises (out of 12,834 firms) was collected.[5] It is also not clear how these firms were selected for the cost module. As there is cost data on only a relatively small sub-sample in one year available for the current study, the analysis of allocative efficiency (which, together with technical efficiency, is a part of the economic efficiency) in the current research (see chapter 3 for a discussion on these types of efficiency) is not pursued (see chapter 3 for further discussion).

In acknowledging these data issues and their potential effects on the results, alternative data sources were also considered. As will be discussed in more detail in chapter 3, there is a modest but growing number of studies on technical efficiency of Vietnam enterprises. Most of these studies have employed small-scale surveys. For instance, Vu (2003) used a sample of 164 manufacturing SOEs surveyed by the Ministry of Finance between 1997 and 1998. Nguyen *et al.* (2002) employed another small sample of 96 textiles and garment firms surveyed between 1999 and 2001. Tran *et al.* (2008) used a sample of nearly 600

[4] This reporting data is regulated by Decision 62/2003/BKH dated 17/01/2003 of the Minister of Planning and Investment; Decision 156/2003/QĐ-TCTK dated 13/3/2003 of the General Director of GSO; and Decision 167/2000/QĐ-BTC dated 25/10/2000 of the Minister of Finance.

[5] According to the Survey Plan, the total number of enterprises which was subject to the cost module was 9600 (for all sectors), which accounted for nearly 10 percent of the total firms in the survey.

SMEs surveyed by the MOLISA and Stockholm School of Economics in 1996 and 2001. A comprehensive analysis of technical efficiency was found in Le (2010), who used the SME surveys between MOLISA and research partners from Demark and Sweden in 2003, 2005, and 2007.[6] Most recently, Larsen, Rand, and Torm (2011) also used the later survey round of that series.[7] During the course of this study, these datasets were also considered as alternatives. However, compared to the VES series, most of these datasets represent small and medium scale surveys. Results from these surveys would be informative but might not be representative of the manufacturing sector as a whole. The surveys used in Le (2010) and Larsen *et al.* (2011) could be considered as a quality data source but are of small scale and subject to a number of limitations (see Le, 2010 for a discussion). Given this consideration, the current research employed the series of VESs in the period 2001-2007 as the major data source for its empirical analysis, while acknowledging certain data issues noted above. The potential effects of these data issues on the empirical results will be discussed in detail in the relevant chapters of the thesis.

2.2 Trade Data Sources

One challenge in any empirical work on the effects of trade reforms on economic performances is how to capture trade reforms in empirical models. This has been a subject of intensive debate in the literature. The choice of trade data sources for the current study is guided by the literature on trade liberalization and its impacts on economic performance (see further discussion in chapter four).

[6] The first survey was supported by Swedish SIDA while the latter two surveys were supported by DANIDA. The samples covered in 2003, 2005, and 2007 were 1,388; 2,739; 2,492 manufacturing SMEs respectively.

[7] Larsen *et al.* (2011) studied potential linkage between recruitment ties on wages and did not examine technical efficiency in their paper. But this data set could also be used to explore technical efficiency.

With regard to measures of trade exposure, Edwards (1993) emphasizes the difficulty of constructing reliable measures for trade policy reforms. Rodrik (1995) argues that in most studies on trade liberalization and economic performance "[…] the trade-regime indicator used is typically measured very badly" (p.2941). Winters (2004) highlights '[…] problems in defining and measuring openness, in identifying causation and in isolating the effects of trade liberalization' (p.4).

In this context, a number of measures for trade liberalization have been developed in the literature, especially for cross-country analysis. The World Bank's 'outward orientation index' developed in the 1987 World Development Report that ranks the country's trade openness according to their outward orientation. This index is criticized for its definition of outward orientation and failure to distinguish among countries according to their level of development (Singer, 1988). The Sachs and Warner's (1995) index is a composite openness proxy using a series of trade-related indicators, including tariffs, quotas coverage, black market premia. However, the Sachs and Warner's index suffers from a pitfall of measuring openness as a dichotomous index (i.e. a country is categorized as either closed or open). The IMF's trade restrictiveness index is also subject to the same criticism.

The same situation is also observed for the measures that have been used for within country analysis. Harrison (1994) uses a dummy for the pre-reform and post-reform period and examines the association between trade policy reforms and productivity. However, using a trade reform dummy implicitly assumes that trade reforms are a once-for-all event, meaning that the reform is completed right after the first 'move'.

An alternative measure of trade liberalization is import penetration and/or export ratio, which can be obtained from input-output tables or social accounting matrices. They are also subject to certain criticisms. According to Chand and Sen (2002), these ratios measure the outcome of changes, but not the policy changes themselves. In addition, trade reforms may affect firm-level efficiency without inducing changes in structures of inputs and markets for outputs. In this vein, Chand and Sen introduce a 'price wedge', which is defined as the deviation of the domestic price of the output produced by an industry from the world free trade price for that industry. Nevertheless, this measure is challenged by those who question how to accurately specify prices for products made by an industry, and what are the appropriate 'world free market prices'.

As all measures have their own pros and cons, Edwards (1997) emphasizes that "[…] despite significant efforts and ingenuity there hasn't been much progress in this area (i.e. measuring trade exposure)" (p.6). In this regard, Edwards suggests that empirical studies on trade-economic performance linkages should concentrate on determining whether their econometric results are robust to different measures of trade reforms. To illustrate this argument, Edwards uses nine alternative openness measures, including among others the Sachs and Warner's index, the World Bank's outward orientation index, average tariffs on manufacturing activities, average coverage of quantitative restrictions. "[…] in spite of some important differences, these indicators tend to tell a somewhat similar story" (p.11). The productivity regression results were then reported to be robust to the use of openness indicators and estimation techniques.

This research takes the advice of Edwards (1997) into account when constructing the proxy for trade openness. It is useful to test whether or not the econometric results on the impact of trade liberalization are robust to different measures of trade exposure. However, the construction of trade exposure measures is usually constrained by data availability. Given these considerations, tariffs at sectoral level are first used to capture the trade reforms in Vietnam. The tariff data used in this study is obtained from the Trade Analysis and Information System database of the United Nations Conference on Trade and Development (UNCTAD-TRAINS), which provide information on the tariffs of Vietnam since 1994.

According to Athukorala (2005), tariff reform is only one part of the trade reform process in Vietnam and hence tariffs do not reflect fully the openness outcome. Empirical studies often adopt social accounting matrices or input-output tables to calculate an export ratio and/or an import penetration ratio of different sectors as alternative measures for openness (see, for instance, Fernandes, 2003). In the case of Vietnam, it is unfortunate that there is only one SAM available during the period 2000-2006. This is the SAM 2000, which was developed and updated by the Central Institute for Economic Management (CIEM) in collaboration with the Nordic Institute for Asian Studies (NIAS) (see CIEM and NIAS, 2004 for details).[8] Given the data constraint, this study employs the SAM 2000 to construct the export ratio and import penetration measures to perform a sensitivity test for the potential impacts of trade reforms. By assuming that the structural relations among different manufacturing sub-sectors change slowly, these export ratio and import penetration for 2000 could be probably applied for the 2001 and 2002 data. But sensitivity test using these ratios for the more recent years is constrained by data availability.

2.3 Conclusions

Data on the manufacturing sector in the period 2000-2006 available from the VESs in the period 2001-2007 are employed for the main empirical analysis undertaken in this thesis. Despite certain shortcomings, partly caused by the dissemination policy of GSO and some potential quality concerns, these VESs represent a data source that can be used to examine empirically the main research questions of this thesis. Limitations of this main data source will certainly have implications on the empirical analysis of the current study and these issues will be discussed in the empirical chapters of the thesis.

[8] Another SAM for Vietnam is called the IFPRI VIETSAM 1997. This SAM was developed by the International Food Policy Research Institute in 1997. There is also another SAM published by the United Nations in the mid-1990s. However, it is highly aggregated and relies on an outdated 10-sector Input-Output table from 1989 (Tarp, Ronald-Holst and Rand (2003)).

In attempts to explore potential impacts of trade reforms on technical firm performance and workplace safety, tariff data from the UNTRAINS database are extracted for the analysis. Data available from SAM 2000 – which is the only SAM available in the period 2000-2006 under consideration – will also be used to examine the sensitivity of the trade impact. In addition to these two databases, additional data sources are also used to support and/or re-inforce the empirical analysis of the current research. These sources will be outlined in the thesis when appropriate. Definitions and constructions of variables used in the empirical analysis will be described in the subsequent chapters.

Chapter 3: Technical Efficiency in Vietnam's Manufacturing Sector over the Period 2000-2006

The rapid economic growth experienced in Vietnam during the *Doi moi* era has been partly attributed to the role performed by a vibrant business sector. The restructuring process led to the dissolution and restructuring of about three-quarters of SOEs. The role of the SOE sector in terms of its contribution to output and employment diminished, and was replaced by the private-owned domestic and foreign-invested sectors. The existence of DPEs was officially recognized for the first time under the provisions of the Constitution 1992 and subsequently by a series of legislative reforms to support the private sector development. The policy of attracting FDI has made Vietnam a significant recipient of FDI in the developing world, with the value of FDI commitments close to ten percent of GDP. Currently, the domestic private and FDI sectors comprise more than one-half of GDP and about two-thirds of the total industrial output (Dao, Pham and Reilly, 2010). The diverse nature of the business sector is one of the key features of Vietnam's economic transition to a market economy.

In contrast to most other transitional economies, Vietnam had a relatively small industrial sector prior to its transition to a market economy. At the launch of the *Doi moi* in 1986, the industrial sector accounted for roughly 14 percent of GDP. After nearly two decades the sector now constitutes around 42 percent of GDP (GSO Statistical Yearbook 2006). Though the industrial sector has become an increasingly important component of the economy, there is limited research available on the efficiency of that sector. Previous studies on this topic for Vietnam have based their analysis on small-scale surveys. For instance, Nguyen and others (2002) surveyed 96 textiles and garment firms between 1999 and 2001; Vu (2003) employed the recorded data by the Ministry of Finance on 164 SOEs located in Hanoi and Ho Chi Minh City; Tran, Grafton and Kompas (2008) focused on around 600 private small and medium-sized enterprises (defined as those who employed less than 100 employees) surveyed jointly by the Ministry of Labour, War Invalids, and Social Affairs (MOLISA) and the Stockholm School of Economics in 1996 and 2001. More recently, Hoang, Carlin, and Pham (2008) using the limited panel of 4600 enterprises available from the VESs that cover the period 2001-2005 to examine mainly the effect of ownership on different measures of firm performance.

The primary motivation of this chapter is to fill the existing gap in our knowledge by estimating the level of technical efficiency of Vietnam's manufacturing sector using data drawn from the sector between 2000 and 2006 (see chapter two). In particular, the chapter explores if, among other things, the estimates of technical efficiency obtained using the stochastic frontier approach are sensitive to different distributional and econometric assumptions made for the errors governing the underlying production process. This chapter is structured as follow. The next section provides a contextualization for the empirical analysis with a review of Vietnam's manufacturing sector. This is then followed by a section reviewing the theoretical and empirical literature on technical efficiency in the context of the stochastic frontier approach. Section 3 outlines the empirical strategy and data used in estimating technical efficiency in Vietnam's manufacturing sector. Estimates obtained from applying this empirical strategy will be reported in section 4. The final section provides conclusions and some policy implications.

3.1 Overview of Vietnam's Manufacturing Sector

During the *Doi moi*, Vietnam has transformed dramatically from a largely agrarian economy with an agricultural sector accounting for nearly 40 percent of GDP in the early 1990s to an economy with a manufacturing sector assuming a more significant role.

Particularly, the share of manufacturing in total GDP has increased from 23 percent in 1990 to 36.7 percent in 2000, and to nearly 42 percent by 2007 (see Table 1.1 in chapter 1). Although the manufacturing sector has emerged as the most important economic sector in terms of GDP contribution, there have been less impressive structural changes within the manufacturing sector itself. As official statistics do not provide data to analyze the manufacturing sector in a more disaggregate level, the data on the manufacturing sector obtained from the VES are used for this purpose. Table 3.1 reports the output structure of the manufacturing sector over the period 2000-2006. During this seven-year period, the share of the food and beverage sub-sector was the agriculture resource-intensive sector decreased by 5.4 percentage points. This reduction in the share of the food and beverage was attributed almost equally to labour-intensive and capital-intensive sub-sectors, while the contribution of the machinery and technology-intensive sub-sectors remained stable.

Table 3.1 Output Structure of the Manufacturing Sub-Sectors

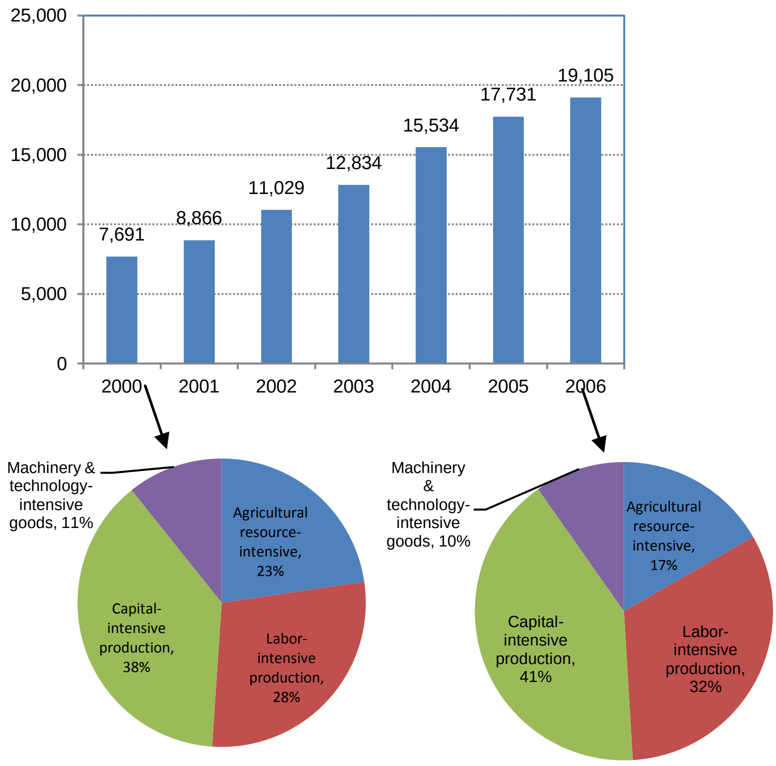
	2000	2001	2002	2003	2004	2005	2006
Agricultural resource-intensive	**27.79**	**26.26**	**26.72**	**24.65**	**23.53**	**23.91**	**22.42**
− Food and beverages	27.79	26.26	26.72	24.65	23.53	23.91	22.42
Labour-intensive production	**19.67**	**18.19**	**19.14**	**19.46**	**19.60**	**20.43**	**22.39**
− Textiles	5.45	5.18	4.78	4.55	4.00	4.77	6.98
− Wearing apparel	4.39	3.88	4.45	4.76	4.67	4.40	4.47
− Leather tanning and processing	6.04	5.35	5.05	5.36	5.33	5.19	4.79
− Wood and wood products	1.79	1.57	1.71	1.48	1.65	1.76	1.45
− Furniture	2.00	2.21	3.15	3.32	3.94	4.31	4.70
Capital-intensive production	**32.58**	**35.76**	**34.48**	**34.99**	**34.66**	**34.90**	**34.65**
− Tobacco products	2.17	2.22	2.93	2.72	2.14	2.14	1.83
− Paper and paper products	3.06	2.46	2.39	2.27	2.34	2.58	2.32
− Chemical and chemical products	7.39	7.04	7.09	7.22	7.27	7.45	7.57
− Non-metallic mineral products	7.81	11.57	7.98	7.85	6.96	6.51	6.35
− Basic metal products	3.42	3.50	4.05	4.57	4.67	4.75	4.79
− Fabricated metal products	2.83	2.95	3.50	3.84	4.41	4.88	5.70
− Rubber and plastic products	3.91	3.98	4.29	4.61	5.02	4.75	4.45
− Coke, refined petroleum products	0.38	0.42	0.55	0.28	0.28	0.30	0.32
− Publishing and printing	1.60	1.63	1.70	1.63	1.57	1.54	1.33
Machinery & technology-intensive goods	**19.95**	**19.79**	**19.66**	**20.89**	**22.21**	**20.76**	**20.55**
− Machinery and equipment	1.89	1.81	1.73	1.86	2.08	1.87	1.46
− Office, accounting & computing machinery	3.59	2.10	1.09	1.44	1.63	1.98	2.40

− Electrical machinery and apparatus	3.08	3.71	3.91	4.07	4.74	4.11	4.92
− Television & communication equipment	2.97	2.94	3.04	3.00	2.76	2.69	2.75
− Medical & optical instruments, watches	0.44	0.42	0.42	0.40	0.42	0.33	0.29
− Motor vehicles	2.58	3.23	4.21	4.78	4.27	3.67	3.27
− Other transport equipment	5.41	5.59	5.27	5.34	6.31	6.11	5.46
Total manufacturing	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: calculations from VES 2001-2007 (for the data in the 2000-2006 period)
Note: The manufacturing sub-sectors are classified by factor intensity using the classification adopted by GSO

With regard to the number of manufacturing establishments, it is unfortunate that no official statistics are available. As estimates from different sources might be different from one to the other, this section employs the VESs to inform the number of recent establishments in the manufacturing sector. As shown in figure 3.1 the number of manufacturing firms increased continuously from 7,691 in 2000 to 12,834 in 2003, and 19,105 in 2006, implying an average growth rate of 16 percent per annum. This could be partly attributed to ‘the Enterprise Law effect’ as the Enterprise Law being effective in January 2000 introduced a substantially simplified legal framework for new establishments (see Chapter one for more details). Figure 3.1 shows that the share of manufacturing establishments in agricultural resource-intensive industries decreased from 23 to 17 percent between 2000 and 2006. This six percentage point reduction was off-set by steady increases in the number of the labour-intensive enterprises (i.e. four percentage points) and capital-intensive ones (i.e. three percentage points). Further details on the number of establishments in the manufacturing sub-sectors using the two-digit level classification are reported in table A3.1 of the Appendix.

Figure 3.1 Number of Manufacturing Firms in 2000-2006



Source: compiled from VES 2001-2007 for the data in the period 2000-2006

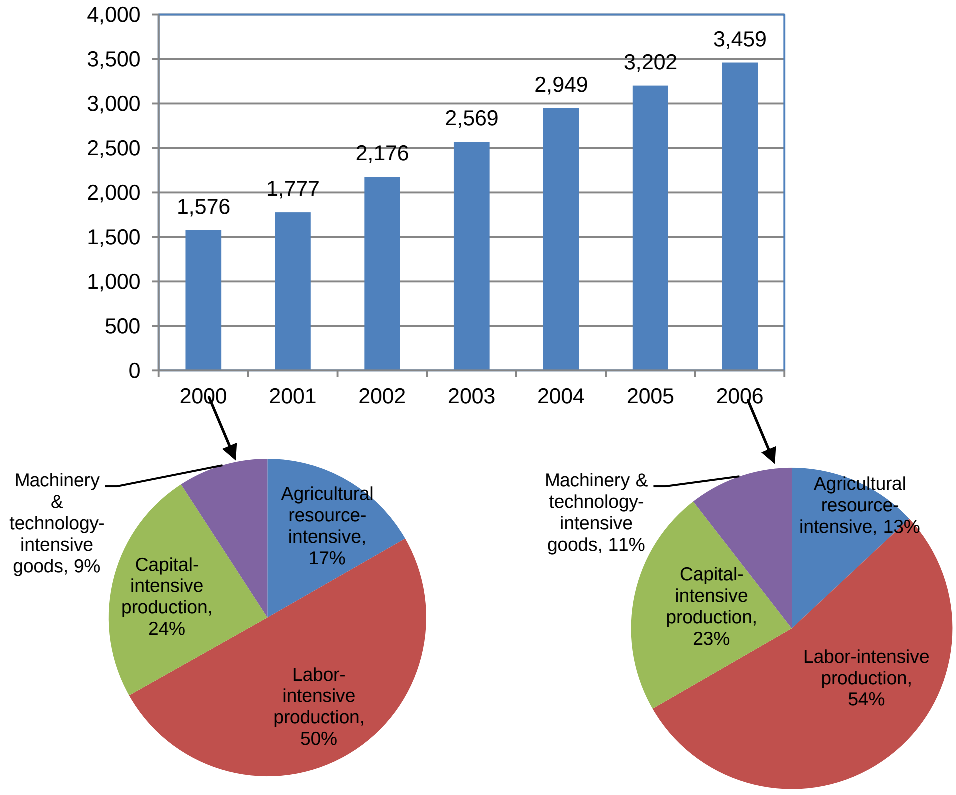
Along with the increase in the number of enterprises, the number of employees in manufacturing enterprises also increased strongly. Figure 3.2 represents employment in the manufacturing sector.[9] It is firstly noted that employment in the manufacturing sector has more than doubled during the period 2000-2006 (i.e. from 1.576 million to 3.459 million employees). This represents an annual growth rate of 14 percent with the highest growth rate found in the machinery and technology-intensive sub-sectors (i.e. 17 percent) and the labour-intensive manufacturing sub-sectors (i.e. 15 percent). This 14 percent growth rate of employment creation in the manufacturing sector is very significant when compared with the overall growth rate of employment of three percent in the period covering 1990-2006

[9] It should be noted that the figures are compiled for VESs. Compared to the total manufacturing employment provided in the GSO Statistical Yearbook 2006, employment of these enterprises surveyed in VESs accounted for nearly 94 percent of the total employment in the manufacturing sector (GSO, 2008).

(using data on the total employment recorded in GSO Statistical Yearbook 1996, 2000 and 2006).

Figure 3.2 Employments in the Manufacturing Sector, 2000-2006

Unit: thousand and %



Source: compiled from VES 2001-2007 for the data in the period 2000-2006

Although the growth of employment was impressive, the structure of employment in the manufacturing sector was stable over the period 2000-2006. There have been modest changes in the contribution of the labour-intensive and agricultural resource-intensive sub-sectors. The employment share of the labour-intensive sub-sectors has slightly increased by 3.5 percentage points while the corresponding figure in the agricultural resource-intensive sub-sectors has decreased by 3.6 percentage points. The sub-sectors which have experienced the largest increases in their employment shares were garments and furniture production (i.e. by 3.6 and 5.1 percentage points, respectively). The sub-sectors with the largest decreases in their employment contributions were food and beverage (minus 3.6

percentage points), textiles (minus 2.2 percentage points), leather tanning and processing (minus 2.5 percentage points) (see table A3.2 in the Appendix).

Vietnam has experienced an impressive export growth since the launch of the *Doi moi.* Merchandise exports clearly reflect the consequence of the openness and market reforms of the economy (see chapter 1). The total merchandise export value in 2007 is estimated to be equivalent to 68.79 percent of GDP (GSO Statistical Yearbook 2006). Before 2000, this export expansion was dominated by crude oil, but after 2000 – by manufacturing exports rather than crude oil. This is because manufacturing exports grew at an annual rate of 22 percent between 1995 and 2007, implying an eight percentage point faster growth than the growth rate of primary commodity exports (see table 3.2). As a result, the share of manufacturing exports rose from about 38.7 percent in 1995 to about a half of total exports in 2007.

It is also noted that manufacturing exports are concentrated in labour-intensive products such as textile and garments, footwear, wood and wood products, handicraft and fine art items (i.e. 32 percent of total exports and 65 percent of manufacturing exports). Over the last few years, there has been a trend towards a larger role of machinery and technology-intensive products (including computer, electronic goods and components, electrical wire and cable, bicycles and parts of bicycles, and others) in the manufacturing export value. The share of this group in the total export value increased from 0.4 percent in 1995 to 7.7 percent in 2007.

Table 3.2 Structures and Growth of Merchandise Exports, 1995-2007

	1995	2000	2001	2002	2003	2004	2005	2006	2007
Structure of exports (%)									
Total	100	100	100	100	100	100	100	100	100
Crude oil	*18.8*	*24.2*	*20.8*	*19.6*	*19*	*21.4*	*22.7*	*20.8*	*17.5*
Non oil exports	*81.2*	*75.8*	*79.2*	*80.4*	*81*	*78.6*	*77.3*	*79.2*	*82.5*
- *Primary commodities*	*29.3*	*12.8*	*11*	*11.5*	*11.4*	*12.3*	*13.6*	*13.9*	*14.2*
Agricultural	27.8	12.1	10.3	10.6	10.5	11	11.5	11.6	12.1

Mining	1.5	0.6	0.8	0.9	0.9	1.3	2.1	2.3	2.1
- *Manufacturing products*	*38.7*	*46.8*	*47.4*	*53.9*	*54.8*	*52*	*49.6*	*48.5*	*50.1*
Agricultural resource-intensive	12.7	12.4	14	14	12.4	10.3	9.7	9.5	8.7
Labour-intensive production	25.3	26.9	27.5	33.6	36	34.2	32.3	31.4	32.1
Capital-intensive production	0.4	0.7	0.9	0.9	1	1	1.1	1.3	1.5
Machinery & technology-intensive	0.4	6.8	5	5.5	5.4	6.4	6.5	6.4	7.7
- *Other (non-classified) items*	*13.2*	*16.2*	*20.8*	*15*	*14.9*	*14.3*	*14.1*	*16.9*	*18.2*
Growth rate (%)									
Total export	23.3	25.5	3.8	11.2	20.6	31.4	22.5	22.8	21.9
Crude oil	*69.8*	*67.4*	*-10.8*	*4.6*	*16.9*	*48.4*	*30*	*12.1*	*2.7*
Non oil exports	*16.3*	*16.2*	*8.4*	*12.9*	*21.5*	*27.5*	*20.4*	*25.9*	*27*
- *Primary commodities*	*4.7*	*-14.9*	*-10.7*	*16.1*	*19.2*	*42.5*	*35.1*	*25.4*	*24.9*
Agricultural	5.3	-15.5	-12.3	14.5	19.3	38.1	28.5	23.3	27.9
Mining	-5.9	-2.1	20.2	38.1	18.2	92.7	88.5	36.6	9.3
- *Manufacturing products*	*26.3*	*29.9*	*5.1*	*26.5*	*22.5*	*24.7*	*16.9*	*20*	*26*
Agricultural resource-intensive	18.6	66.7	17	11.2	6.6	9	15.7	20.5	11.7
Labour-intensive production	30.5	9.8	6.1	35.8	29.3	25	15.6	19.2	24.9
Capital-intensive production	na	na	40.3	7	35.8	41	32.1	37.9	47.7
Machinery & technology-intensive	17.5	66.9	-23.9	22.3	19	56.3	23.3	20.5	48.2
- *Other (non-classified) items*	*7.2*	*14.4*	*32.9*	*-19.9*	*19.9*	*26.1*	*20.8*	*47*	*31.6*

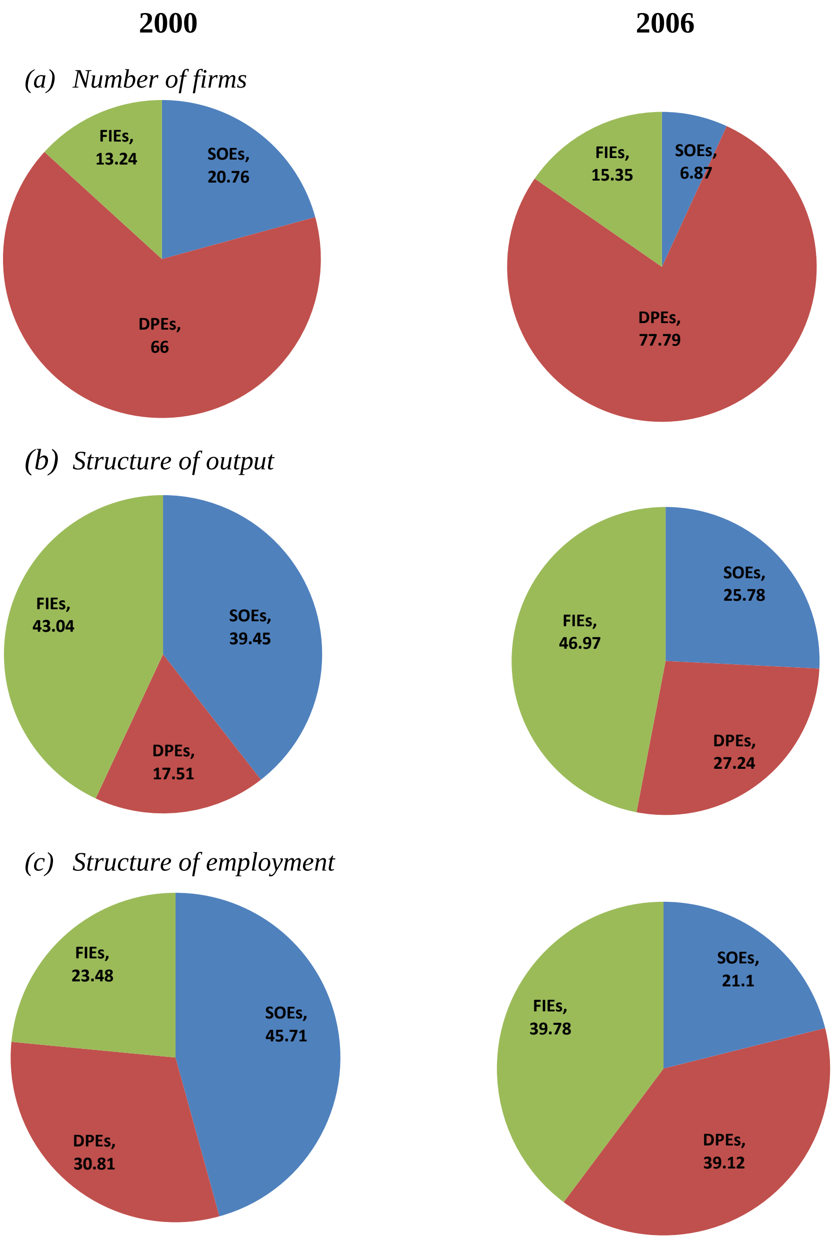
Source: compiled from GSO (2006), GSO (2007)

The rapid growth of the manufacturing sector in terms of output, job creation, exports, and number of establishments has been associated with marked changes in types of ownership. In the early 1990s, the manufacturing sector was dominated by SOEs and the role of the private sector was fairly modest. However, the role of SOEs in this sector has contracted substantially overtime (figure 3.3). With regard to the number of establishments, the proportion of SOEs declined from around one-fifth in 2000 to less than seven percent in 2006. In terms of output contribution, the share of the SOE sector sunk from nearly 40 percent to around 26 percent. Concerning employment, SOEs accounted for one-fifth of the total employment in the manufacturing sector in 2006 compared to 45 percent in 2000 (see table A3.3 in the Appendix). In contrast to the relative contraction of SOEs, the domestic private and foreign-invested sectors have experienced impressive growth in all of these aspects.

The diminishing role of SOEs in the manufacturing sector is associated with the restructuring process of the SOE sector that has been on-going since the early 1990s. In 1991, SOEs deemed either inefficient or not having sufficient demand for their products were forced to dissolve or merge with others. This was then followed by the so-called ownership transformation process, usually known as “equitization” (as in chapter 1). However, there is little evidence that the SOEs, which survived the restructuring process, improved their profitability substantially. GSO (2004) reports roughly 24 percent of SOEs being either insolvent or having negative rates of return on equity in 2003, while 35 percent were between zero and five percent. Though the profitability of SOEs is poor, this sector remains a key contributor to the state budget. For instance, it generated about 54 percent of corporate income tax and about 42 percent of VAT revenues earned from domestic production in 2004.[10]

[10] In 2004, corporate income tax accounted for 43% of the total tax revenue, and VAT for 27% (calculations from IMF, 2006).

Figure 3.3 Structure of the Manufacturing Sector by Types of Ownership, 2000-2006



Source: compiled from VES 2001-2007 for the data in the period 2000-2006

A plethora of policy reforms ushered in during the *Doi moi* resulted in a thriving domestic private sector. In the manufacturing sector, this is reflected in panel (a) of figure 3.3. The share of DPEs in the total number of manufacturing firms increased by 12 percentage points between 2000 and 2006 (i.e. from 66 to nearly 78 percent). This increase in the number of establishments was also associated with a significant increase, though less impressive, in the contribution of the private sector in the total manufacturing output.

During the period 2000-2006, the output share of the private sector has increased from 17.5 percent to 27 percent. In terms of employment, there was also a considerable improvement of nine percentage points in the contribution of the private sector in job creation in manufacturing activities over the period 2000-2006.

The Law on Foreign Investment promulgated in 1986 to attract FDI was considered one of the first concrete steps of the *Doi moi*. FDI inflows have created a foreign-owned sector that has played an increasingly important role in the Vietnamese economy (see chapter 1). Figure 3.3 also reflects this rapid growth of the FDI sector by its marked improvements in contributing to the total manufacturing output and employment. While the share of FIEs in the total number of establishments has been stable over time, the FDI sector's contribution to output was very substantial. As figure 3.3 reports, FIEs produced nearly a half of the total manufacturing output in 2006. In this regard, the FDI sector has steadily replaced the SOE sector as the driving force underlying the growth of the manufacturing sector. Panel (c) of figure 3.3 represents an important insight on the contribution of the FDI sector in job creation. It has been commonly understood that while the FDI sector has had important effects on the growth of manufacturing output and exports, its contribution to agriculture and job creation has been marginal. For instance, Pham (2007) shows that the FDI sector has never surpassed one percent of the total labour force. This is because only 5.5% of the total FDI committed (or 8.7% of the total FDI projects) in the period 1990-2006 was invested in agriculture – the major sector for employment (as shown in table 1.1 in chapter 1).[11] This could be linked to the concentration of the FDI flows in manufacturing activities. With the current contributions to employment and output, the FDI sector is now pursuing the leading role in the growth of the manufacturing sector of Vietnam.

[11] The distribution of foreign investment across the country reflects this limited contribution of the FDI sector in agriculture. The two largest cities (Hanoi and HCMC) absorbed 42% of the total capital. The Mekong River Delta (being the main bowl for rice export) and the Central Highlands (being the main area for coffee, cashew nut, and other perennial crops for export) received respectively 2.1 and 1.5 percent of the total capital committed (GSO Statistical Yearbook, various years).

In summary, Vietnam's manufacturing sector has exhibited impressive growth during the *Doi moi* and become the dominant sector in the recent economic growth. The manufacturing sector has also experienced a radical transformation in terms of ownership, in which the FDI sector has steadily replaced the SOE sector in assuming the leading role in the sector. In this context, investigating the technical efficiency of the manufacturing sector provides potentially useful insights on the performance of this sector, in addition to those obtained from the descriptive analysis above. The next section reviews the literature on technical efficiency in order to provide a background for the empirical estimation of technical efficiency in Vietnam's manufacturing sector.

3.2 Literature Review

3.2.1 Technical Efficiency: Concepts and Measurement Techniques

There are many different ways to measure firm performance, depending on the specific objectives, methodological approaches, and data availability. To analyze firm performance, this chapter will focus on technical efficiency, which is commonly considered as a meaningful measure of firm performance (see Coelli, Rao, O'Donnell and Battese, 2005 for a review). The estimates of technical efficiency will be a necessary input for the subsequent empirical analysis undertaken in this thesis. Therefore, obtaining reliable estimates of these measures is crucial. The methods to estimate technical efficiency are outlined below.[12]

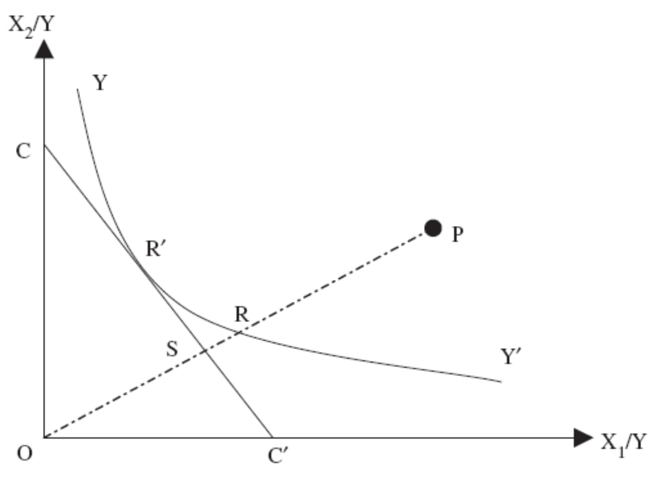
The measurement of technical efficiency is linked to the seminal paper by Farrell (1957), who advocated a method to decompose the overall (or economic) efficiency of a

[12] It is acknowledged that there are other measures of firm performance but such measures are not considered in this thesis due to either (i) the intention to keep the scope of the research manageable or (ii) data constraints (which will be discussed in details in the subsequent analysis).

production unit into its technical and allocative components. Accordingly, a production unit can be inefficient either by obtaining less than the maximum output available from a given input basket (i.e. technically inefficient) or by not purchasing the best package of inputs given their prices and marginal productivities (i.e. allocatively inefficient).

The analysis of efficiency carried out by Farrell (1957) can be explained in terms of figure 3.4. Assuming constant returns to scale as Farrell (1957) initially does in that pioneer paper, the technological set is fully described by the unit isoquant *YY'* that captures the minimum combination of inputs per unit of output needed to produce a unit of output. Thus, under this framework, every package of inputs along the unit isoquant is considered as technically efficient while any point above and to the right of it, such as point *P*, defines a technically inefficient producer since the input package that is being used is more than enough to produce a unit of output. Hence, the distance *RP* along the ray *OP* measures the technical inefficiency of the producer located at point *P*. This distance represents the amount by which all inputs can be divided without decreasing the amount of output. Geometrically, the technical inefficiency level associated with package P can be expressed by the ratio *RP/OP*, and therefore; the technical efficiency (TE) of the producer under analysis would be given by the ratio *OR/OP*.

Figure 3.4 Concept of Technical Efficiency: An Illustration



If information on market prices is known and a particular behavioural objective such as cost minimization is assumed in such a way that the input price ratio is reflected by the slope of the isocost-line *CC'*, allocative inefficiency can also be derived from the unit isoquant plotted in Figure 3.4. With respect to the least cost combination of inputs given by point R', the *SR/OR* indicates the cost reduction that a producer would be able to reach if it moved from a technically but not allocatively efficient input package (*R*) to both a technically and allocatively efficient one (*R'*). Therefore, the allocative efficiency (*AE*) that characterizes the producer at point *P* is given by the ratio *OS/OR*.

Together with the concepts of technical efficiency and allocative efficiency, Farrell (1957) describes a measure that he termed overall efficiency, which subsequently the literature renamed economic efficiency (*EE*). This measure comes from the multiplicative interaction of both technical and allocative components as

$$EE = TE.AE = \frac{OR}{OP}.\frac{OS}{OR} = OS.OP$$

where the distance involved in its definition (*SP*) can also be analyzed in terms of cost reduction.

This expression implies that allocative efficiency is also an important measure of firm performance. However, the analysis of allocative efficiency requires data on input combination and the cost structures of the production units under consideration. In the current study, information on cost structures of firms is only available for a relatively small sub-sample in one year (out of the seven under analysis here). Given this consideration, this research does not focus on allocative efficiency (see section 2.1.3 in chapter 2 for more details on data availability) or economic efficiency (which requires examination of both technical and allocative efficiency).[13]

Following the pioneering work of Farrell, a number of techniques have been developed to measure technical efficiency, including both parametric and non-parametric approaches (see Murillo-Zamarano, 2004 for a review). The major non-parametric technique is the Data Envelopment Analysis (DEA) approach introduced by Charnes, Cooper and Rhodes (1978), which generalized Farrell's (1957) single input/output efficiency measure and reformulated it as a mathematical programming problem. The DEA procedure essentially involves the construction of a frontier envelopment surface, which is determined by those units that lie on it (i.e. the efficient units). Units that do not lie on this envelopment surface can then be considered as inefficient and individual inefficiency scores can then be calculated for each unit. The main attributes of DEA techniques are their flexibility and adaptability which led to the development of a large number of extensions to the initial model proposed by Charnes *et al.* (1978). However, the main pitfall of this approach is that it does not allow for any control of statistical noise, and thus can be initially considered as a non-statistical technique where the inefficiency scores and the envelopment surface are 'calculated' rather than 'estimated'.

The parametric approaches are generally divided into the estimation of deterministic (or full frontier) or stochastic models. Unlike the non-parametric approach, the deterministic approach envelopes all observations and identifies the distance between the observed production and the maximum production (defined by the frontier and the available technology) as technical inefficiency (see Aigner and Chu, 1968). By such a definition,

---

[13] Dollar and Wei (2007) examine the dispersion of marginal returns to capital as proxy for investment efficiency in the manufacturing sector of China. As the major interest of the current study is technical efficiency and workplace injuries, other measures of efficiency (including the Dollar and Wei's (2007) proxy for investment efficiency) are not examined in this thesis. However, as an additional exercise to assess whether the determinants of technical efficiency might have similar effects on other measures of efficiency, the Dollar and Wei's (2007) approach was also explored as part of chapter four.

this approach implicitly assumes that all deviations from the efficient frontier are under the control of the firm. However, there are in fact circumstances beyond the firm's control such as regulatory framework, socio-economic and demographic factors, among others, that can also determine the firm's performance. In addition, as it is parametric, the approach requires some pre-defined or imposed functional forms and some distributional assumptions. Any specification problem is thus considered as inefficiency under the deterministic approach. On the contrary, the stochastic frontier approach allows both specification errors and uncontrollable factors to be modeled independently from the technical efficiency component by introducing a double-sided random error term in the production functions of some imposed functional forms (see Coelli *et al.*, 2005).

In fact, the choice of method to be used in measuring technical efficiency (either 'estimating' using parametric approaches or 'calculating' using non-parametric approaches), according to Coelli *et al.* (2005), depends on the specific objectives and such a choice should be empirically feasible. Murillo-Zamarano (2004) further argues that "[…] neither goal programming models (i.e. DEA) nor deterministic econometric approaches provide accurate measures of the productive structure" (p. 48). In this regard, the stochastic frontier models are preferred and this approach has become the most popular and widely used parametric approach in the measurement of technical efficiency in the economics literature (see Kalirajan and Shand, 1999; Murillo-Zamarano, 2004; and Coelli *et al.*, 2005 for a comprehensive review). Given this consideration, the research reported in this thesis uses the stochastic frontier models, which are explained below, for empirical analysis in this chapter.

3.2.2 Stochastic Frontier Approach

Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977) simultaneously developed a Stochastic Frontier Model (SFM) by introducing a double-sided random error term into the specification of the production frontier function to account for statistical noise. In the simplest specification, a production function in a cross-sectional context can be expressed as

$$y_i = \beta_0 + \boldsymbol{x}_i'\beta + v_i - u_i \qquad \text{with} \quad i = 1, 2, \ldots, n \qquad [3.1]$$

where y_i is a measure of (log) output of firm i, $\boldsymbol{x}_i$ is the vector of the logarithms of inputs, β is a vector of unknown parameters applicable to the vector $\boldsymbol{x}_i$. The term $(v_i - u_i)$ is a composed error term, where v_i represents randomness (i.e. statistical noise) and u_i represent the technical inefficiency of firm i. With this expression for the production frontier function one can evaluate whether the difference between the actual output obtained and the potential frontier output is mainly because the firm did not use the best practice technique or is due to external random or unobserved factors (Kalirajan and Shand, 1999).

In expression [3.1], the random error term is independent and identically distributed, v_i~ *iid* (0, σ_v^2), while a number of distributions have been assumed for the non-negative one-sided (inefficiency) error in the literature. For instance, Aigner *et al.* (1977) obtained maximum likelihood (ML) estimates of equation [3.1] under the half-normal (or truncated normal) distribution assumptions of u_i (or u_i~ $iid(\mu, \sigma_u^2)$), which means that the probability density function of each u_i is a truncated version of a normal random variable having zero mean and variance σ_u^2. Meeusen and van den Broeck (1977) used an exponential distribution with mean λ for u_i (i.e. u_i~ *iid* (λ,0)). For efficiency measurement analysis, the composed error term needs to be separated and distributional assumptions are required.

The half-normal distribution model

If u_i~ *iid* $N^+(0,\sigma_u^2)$, that is, the one-sided technical inefficiency error component is assumed to be half-normal distributed, the log likelihood function for a sample of I producers is

$$\ln L = const - I\ln\sigma + \sum_i \ln\Phi\left(-\frac{e_i\lambda}{\sigma}\right) - \frac{1}{2\sigma^2}\sum_i e_i^2 \qquad [3.2]$$

and Jondrow, Lovell, Materov and Schmidt (1982) showed that the expected value of u_i conditional on the composed error term is

$$E[u_i|e_i] = \frac{\sigma\lambda}{(1+\lambda^2)}\left[\frac{\phi(e_i\lambda/\sigma)}{\Phi(-e_i\lambda/\sigma)} - \frac{e_i\lambda}{\sigma}\right] \qquad [3.2']$$

where $\phi(.)$ is the density of the standard normal distribution, $\Phi(.)$ the cumulative distribution function (on the integral of the density function), $\lambda = \sigma_u/\sigma_v$, $e_i = v_i - u_i$ and $\sigma = (\sigma_u^2 + \sigma_v^2)^{1/2}$.

The exponential distribution model

If u_i~ *iid exponential*, that is, the asymmetric error term follows an exponential distribution, the log likelihood function for a sample of I producers can be written as

$$\ln L = const - I\ln\sigma_u + I\left(\frac{\sigma_v^2}{2\sigma_u^2}\right) + \sum_i \ln\Phi\left(\frac{-e_i - \theta\sigma_v^2}{\sigma_v}\right) + \sum_i \theta e_i \qquad [3.3]$$

Jondrow *et al.* (1982) also computed the expected value of u_i conditional on the composed error term with the following result:

$$E[u_i|e_i] = (e_i - \theta\sigma_v^2) + \frac{\sigma_v\phi[(e_i - \theta\sigma_v^2)/\sigma_v]}{\Phi[(e_i - \theta\sigma_v^2)/\sigma_v]} \qquad [3.3']$$

where $\theta = 1/\sigma_u$.

The truncated normal distribution model

Half-normal and exponential distributions both have a mode at zero. This causes conditional technical inefficiency scores, especially in the neighbourhood of zero, to be artificially high. Moreover, these distributional assumptions fix a pre-determined shape for the distribution of the disturbances that can also be considered as something of a shortcoming. Stevenson (1980) argued that the zero mean assumed in the model of Aigner *et al.* (1977) was an unnecessary restriction and produced some results for a truncated distribution as opposed to a half-normal distribution. The truncated normal distribution assumed for *u* generalizes the one-parameter half normal distribution, by allowing the normal distribution, which is truncated below at zero, to have a nonzero mode (u_i~ *iid* $N^+(\mu, \sigma_u^2)$ where μ is the mode of the normal distribution). The log likelihood function for a sample of *I* producers are then given by:

$$\ln L = const - I \ln \sigma - I \ln \Phi\left(\frac{\mu}{\sigma_u}\right) + \sum_i \ln \Phi\left(\frac{\mu}{\sigma\lambda} - \frac{e_i \lambda}{\sigma}\right) - \frac{1}{2}\sum_i \left(\frac{e_i + \mu}{\sigma}\right)^2 \qquad [3.4]$$

Greene (1993) shows that the conditional technical inefficiencies for the truncated model are obtained by replacing $e_i \lambda / \sigma$ in the expression [3.2] for the half-normal case with:

$$u_i^* = \frac{e_i \lambda}{\sigma} + \frac{u_i}{\sigma\lambda} \qquad [3.4']$$

Given different distributional assumptions for the density function for u_i, Coelli *et al.* (2005) argue that the estimates of technical efficiency are quite sensitive to which distributional assumption is invoked in estimation. Therefore, investigating estimates of technical inefficiency under alternative distributional assumptions of the one-sided error term should be made in empirical studies on firm efficiency. In addition, the results might vary depending on different assumptions made regarding the production function structure (e.g. Cobb-Douglas or translog form) and this also calls for attention in implementing empirical analysis on technical efficiency.

One assumption underlying the stochastic production frontier model is that of homoscedasticity of both error components (i.e. both error terms have constant variances). However in many cases the error term may be heteroscedastic, with the variance positively correlated with size-related characteristics of the observations. The heteroscedasticity problem is potentially severe in a stochastic production frontier context, especially with the cross-sectional analysis adopted in this chapter. The symmetric noise error component might be heteroscedastic if the sources of noise vary with the size of producers. Similarly, the one-sided technical inefficiency error component might be heteroscedastic if the sources of inefficiency vary with the size of producers (Kumbhakar and Lovell, 2003). Heteroscedasticity can appear in either error components, and it can affect inferences concerning production technology parameters, as well as the parameters of either error components. As a result it can ultimately affect inferences concerning technical efficiency.

As argued in Kumbhakar and Lovell (2003), if heteroscedasticity appears in the symmetric noise error component v, it does lead to bias and inconsistent in the estimates of technical efficiency, although it does not lead to bias in estimates of parameters describing the structure of the production frontier. The effect of heteroscedasticity in u makes matters worse than when heteroscedasticity features in v alone. In this case both the estimates of the parameters describing the structure of the production frontier and the estimates of technical efficiency will be adversely affected by neglected heteroscedasticity (Caudill and Ford, 1993). If heteroscedasticity occurs in both error components, estimates of the parameters describing the structure of the production frontier are biased by the neglect of heteroscedasticity in u, and estimates of technical efficiency are biased by the neglect of heteroscedasticity in either v or u. Kumbhakar and Lovell (2003) also suggest that, from an empirical standpoint, the proper procedure is to start with a model that incorporates heteroscedasticity in both error components. Further details regarding modeling and estimation in the presence of heteroscedastic errors are provided in Caudill and Ford (1993), Caudill, Ford, and Gropper (1995) and Kumbhakar and Lovell (2003).

3.2.3 Empirical Evidence on Technical Efficiency in Transition Economies

The above empirical framework has been used in many applications and helped generate a vast empirical literature on technical efficiency in various fields of economics including *inter alia* finance and banking, agriculture, industries, environmental economics, development economics. Kalirajan and Shand (1999), Murillo-Zamarano (2004), and Coelli *et al.* (2005) provide a comprehensive review of the empirical studies using the stochastic frontier approach. Given the focus of this chapter is on technical efficiency of the manufacturing sector in Vietnam, this sub-section reviews a limited but growing number of studies on technical efficiency of the manufacturing sectors in transitional economies. As Vietnam shares a number of common features with other countries that experienced a transformation from centrally planned to market economies, this review should help to contextualize the empirical analysis represented in section 4 below..

In the existing empirical studies on technical efficiency of the manufacturing sectors in transitional economies, Danilin, Materov, Rosefielde and Lovell (1985) provides an early examination of technical efficiency in the former Soviet Union. The paper estimated technical efficiency for 151 cotton refining enterprises by assuming a truncated normal distribution of the technical inefficiency error term. The overall mean technical efficiency was reported at a very high level of 92.9 percent. There existed some very inefficient enterprises, but is noteworthy that more than half of the enterprises had estimated technical efficiency levels in excess of 94 percent, with 90 percent of the sampled enterprises at least 84 percent technically efficient. Brock (1999) reported evidence on technical efficiency of industrial firms in a Siberian province during a period from 1971 to 1990. In contrast to Danilin *et al.* (1985), this research found an average level for technical efficiency varying from 33 to 59 percent. Brock (1999) also noted that technical efficiency estimates may be sensitive to the econometric method chosen and thus recommended that several methods should be used simultaneously when measuring technical inefficiency in any economic application.

Jones, Klinedinst and Rock (1998) used the data from the Bulgarian Labour Flexibility Survey, the Bulgarian Management Survey, and the Bulgarian Economic Survey for 247 firms in 1989, 1991 and 1992 to estimate the technical efficiency level of the Bulgarian manufacturing sector. The average level of technical efficiency using this data was found to be between 60 and 72 percent. In addition, the dispersion of technical efficiency increased during the early transition. This is somewhat in contrast with Danilin *et al.* (1985) who argued that variation in technical efficiency in the former Soviet Union and other transitional economies was limited. Such large variation in technical efficiency of manufacturing activities in transitional economies was also found in Brada, King and Ma (1997) for the case of Czechoslovakia and Hungary. Brada *et al.* employed the Cobb-Douglass production function with a half-normal distribution of the technical efficiency error term to examine efficiency of the Czechoslovak manufacturing sector in 1990 and the Hungarian manufacturing sector in 1991. A great dispersion in enterprise efficiency within each sector was noted and average levels of efficiency were reported in a range from 40 to 80 percent. In both countries there was evidence of inefficient firms, with the distribution of efficiency affected by a small number of inefficient outliers.

In terms of transitional economies, China is probably most similar to Vietnam in terms of the economic transition agenda. In particular, the manufacturing sectors in China and Vietnam could both be characterized by a gradual process of SOE reforms. Therefore, evidence on technical efficiency in China is of potential interest to this research.

Reviewing the empirical literature on the Chinese manufacturing sector, Liu and Liu (1996) provided probably the earliest study on technical efficiency in that country. The study used the data from 382 SOEs observed for the period 1980–1989 in four provinces (comprising Jiangsu, Sichuan, Shanxi, and Jilin) operating in seven manufacturing sub-sectors, including food processing, textiles, chemicals, construction materials, metallurgy, machinery, and electronics. The paper found a very low level of technical efficiency in the early stages of the Chinese economic reform. With the exception of textiles and food, the average level of technical efficiency was around 40 percent in 1980. However, reform-induced gains in technical efficiency were significant in all industries. In electronics, machinery, and metallurgy in particular, the average level of efficiency grew by 35, 32, and 19 percent from 1980 to 1989, which amounted to increases of 3.5, 3.2, and 1.9 percent per annum.

More recently, Movshuk (2004) examined technical efficiency in the iron and steel industry in China by focusing on 82 iron and steel enterprises (which accounted for two-thirds of total output) in various years during the period 1988-2000. In contrast with Liu and Liu (1996), this study reported a very high level of efficiency in iron and steel enterprises. On average, these enterprises were found to be operating at around 91 percent efficiency. In addition, Movshuk noted the poor performance of the largest SOE firms in this industry compared to the average level. Investigating the four largest SOE steel enterprises, the study found that they were all subject to generous access to bank loans and a number of privileges from the authorities as they were considered ‘too big to fail’. Based on this observation, the author concluded that large enterprises had no efficiency advantages over smaller ones and SOEs in this industry may bring little, if any, improvement in performance of this industry in China.

In the context of Vietnam, there has been a modest but a growing literature on technical efficiency of the manufacturing sector. Nguyen *et al.* (2002) and Vu (2003) are probably the first studies using the stochastic frontier approach to inform technical efficiency. Vu (2003) applied this approach to estimate technical efficiency of 164 manufacturing SOEs surveyed by the Ministry of Finance between 1997 and 1998. In this study, the author used a translog production function but did not investigate the sensitivity of estimates to the distributional assumptions of the technical inefficiency error term. Using such a specification, Vu reported an average technical efficiency level of 79 percent in both 1997 and 1998. Nguyen *et al.* (2002) employed the same method to examine the efficiency of 96 textiles and garment firms surveyed between 1999 and 2001. The study found that most of the firms in the sector were operating at a high level of technical efficiency (the mean values of technical efficiency were estimated at around 87 percent). More recently, Tran *et al.* (2008) using a sample of around 600 private SMEs surveyed by the MOLISA and Stockholm School of Economics in 1996 and 2001 to inform the efficiency of these private firms. Dividing this sample into five sub-sector (including chemicals, manufactured goods, machinery and transport equipment, and miscellaneous manufactured articles), Tran *et al.* found an average technical efficiency in the range between 80 to 92 percent, which is as high as that found for the textile and garment industry surveyed by Nguyen *et al.* (2002)

The above studies in Vietnam have been based on the samples of firms that were collected through small and medium-sized surveys. Though these studies are informative, they are less convincing in informing efficiency of the manufacturing sector as a whole. Nguyen and Giang (2008), Hoang, Carlin and Pham (2008), and Dao *et al.* (2010) represent a departure from the above approach. Nguyen and Giang (2007) used the VESs 2002 and 2003 to investigate technical efficiency in a number of industries in Vietnam including metalware, aquaculture processing, construction, banking, hotel services, hospital and health centres. The study used a combination of the stochastic frontier approach and non-parametric approach (DEA method). In the case of the metalware industry, the study found an average technical efficiency level of around 40 percent with standard deviation of nearly 20 percent. The level of technical efficiency in aquaculture processing varied between 40 to 60 percent, depending on the years and the estimation techniques employed. Hoang *et al.* (2008) examined technical efficiency in the manufacturing sector by focusing on around 4,600 enterprises in the period from 2001 to 2005. As reported in this study, Vietnam's industrial sector has operated from between 44 to 52 percent of its efficient frontier, depending on the sectors of interests. Using the entire sample of manufacturing enterprises available from the Vietnam Enterprises Survey 2002, Dao *et al.* (2010) while investigating the potential linkage between trade liberalization and technical efficiency found an average technical efficiency level of 62 percent with a standard deviation of around 16 percent. Dao *et al.* noted that the estimated technical efficiency and its variation across industries in Vietnam are compatible with those reported for some other transitional economies.

This study will expand previous studies by using large-sample surveys covering the period from 2000-2006. The next section will outline the empirical strategy used in estimating technical efficiency for Vietnam's manufacturing sector in this period as well as a brief description of the data sources and variables used.

3.3 Methodology and Data

3.3.1 Empirical Methodology

In this chapter, the SFM approach is used to estimate technical efficiency using the cross-sectional firm level data on the manufacturing sector in Vietnam. Similar to the existing empirical literature on technical efficiency (as noted above), either a Cobb-Douglas or a translog production function could be used in estimating technical efficiency. The regression equation for the former can be expressed as

$$\ln y_i = \beta_0 + \ln \boldsymbol{k}_i{}'\beta_k + \ln \boldsymbol{l}_i{}'\beta_L + v_i - u_i \qquad [3.5]$$

and the regression equation for the latter can be expressed as

$$\ln y_i = \beta_0 + \ln \boldsymbol{k}_i{}'\beta_k + \ln \boldsymbol{l}_i{}'\beta_l + [\ln \boldsymbol{k}_i]^2{}'\beta_{kk} + [\ln \boldsymbol{l}_i]^2{}'\beta_{ll} + [\ln \boldsymbol{k}_i \ln \boldsymbol{l}_i]'\beta_{kl} + v_i - u_i \qquad [3.6]$$

where ***k*** and ***l*** are respectively vectors of capital and labour input for firm *i* with *i* = 1, 2, …n; the other variables and terms are expressed in the same manner as in [3.1].[14]

As both [3.5] and [3.6] could be used, a specification test to verify the appropriate functional form for the production function is necessary. In this chapter, a log likelihood ratio test is employed to evaluate whether a Cobb-Douglas production function or a translog form is preferable given the actual relationship between output and input in the manufacturing sector of Vietnam. The essence of this log likelihood ratio test is explained below.

A log likelihood ratio test (Mood, Graybill and Boes, 1974; Bickel and Doksum, 1977; Hogg and Tannis, 1983) is based on the ratio of the likelihoods. Assuming that the null hypothesis of the Cobb-Douglas specification is preferable in the manufacturing sector of Vietnam, the log likelihood function in this case will be that of equation [3.5]. This equation is known as the restricted log-likelihood function (log L_R) since it is obtained by imposing restrictions on the cross-product and quadratic parameters in the translog model. The equation [3.6] is known as the unrestricted log-likelihood function (log L_U). To test

[14] It is noted that the framework in [3.5] and [3.6] represents cross-sectional analysis for the period 2000-2006 under consideration. This focus on cross-sectional analysis does not allow an investigation of movements of technical efficiency over time – which might be likely. To overcome this shortcoming, the panel of 5,880 firms constructed for the years 2001-2006 (as noted in section 2.1.3 of chapter three) will be used to estimate the technical efficiency in the manufacturing sector. The results will be discussed in section 3.4.2 (and explored further in chapter 4). As this panel is subject to potential problems, this exercise is best interpreted as suggestive in this thesis and is undertaken to provide a basis for some discussion on the above issue. Therefore, the technical details of this panel framework are not outlined here. However, Coelli et al. (2005) provide a discussion of the stochastic frontier model with panel data (p.275-p.280).

whether a Cobb-Douglas production function or a translog is preferable, the log likelihood ratio test obtains the following test statistic:

$$LRT = -2(\log L_R - \log L_U) \sim \chi_k^2 \qquad [3.7]$$

where k is the number of restrictions under test, log L_U and log L_R are the unrestricted log-likelihood function (equation [3.6]) and the restricted log-likelihood function (equation [3.5]), respectively. Since the sample size is large, the test statistics LRT given in expression [3.7] follows the chi-square distribution with the degree of freedom equal to the number of restrictions imposed by the null hypothesis, which equals three in this case. If the value of the test statistic LRT is larger than the critical value then the null hypothesis of the Cobb-Douglas production function is rejected, suggesting the translog production function is statistically favoured.

As discussed in section 2, the presence of heteroscedasticity in either one of the two error terms or both of these two terms results in biases in either the coefficient estimates or technical inefficiency or both. Therefore, once the functional form of the production function is statistically justified, it is then necessary to test for heteroscedasticity. In this regard, the log likelihood ratio test can again be adopted to verify three following cases: (i) the two error terms are assumed to be homoscedastic; (ii) the error term v_i is assumed to be heteroscedastic; (iii) both error terms v_i and u_i are heteroscedastic. To test for heteroscedasticity, the log likelihood ratio test (as above) can also be used to verify whether the data used in this chapter exhibits one of the three aforementioned cases.

If heteroscedasticity is detected, it is then necessary to adopt appropriate solutions to correct for heteroscedasticity. As shown in Schmidt (1986), when only the error terms v_i is found to be heteroscedastic, a model incorporating heteroscedasticity in v must conserve on parameters by expressing σ_{vi}^2 as a function of a vector of factors outside the control of the firm, z_i , such as $\sigma_{vi}^2 = g_1(z_i;\delta_1)$, which can be estimated using maximum likelihood techniques.

However, when technical inefficiency error term is heteroscedastic, the solution is more complicated. Some approaches to correct for heteroscedasticity of the one-sided error term were suggested by Schmidt (1986), Caudill and Ford (1993), and Caudill *et al.* (1995). Accordingly, the technical inefficiency error term is assumed to be a function of factors, z_i , that are under control of producers. If we make the distributional assumptions u_i~ $N^+(0,\sigma_{ui}^2)$ with $\sigma_{ui}^2 = g_2(z_i;\delta_2)$ this model could be estimated using maximum likelihood techniques as suggested in Caudill *et al.* (1995).

Finally, the model in which both *u* and *v* are heteroscedastic is a combination of the two models above. In this case, σ_{vi}^2 could be expressed as a function of a vector of factors outside the control of the firm z_i with $\sigma_{vi}^2 = g_1(z_i;\delta_1)$ and σ_{ui}^2 as a function of factors that are under control of producers with $\sigma_{ui}^2 = g_2(z_i;\delta_2)$. Similar to the case when the technical inefficiency error term, u_i, is heteroscedastic, estimation by maximum likelihood is the only option available. Given this consideration, this chapter follows the methods used in Schmidt (1986) and Caudill *et al.* (1995) to correct for potential heteroscedasticity problems in the stochastic frontier model estimated here.

Once the functional form of the production function and the assumption regarding heteroscedasticity are determined, the next step is to evaluate which distributional assumption of the technical inefficiency error term is appropriate given the nature of the data on Vietnam's manufacturing sector available to this research. Coelli *et al*. (2005) suggest that empirical studies on technical efficiency should consider for the robustness of the estimates of technical efficiency by using alternative distributional assumptions for u_i, namely the half-normal, the truncated normal and the exponential. This chapter also adopts this strategy in order to inform on whether or not the estimates for technical efficiency are sensitive to these distributional assumptions. In addition, to overcome the so-called “model selection problem”, the Akaike information criterion (AIC) and the Bayesian information criterion (BIC) are employed to infer which distributional assumption is most appropriate for the empirical analysis. The essence of these AIC and BIC are briefly explained below.

Following Akaike (1974), the Akaike information criterion (AIC) is a criterion for selecting among nested econometric models, not a test on the model in the sense of hypothesis testing. When there are several competing models the AIC is a number associated with each model, which is given as

$$AIC = 2k - 2\ln(L) \qquad [3.8]$$

where k is the number of independently adjusted parameters within the model, and L is the maximized value of the likelihood function for the estimated model. Given a data set, several competing models may be ranked according to the value of their AIC, with the one having the lowest AIC being the best among the given alternatives. According to Raftery (1986) one drawback of the AIC method is that as the sample size increases there is an increasing tendency to accept the more complex model. In this regard the Bayesian information criterion (BIC) (Schwarz, 1978) takes sample size into account and for each model, it is calculated as

$$BIC = \left[-2\ln L + k\ln(n)\right] \qquad [3.9]$$

where k and L are defined similar to the above; n is the sample size. As with the previous method, the model is chosen with the smallest value of BIC. In this chapter, the AIC and BIC will be calculated for each model where the technical inefficiency error term follows either half-normal, exponential or truncated normal distribution in order to evaluate which distributional assumption of the technical inefficiency error term is appropriate given the nature of the manufacturing sector in Vietnam.

3.3.2 Data and Construction of Variables

As discussed in chapter 2, the current chapter will extract the data on manufacturing enterprises available from the VESs in the period 2001-2007. The construction of main variables used in this chapter is summarized below. Table A3.4 in the Appendix provides a brief description and summary statistics for these variables.

Output [*lnY*] is the firm's total revenue derived from selling various outputs during the year. It is theoretically preferable to use value added as an indicator for the value that a firm creates over a year (see some researches which have used value added for output, for instance, Hossain and Karunaratune, 2004 for Bangladesh, Jones *et al.*, 1998 for Bulgaria, Wadud, 2004 for Australia) but calculating value added is usually constrained by a lack of data. Moreover, as pointed out by Basu and Fernald (1995), adopting a value-added production function may yield misleading results if there is imperfect competition or increasing returns to scales.[15] Ideally, revenue from main activities should be separated from other subsidiary sources. And as a consequence, this will require having labour, capital, and other firm-level characteristics identified for those used for major business activities and those used for other supplementary activities. Unfortunately, while separating revenues by different sources is possible, the surveys do not allow a distinction on how inputs are used for different activities. Given this consideration, the information on the total revenue is used as the only possible choice. In order to ensure comparison over time, revenues were adjusted to the base year of 2000 using the official CPI published by the GSO. It is acknowledged that using the CPI in adjusting current values of revenues

[15] Nevertheless, the usage of revenue as the dependent variable in the production function in the current study is mainly driven by data constraints. This was also acknowledged as a constraint in previous studies on technical efficiency in the manufacturing sector of Vietnam (for instance, see Hoang *et al.* 2008; Nguyen *et al.* 2002; Nguyen and Giang 2008).

generated by manufacturing firms is subject to certain shortcomings as the CPI series might not be the best price index for this purpose. Alternative choices such as the use of sector price indices are, however, constrained by a lack of data.[16] In estimating the production function, firm's revenues as the dependent variable are given in the natural logarithm.

Capital [*lnK*] as a proxy for capital input is measured by the purchased value of fixed assets, including fixed assets, net of accumulative depreciation. This measure of capital may not be the best proxy since different depreciation schemes adopted across firms may result in inaccurate estimates of the true capital stock. In addition, this proxy measure cannot reflect the flow of the service provided, which is the true measure of a capital input. According to Lundrall and Battese (2000) a better measure of capital could be the replacement value of the capital stock, corrected for capacity utilization. This measure can reflect the flow of capital service, but also allows capturing the difference in the quality of capital. However, data on replacement value and capacity utilization are not available in the VESs. Hence, this study employs the purchased value of fixed assets adjusted for depreciation as the measure for capital. In order to facilitate comparison over time, monetary values of capital over times were also adjusted to the base year of 2000 using the GSO's official CPI.

Labour [*lnL*] could be measured either by a firm's number of employees or by the total wage bills. The measure of labour by the firm's number of employees is an imperfect measure of labour inputs as it cannot capture differences in labour quality and labour

---

[16] Vietnam's GSO has never published manufacturing/producer price indices or regional price indices. The only estimation for regional differences was undertaken by GSO and the World Bank in the series of the Vietnam Households Living Standard Survey (VHLSSs) in order to adjust for regional differences in the household consumption expenditures. However, as this reflects difference in purchasing a standard basket of consumer goods, these are not the relevant indices for adjusting the revenues of manufacturing firms. More importantly, manufacturing firms supply their products nationwide, many of them also export to the international marketplace (around one-third of manufacturing firms export). In any event, once regional dummies are controlled for, these should capture adequately the effects of the more important regional cost differences.

effort, which could be partially captured by total wage bill. However, the measure of total wage bill as a labour input causes the problem of identity and leads to estimations of technical efficiency and technical inefficiency effect variable do not have much economic meaning (Nguyen *et al.* 2002). Consequently, the firm's number of employees, which is chosen to measure labour input, could be regarded as a logical measure for the labour input. In this chapter, this variable is captured by the natural logarithm of employment size (measured in persons).

Other variables are used to correct for heteroscedasticity of the random error term and the technical inefficiency error term. These variables are identified on the basis of a survey of the literature and data availability. As Schmidt (1986) suggests in his survey article, the random component v_i can be associated with factors outside the control of the firm, while u_i can be associated with factors under the control of firm. Therefore, this chapter employs a trade variable and the age of firms as a set of variables which is outside the control of the firm to correct for heteroscedasticity of the random error term. In the model, a weighted tariff in the previous year expressed in fractional terms is used as a measure of trade protection and the age of the establishment is proxied for firm's age which is the number of years since the firm's establishment year.

In regard to a set of variables under the control of the firm, types of ownership, regional effects and firm's characteristics such as the proportion of female employees, proportion of employees with contract and personal computer (PC) per employees are employed to correct for heteroscedasticity of the technical inefficiency error term.[17] With regards to types of ownership, firms are classified into one of the following ownership forms

[17] It should be noted that the structure of heteroscedasticity in the production frontier model is hardly known so the variables using in this study might not fully represent the true structure of heteroscedasticity. As a result, there is a potential for mis-specification though there is little that can be done about it. In addition, it is also likely that the heteroscedasticity modelling in the current study may simply be attributable to the non-linear effect of the assumed heteroscedastic variables on production rather than the effect of heteroscedasticity.

including SOEs, FIEs, and DPEs.[18] With regards to location, we use a set of dummy variables for regions including the Northern Uplands, Red River Delta, North Central Coast, South Central Coast, Central Highlands, Southeast and Mekong River Delta. In addition, other variables of firm's characteristics are also used in the model. The proportion of female employees is calculated as the total number of female employees over total employees at the end of the year. The proportion of employees with a contract is defined as the total number of employees that have contract with the firm over the total number of employees at the end of the year. PC per employees is a factor to proxy for the technology level of firms, which is the number of computers per employees (further description of these firm-level variables will be provided in subsequent chapters).

3.4 Empirical Results

This section reports the empirical results obtained from implementing the empirical strategy on the data samples as specified in section 3. As highlighted earlier, verifying the functional form of the production functions, distributional assumptions of the technical inefficiency term, and heteroscedasticity of the error terms are essential to providing reliable estimates of technical efficiency, the first sub-section focuses on these specification tests. Once these issues are tested, the second sub-section concentrates on analyzing the estimates of technical efficiency in the Vietnamese manufacturing sector over the period 2000-2006. It should be emphasized that this chapter will focus on computing the technical efficiency of the manufacturing sector without investigating the

[18] It is desirable to distinguish between different types of SOEs (for instance 'central-level' SOEs which are under the oversight of Prime Minister or line ministries, and 'local-level' SOES which are under the management of provincial authorities). It is also desirable to make distinction between 100 percent foreign-invested firms and joint ventures (with some shares contributed by domestic counterparts). However, questions on types of ownerships are not defined consistently across VESs. Changes in legal system on different types of enterprises (for instance the Enterprise Law as reviewed in chapter one) provides a partial explanation for this inconsistency. Therefore, it is not possible to adopt a finer set of ownership variables.

determinants of this efficiency measure – which will be the subject of a subsequent chapter.

3.4.1 Specification tests

It is first important to test for the functional form of the production function. In this chapter, the Cobb-Douglas production function is tested against the translog production function using the log likelihood ratio test (see section 3.1). The LRT test results under different assumptions of the distribution of the technical inefficiency term and heteroscedasticity of the two error terms are reported in table 3.3. It is apparent that the translog production function is favoured as the Cobb-Douglas function is decisively rejected in all cases over the period 2001-2006. However, the 2000 data represents a less conclusive finding as a Cobb-Douglas functional form is preferred in five cases, while the translog production function is decisively accepted in four (out of nine) cases. This less conclusive result calls for an investigation of the 2000 data. However, no evidence either of outliers or inconsistencies between the data in 2000 and those in the remaining years were found. Moreover, it should be noted that the translog production function is favoured in all cases where both error term v_i and u_i are assumed heteroscedastic, which is, as shown below, the appropriate case for estimation in this chapter. Under such circumstances, the translog production function is adopted, though the estimates obtained for 2000 may need to be interpreted with some degree of caution. In addition, the consequences of over-parameterisation of the production function are less severe than if we mis-specify the function through the adoption of an unjustified austere form. Hence, we believe our estimates are not biased as a consequence of this decision.

Given the translog production function is employed, the next step is to verify whether one or both of the two error terms are heteroscedastic. Table 3.4 reports the test results using the same log likelihood ratio test for the three assumptions, including (i) the two error terms are assumed to be homoscedastic; (ii) the error term v_i is assumed to be heteroscedastic; (iii) both the error terms v_i and u_i are assumed heteroscedastic. These heteroscedasticity assumptions are tested using the translog production function under all the three distributional assumptions of the technical inefficiency terms (i.e. half-normal, exponential, and truncated). Under each distributional assumption of the technical inefficiency term, the log likelihood ratio tests the three following cases (a) the homoscedasticity of both error terms against the case when only the random error term is assumed heteroscedastic; (b) only the random error term is assumed heteroscedastic *versus* the case when both error terms are assumed heteroscedastic; and (c) the homoscedasticity of both error terms against the case when both error terms are assumed heteroscedastic. Results show that under (a) the homoscedasticity assumption of both error terms is decisively rejected at the 1% significance level in all cases. Under (2) and (3) the homoscedasticity assumption of both error terms is also rejected at the 1% significance level. From these test results, it is inferred that the model in which both the random error term and the inefficiency error term are heteroscedastic is chosen for all years under consideration.

Table 3.3 Log Likelihood Ratio Tests for Translog vs. Cobb-Douglas Production Function

	Half-normal			Exponential			Truncated normal		
	(1)	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**
2000									
Test statistics	3.2	3.68	10**	4.46	5	10**	4.46	7.1*	10**
Decisions	Cobb-Douglas	Cobb-Douglas	Translog	Cobb-Douglas	Cobb-Douglas	Translog	Cobb-Douglas	Translog	Translog
2001									
Test statistics	14.92***	16.06***	28***	16.9***	17.24***	38***	16.9***	13.06***	28***
Decisions	Translog	Translog	Translog	Translog	Translog	Translog	Translog	Translog	Translog
2002									
Test statistics	62***	74***	102***	74***	82***	108***	74***	88***	94***
Decisions	Translog	Translog	Translog	Translog	Translog	Translog	Translog	Translog	Translog
2003									
Test statistics	85.76***	93.76***	120***	103.22***	111.9***	138***	103.18***	97.68***	118***
Decisions	Translog	Translog	Translog	Translog	Translog	Translog	Translog	Translog	Translog
2004									
Test statistics	59.28***	71.16***	100***	100.38***	114.38***	134***	100.3***	91.82***	112***
Decisions	Translog	Translog	Translog	Translog	Translog	Translog	Translog	Translog	Translog
2005									
Test statistics	91.2***	100.26***	102.26***	112.62***	124.52***	127.8***	112.52***	88.12***	102.24***
Decisions	Translog	Translog	Translog	Translog	Translog	Translog	Translog	Translog	Translog
2006									
Test statistics	129.24***	147.84***	141.62***	158.12***	175.68***	172.68***	158.52***	145.02***	148.76***
Decisions	Translog	Translog	Translog	Translog	Translog	Translog	Translog	Translog	Translog

Notes:

(a) (1) refers to the case where the error terms (v_i and u_i) are assumed to be homoscedastic; under (2), only the error term v_i is assumed to be heteroscedastic; under (3) both error terms v_i and u_i are assumed heteroscedastic.
(b) ***,**, * denotes the null hypothesis of the Cobb-Douglas specification is decisively rejected at 1%, 5%, 10% significance level, respectively.

Table 3.4 Log Likelihood Ratio Tests for Heteroscedasticity using Translog Production Function

Distributional Assumption	Half-normal			Exponential			Truncated normal		
	(1)	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**
2000									
Test statistics	176.18***	484.76***	660.94***	169.14***	394.34***	563.48***	98.06***	301.78***	399.84***
Decisions	*Het1*	*Het2*	*Het2*	*Het1*	*Het2*	*Het2*	*Het1*	*Het2*	*Het2*
2001									
Test statistics	134.64***	400.14***	534.78***	99.64***	308.5***	408.14***	145.84***	238.92***	384.76***
Decisions	*Het1*	*Het2*	*Het2*	*Het1*	*Het2*	*Het2*	*Het1*	*Het2*	*Het2*
2002									
Test statistics	188***	568***	756***	156***	476***	632***	290***	348***	638***
Decisions	*Het1*	*Het2*	*Het2*	*Het1*	*Het2*	*Het2*	*Het1*	*Het2*	*Het2*
2003									
Test statistics	35.54***	697.04***	732.58***	44.68***	627***	671.68***	202.92***	495.38***	698.3***
Decisions	*Het1*	*Het2*	*Het2*	*Het1*	*Het2*	*Het2*	*Het1*	*Het2*	*Het2*
2004									
Test statistics	70.74***	771.68***	842.42***	85.18***	630.44***	715.62***	204.26***	501.1***	705.36***
Decisions	*Het1*	*Het2*	*Het2*	*Het1*	*Het2*	*Het2*	*Het1*	*Het2*	*Het2*
2005									
Test statistics	143.7***	678.46***	822.16***	140.52***	596.56***	737.08***	676.9***	366.6***	1043.5***
Decisions	*Het1*	*Het2*	*Het2*	*Het1*	*Het2*	*Het2*	*Het1*	*Het2*	*Het2*
2006									
Test statistics	99.1***	629.58***	728.68***	86***	521.66***	607.66***	281.9***	369.46***	651.36***
Decisions	*Het1*	*Het2*	*Het2*	*Het1*	*Het2*	*Het2*	*Het1*	*Het2*	*Het2*

Notes:

(a) *Homo* refers to the case where the error terms (v_i and u_i) are assumed to be homoscedastic; under *Het1*, only the error term v_i is assumed to be heteroscedastic; under *Het2* both error terms v_i and u_i are assumed heteroscedastic.
(b) (1) The log likelihood ratio tests the *Homo* against the *Het1*; under (2) the log likelihood ratio tests the *Het1* against the *Het2*; under (3) the log likelihood ratio tests the *Homo* against the *Het2*.
(c) *** denotes the null hypothesis in all cases is decisively rejected at 1% significance level in all cases (the critical value of the chi-square distribution with 1, 2, 10, 11, 12, 13, and 14 degree of freedoms at 1% significance level is far less than the test statistics in all tests).

Once the functional form of the production function and the assumptions on heteroscedasticity of the error term(s) are verified, the final specification test required before embarking on empirical analysis is to test whether the technical inefficiency term follows a half-normal, exponential, or truncated normal distribution. As specified in section 3, the AIC and BIC are employed in this chapter to assess which distributional assumption is more relevant for the data used in this chapter. The information criteria obtained from estimating the translog production function when both error terms are heteroscedastic are reported in table 3.5.[19] Based on the results, the exponential distribution is deemed the most relevant distributional assumption for the technical inefficiency term in 2000, 2001, 2002, and 2004; while the truncated normal distribution of the technical inefficiency term is selected for the remaining years 2003, 2005, and 2006 (highlighted in bold figures).

Table 3.5: Information Criteria under Different Distributional Assumptions

	Half-normal	Exponential	Truncated normal
2000			
Mean (SD)	0.7078 (0.169)	**0.7243 (0.151)**	0.6114 (0.155)
AIC	22855	**22797**	22964
BIC	22994	**22936**	23110
2001			
Mean (SD)	0.6985 (0.159)	**0.6612 (0.146)**	0.7024 (0.147)
AIC	25923	**25793**	25818
BIC	26065	**25935**	25966
2002			
Mean (SD)	0.5121 (0.16)	**0.6163 (0.166)**	0.6158 (0.168)
AIC	31896	**31643**	31639
BIC	32057	**31804**	31807
2003			
Mean (SD)	0.48 (0.178)	0.6019 (0.178)	**0.5724 (0.181)**
AIC	36632	36301	**36276**
BIC	36788	36458	**36440**
2004			
Mean (SD)	0.4508 (0.183)	**0.5794 (0.182)**	0.5771 (0.18)
AIC	46070	**45312**	45326
BIC	46230	**45473**	45494

[19] The AIC and BIC are also calculated for the other two cases where (i) the two error terms are assumed to be homogenous; (ii) the error term v_i is assumed to be heteroscedastic. These results are provided in Table A3.5 in the Appendix.

	Half-normal	Exponential	Truncated normal
2005			
Mean (SD)	0.4711 (0.176)	0.5891 (0.178)	**0.6198 (0.177)**
AIC	51314	50609	**50306**
BIC	51485	50780	**50485**
2006			
Mean (SD)	0.4692 (0.181)	0.5955 (0.176)	**0.5936 (0.175)**
AIC	54115	53403	**53364**
BIC	54264	53553	**53521**

Notes: standard deviations are reported in parentheses.

In effect, after performing the three specification tests under different assumptions of the functional form of the production function, heteroscedasticity of the error term(s), and distribution of the technical inefficiency term, this chapter elects to use a translog production function assuming both error terms are heteroscedastic. Regarding the distributional assumption of the technical inefficiency, the exponential distribution is selected for 2000-02 and 2004, while the truncated normal distribution is favoured for the remaining three years. Given this, the next sub-section will focus on the estimates of technical inefficiency under these specification features.[20]

3.4.2 Empirical Results

3.4.2.1 Average Level of Technical Efficiency

Before embarking on the empirical analysis, as the estimates of technical inefficiency are obtained from estimating the production function, it is important to note that the coefficient estimates of the production functions are well determined. Details of these estimates are

[20] It should be noted that although the choice is based purely on this limited set of parametric distributions, these are a fairly exhaustive set of alternatives. The only one exclusion from our analysis due to its complexity is the gamma distribution. Aside from providing the most data-coherent models, there are no other particular reasons why truncated normal distributions were selected for three of the seven years, while exponential distribution was selected for the remaining years. In an attempt to examine whether the estimated technical efficiency levels differ if the exponential distribution is adopted for these three years (instead of the truncated normal distribution), the framework in [3.6] is re-estimated using that assumption (while other assumptions on functional form of the production function and heteroskedasticity remain). The results suggest the average levels of technical efficiency are 58.9, 60.2, and 59.6 respectively in 2003, 2005, and 2006. Compared to the results reported in table 3.6, the differences are modest and not materially different. Section 4.4.1 of chapter 4 will provide a further discussion on the implication of this selection on the determinants of technical efficiency.

not reported here but provided in table A3.5 of the Appendix. Tests for constant returns to scales based on the Cobb-Douglas are also performed but not reported here for brevity. The test results suggest that the null hypothesis of constant returns to scale is decisively rejected in all cases. This provides further support for the translog model. Figure A3.1 in the Appendix represents the kernel density plots under alternative assumptions as tested above. It is apparent that technical efficiency estimates are sensitive to those assumptions. In this regard, the use of specification tests (as above) provides a good basis for having confidence that reliable estimates of technical efficiency have been obtained in this study.

Given the specification tests results reported above, this section only focuses on the estimates of technical efficiency obtained using the translog production function with the two heteroscedastic error terms, and the technical inefficiency term following an exponential distribution in 2000-02, 2004, and a truncated normal distribution in the remaining three years. The technical efficiency estimates under such specifications are reported in table 3.6 and further illustrated in figure 3.5 below. As the focus of this chapter is not to examine the determinants of technical efficiency (which will be the subject of the next chapter), the remainder of this section focuses on describing the technical efficiency and its tendency over time and compare the results obtained here to previous studies.[21]

The average technical efficiency level for Vietnam's manufacturing firms was estimated at 62.4 percent. In particular, the technical efficiency declined by 13 percentage points over the research period, from 72.43 percent in 2000 to 59.36 percent in 2006. As reported in table 3.6, the average technical efficiency is highest at around 72 percent with the standard deviation of 15 percent in 2000. The efficiency had decreased until 2003, when the lowest level is observed at 57 percent. There exists a gap of 15 percentage points in the average

[21] Before embarking on the empirical analysis of technical efficiency, it should be noted that Dollar and Wei's (2007) average revenue product of capital (ARPK) – a proxy for investment efficiency is also obtained for the manufacturing sector of Vietnam. The summary statistics of this variable are reported in table A3.6 of Appendix A3. It is noted that this ARPK exhibits many similarities with the estimated levels of technical efficiency analyzed in this section.

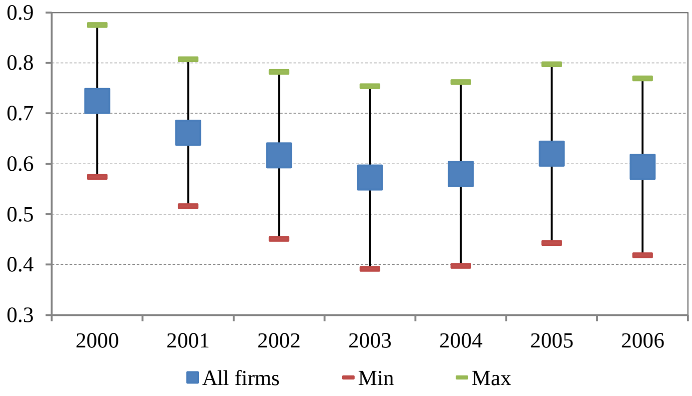
technical efficiency levels in 2000-2003. Particularly, the average technical efficiency decreased by more than six percentage points to 66 percent in 2001 and continued to decrease in 2002 and 2003 at the rate of 6.8 and 7.1 percent to the low levels of 61 and 57 percent, respectively. The average technical efficiency of manufacturing firms in the period 2003-2004 remained at the same level of roughly 57 percent and after that, it increased to an average of 62 percent in 2005, equivalent to the growth rate of seven percent, the highest increase rate of technical efficiency over the period 2000-2006. However, the average technical efficiency level of the manufacturing firms went down once again at the rate of 4.2 percent from the level of 62 percent to the average of 59 percent in 2006, though this decrease was less than in the previous years.

Table 3.6 Average Technical Efficiency, 2000-2006

Year	Mean	SD	Growth (%)
2000	0.7243	(0.151)	
2001	0.6612	(0.146)	-8.71
2002	0.6163	(0.166)	-6.79
2003	0.5724	(0.181)	-7.12
2004	0.5794	(0.182)	1.22
2005	0.6198	(0.177)	6.97
2006	0.5936	(0.175)	-4.23
Average	**0.6239**		

Notes:
(a) Standard deviations are reported in parentheses.
(b) ‘Growth’ is the change of the mean value of the estimates of technical efficiency in current year compared to previous year, measure in percentage.

Figure 3.5 Technical Efficiency of the Manufacturing Sector, 2000-2006



This 'unsteady' growth of the average technical efficiency level of the manufacturing sector in Vietnam is also observed by comparing the positions of the vertical lines (which defined the mean technical efficiency estimates) in the kernel density plots for separate years (see figure A3.2 in the Appendix). This tendency could be partially due to the 'explosion' of the newly-established firms in the period under consideration. As reported in section 3.1, the average growth rate of newly-established firms in manufacturing sector in the period 2000-2006 was 16.5 percent, with the average number of 1,900 firms joining the sector each year (see figure 3.1). There might be a time lag for those newly-established firms to catch up with the technical efficiency level of older firms in the sector and therefore it can lower the average level of technical efficiency of the manufacturing sector as a whole. In order to provide further evidence for this explanation, table 3.7 provides the estimated level of technical efficiency for the sub-samples of manufacturing firms established for less than one year at the time of relevant survey. In addition, the technical efficiency of the incumbents is also estimated and reported in table 3.7 for reference.

Table 3.7 Estimated technical efficiency of the new entrants

	2000	2001	2002	2005
Full sample				
Average	**0.7243**	**0.6612**	**0.6163**	**0.6198**
	(0.151)	(0.146)	(0.166)	(0.177)
SOEs	0.7047	0.6636	0.6369	0.7268
	(0.152)	(0.137)	(0.160)	(0.139)
DPEs	0.7481	0.6806	0.6295	0.6159

	(0.143)	(0.137)	(0.157)	(0.175)
FIEs	0.6364	0.5622	0.5311	0.5834
	(0.147)	(0.160)	(0.183)	(0.184)
Sub-sample of new entrants				
Average	**0.6721**	**0.6022**	**0.5148**	**0.4833**
	(0.174)	(0.177)	(0.206)	(0.225)
SOEs	0.6092	0.6671	0.6141	0.6117
	(0.193)	(0.131)	(0.143)	(0.199)
DPEs	0.7001	0.6215	0.5439	0.4974
	(0.154)	(0.161)	(0.191)	(0.223)
FIEs	0.5037	0.4002	0.3623	0.3689
	(0.195)	(0.207)	(0.213)	(0.208)
Sub-sample of imcumbents				
Average	**0.7332**	**0.6699**	**0.6362**	**0.6436**
	(0.144)	(0.138)	(0.149)	(0.156)
SOEs	0.7070	0.6635	0.6377	0.7362
	(0.151)	(0.137)	(0.161)	(0.129)
DPEs	0.7588	0.6915	0.6486	0.6386
	(0.138)	(0.129)	(0.142)	(0.155)
FIEs	0.6574	0.5783	0.5717	0.6171
	(0.126)	(0.145)	(0.149)	(0.154)

Notes:

a) Standard deviations are reported in parentheses.
b) ‘New entrants’ are defined as those who were established at the same year of survey.
c) For the year 2003, 2004, and 2006, the information on age of establishment is not available (as already discussed in chapter 2) and thus it is not possible to identify which firms were new entrants in these years;
d) The estimated efficiency levels reported in this table were estimated with the following details: (i) translog production function; (ii) the technical inefficiency error terms follows an exponential distribution; (iii) both the two error terms are heteroscedastic.

The figures suggest clearly that the new entrants performed at considerably lower levels of technical efficiency compared to the average level of the whole manufacturing sector. The gap in the technical efficiency levels between the new entrants and the whole sector is most pronounced in 2005, where the gap was nearly 12 percentage points, and this gap tends to widen over time in the period under consideration. It is noted that the gap is largest when comparing the technical efficiency of new foreign-invested firms with older foreign-invested ones. In contrast, the estimated figures for the incumbents suggest that these firms performed at higher levels of technical efficiency compared to the average level of the whole manufacturing sector. The figures lend evidence to the suggestion that the ‘unsteady’ pattern of technical efficiency in the manufacturing sector could be partly driven by a rapid growth in the number of new firms – which was recognized as representing a phenomenon during the period under consideration (see table A1.2 of Appendix A1 for more details).[22]

The estimated average technical efficiency reported in table 3.6 for the manufacturing sector of Vietnam is generally comparable with those reported in some previous papers for transitional economies such as Bulgaria (Jones *et al*., 1998), Czechoslovakia and Hungary (Brada *et al.*, 1997), and the former Soviet Union (Brock, 1999). For the case of China, our results are in contrast with those of Liu and Liu (1996) who reported a rather low level at around 40 percent as well as the estimated results of Movshuk (2004) who reported a very high rate of technical efficiency of around 91 percent. The difference might be due to the timing and the narrow focus on only some sectors within these two papers. In the context of Vietnam, our results are compatible with Dao *et al.* (2010) who reported an average technical efficiency level of nearly 62 percent in 2002 for around 11,000 manufacturing firms. Our results are higher than those reported in Hoang *et al.* (2008) for several sub-sectors and lower than the technical efficiency levels informed by Nguyen *et al.* (2002) and Vu (2003) using data from small-scaled surveys.

As discussed earlier in 3.3.1, the technical efficiency levels above are obtained from estimating within a cross-sectional framework as described in [3.5] and [3.6] – which does not allow an examination of possible movements of the frontier over time. Previous studies have reported a positive and continuing growth of total factor productivity of the industrial sector since the introduction of the *Doi moi* process. For instance, Nguyen and Giang (2008) used various volumes of the Vietnam Statistical Yearbook to examine productivity growth during the period 1985-2006. The study reports a productivity growth of 6.3 percent per annum. Evidence on TFP growth was also found in Vu (2003) for the 1986-

[22] It should be noted that the methodology used for comparison of technical efficiencies of new entrants and incumbents actually measures their efficiency relative to the leader in that category, not relative to all firms. Hence, the absolute level of efficiency between the two groups is not compared. These figures are used to argue that the average technical efficiency level of the whole manufacturing sector might be partially driven by that of the new entrants.

1998 period (only in the SOE sector). In the context of the manufacturing sector, as reported in the current thesis, movements of the technical frontier are a fairly likely outcome. However, as the current analysis relies on cross sectional estimation rather than panel estimation, this issue is not viewed as entirely relevant here. The objective of the research is to determine relative efficiency within each year and is not intended to inform on the evolution of efficiency over time. This is obviously an issue that could be examined as part of an agenda for future research. However, in attempts to inform on this issue, the limited panel of 5,880 firms across 2001 to 2006 is used to estimate the technical efficiency of this panel. It should be noted that the year 2000 is not included in this panel as it would introduce a sharp reduction of the number of firms used in the panel. In addition, there is no manufacturing firm in the Mekong River Delta in this panel (see section 2.1.3 in chapter 2 for a discussion of the construction of the panel).

Before estimating the technical efficiency, the functional form tests using log likelihood ratio tests was conducted to determine whether a Cobb-Douglas or a Translog production function is statistically appropriate for the data. The resultant log likelihood ratio is 308, which is substantially greater than the critical value, the translog production function is thus accepted. Applying the stochastic frontier model within the panel framework (as in Coelli *et al.* 2005) results in the following estimated technical efficiency, under both time-invariant and time-varying models.[23]

Table 3.8 Average technical efficiency estimated from the panel 2001-2006

	Time-invariant model	**Time-varying model**
Average	**0.8459**	**0.8479**
	(0.057)	(0.058)
By sectors		
SOEs	0.8465	0.8494

[23] As discussed in chapter two, identification of this panel is subject to potential problems. Hence, the discussion on panel estimation results provided in this chapter should be best considered as explorative. Therefore, panel data estimation is not structured as a key section of this chapter (and the subsequent chapter). Methodological description of the stochastic frontier model in the panel framework could be found, for instance, in Coelli *et al.* (2005), p. 275-280.

	(0.058)	(0.059)
DPEs	0.8463	0.8445
	(0.056)	(0.056)
FIEs	0.8407	0.8407
	(0.066)	(0.067)
By regions		
Northern Uplands	0.8388	0.8452
	(0.059)	(0.059)
Red River Delta	0.8481	0.8431
	(0.058)	(0.058)
North Central Coast	0.8400	0.8344
	(0.056)	(0.058)
South Central Coast	0.8441	0.8347
	(0.052)	(0.055)
Central Highland	0.8429	0.8302
	(0.052)	(0.053)
Southeast	0.8454	0.8291
	(0.050)	(0.054)

Notes:

a) A description of the stochastic frontier model with panel data could be found, for instance, in Coelli *et al.* (2005), pp.275-280.

b) As this is the stochastic frontier model with panel data, assumptions on distributions of two errors terms could be relaxed and the set specification tests (as performed for the cross-sectional analysis) become redundant in this framework.

Compared to the results reported in table 3.6, the figures obtained from the panel analysis suggest that the levels of technical efficiency of the firms in the panel, in either time-invariant or time-varying models, are considerably higher than the estimated technical efficiency levels reported for the cross-sectional analysis. Depending on the years of comparison, the estimated technical efficiency in the cross-sectional analysis varies from 59 percent to 72 percent. In the panel analysis, the manufacturing firms performed at nearly 86 percent of its technical frontier. In terms of ownership, as suggested by the estimated levels of technical efficiency across sectors, there is almost no difference in technical efficiency across types of ownership (which is contrary to the results reported in the sub-sections below). This high level of technical efficiency obtained from the panel is however understandable as the panel consists of the manufacturing firms that have survived for years. It is likely that these firms have moved along the learning curve and thus approached closer to their technical frontiers.

One question arises from the above is that what are the technical efficiency levels of the firms that were not included in the panel under consideration. In 2002 for instance, what is the level of technical efficiency of 5,149 firms that were not covered in the panel of 5880 firms? Table 3.9 below presents the estimated technical efficiency of these firms (using the same distributional assumptions and functional forms for the results reported in table 3.6).

Table 3.9 Estimated technical efficiency of the firms that were out of the 2001-2006 panel

	2001	2002	2003	2004	2005	2006
Estimated technical efficiency	0.5421	0.4843	0.4578	0.5549	0.5613	0.5547
	(0.147)	(0.201)	(0.193)	(0.203)	(0.164)	(0.183)

Notes:

a) Standard deviations are reported in parentheses.
b) These figures are obtained by estimating the production functions using the set of assumptions that were used to obtained the results reported in table 3.6, including (i) the translog production function; (ii) both the random error term and technical inefficiency error term are heteroscedastic; and (iii) the technical inefficiency error term follows an exponential distribution.

The estimated results suggests that the average level of those firms that are out of the panel over the 2001-2006 period are considerably lower than the average level of those in the panel. Compared to the results reported in table 3.6, the technical efficiency levels of these firms are also lower in all years. However, it is not clear why these firms did not appear in the VES in subsequent years. While the levels of technical efficiency of these firms are not high (as in table 3.9), it is not likely that all of them were liquidated. Therefore, the reason why these firms were not identified in the panel remains unclear. However, this finding goes some way towards reconciling the high technical efficiency levels generated by the panel procedure compared to the cross-sectional findings of more modest technical efficiency levels as reported in table 3.6.

3.4.2.2 Technical Efficiency by Manufacturing Sub-sectors and Types of Ownership

As discussed in the first section of this chapter, when the GSO's classification of manufacturing activities according to factor intensity, the manufacturing sector has steadily moved away from simple labour intensive activities to more added value and complex activities. This broadly defined classification of manufacturing activities could also be used here to shed light on technical efficiency by the manufacturing sub-sectors. Table 3.10 reports the technical efficiency estimates for the manufacturing sub-sectors. It is noted that there has also been changes in efficiency in the period 2000-2006 in association with the structural changes in the output shares as noted before.

Figure 3.6 Technical Efficiency by Factor Intensity, 2000-2006

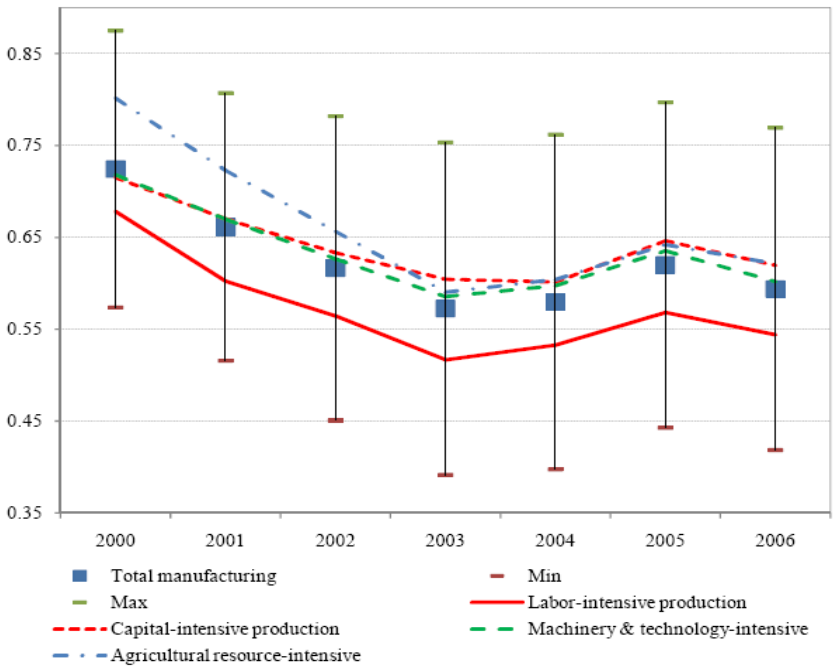


Figure 3.6 shows that all sub-sectors have changed in the same pattern as the aforementioned change in the average technical efficiency. Dividing the manufacturing

sector into the four broad sub-sectors according to factor intensity provides further insights on such aspects of firm efficiency. In the period under consideration, the average technical efficiency is lowest for labour-intensive firms. On average, there has been a gap between four to seven percentage points between the average firm efficiency in the whole manufacturing sector and that of the labour-intensive manufacturing sub-sector. Interestingly, that labour-intensive sub-sector has also been the major exports of Vietnam. As discussed in section 3.1, this labour-intensive sub-sector accounted for 32 percent of the total export and 65 percent of the total manufacturing exports over the period 2000-2006. This is an important finding of this study as it could be taken to suggest that, on average, export-oriented manufacturing enterprises have not done better (technically) than the others. This re-affirms the argument made in Dao *et al.* (2010) on the relative low efficiency of labour-intensive manufacturing activities. Moreover, it is also important to note that agricultural resource-intensive firms (i.e. food and beverage enterprises in this case) have recorded the best technical efficiency performance in Vietnam’s manufacturing sector. During the period under investigation, there has been a gap of between seven to 13 percentage points in average firm efficiency between this sub-sector and the labour-intensive counterpart. It suggests that, on average, food and beverage enterprises have outperformed, in terms of technical efficiency, other manufacturing firms. The average level of technical efficiency of the capital-intensive and machinery and technology-intensive sub-sectors was mainly constant over time, though firms in the capital-intensive sub-sectors performed slightly better than the others. The average technical efficiency of these two groups declined from around 71 percent in 2000 to approximately 61 percent in 2006 (see figure A3.3 in the Appendix A3).

Table 3.10 Technical Efficiency of the Manufacturing Sub-Sectors

Code	Description	2000	2001	2002	2003	2004	2005	2006
	Agricultural resource-intensive	**0.8012 (0.161)**	**0.7225 (0.153)**	**0.6563 (0.168)**	**0.5904 (0.196)**	**0.604 (0.196)**	**0.6419 (0.184)**	**0.6212 (0.184)**
15	− Food and beverages	0.8012 (0.161)	0.7225 (0.153)	0.6563 (0.168)	0.5904 (0.196)	0.604 (0.196)	0.6419 (0.184)	0.6212 (0.184)
	Labour-intensive production	**0.6780 (0.155)**	**0.6022 (0.152)**	**0.5641 (0.179)**	**0.5164 (0.186)**	**0.5325 (0.195)**	**0.568 (0.185)**	**0.5439 (0.177)**
17	− Textiles	0.6441 (0.174)	0.5901 (0.167)	0.545 (0.192)	0.4978 (0.196)	0.5222 (0.207)	0.5564 (0.201)	0.5364 (0.184)
18	− Wearing apparel	0.6441 (0.162)	0.5538 (0.162)	0.5266 (0.189)	0.4671 (0.18)	0.497 (0.208)	0.5305 (0.182)	0.4998 (0.165)
19	− Leather tanning and processing	0.6686 (0.148)	0.5948 (0.142)	0.5449 (0.18)	0.5226 (0.175)	0.5197 (0.183)	0.5860 (0.177)	0.5436 (0.181)
20	− Wood and wood products	0.7140 (0.136)	0.6379 (0.137)	0.6132 (0.147)	0.5783 (0.175)	0.5732 (0.171)	0.6123 (0.177)	0.5895 (0.177)
36	− Furniture	0.7080 (0.140)	0.6297 (0.131)	0.5783 (0.177)	0.5219 (0.183)	0.5456 (0.191)	0.5667 (0.180)	0.5583 (0.172)
	Capital-intensive production	**0.7149 (0.127)**	**0.6698 (0.123)**	**0.6332 (0.147)**	**0.6042 (0.162)**	**0.601 (0.162)**	**0.6462 (0.160)**	**0.6195 (0.163)**
16	− Tobacco products	0.8168 (0.093)	0.7606 (0.155)	0.811 (0.088)	0.7000 (0.116)	0.6959 (0.269)	0.7258 (0.174)	0.6558 (0.159)
21	− Paper and paper products	0.7292 (0.106)	0.6882 (0.109)	0.6598 (0.135)	0.6266 (0.148)	0.6113 (0.164)	0.6570 (0.144)	0.6335 (0.153)
24	− Chemical and chemical products	0.7408 (0.105)	0.6848 (0.125)	0.659 (0.133)	0.6311 (0.165)	0.6108 (0.165)	0.6604 (0.166)	0.6353 (0.176)
26	− Non-metallic mineral products	0.6804 (0.146)	0.6323 (0.129)	0.5717 (0.159)	0.5349 (0.163)	0.5454 (0.166)	0.6037 (0.173)	0.555 (0.169)
27	− Basic metal products	0.7623 (0.08)	0.6942 (0.105)	0.679 (0.101)	0.6627 (0.145)	0.6485 (0.151)	0.6878 (0.145)	0.6835 (0.142)
28	− Fabricated metal products	0.7186 (0.124)	0.6807 (0.125)	0.6429 (0.146)	0.6201 (0.159)	0.6125 (0.157)	0.6449 (0.156)	0.6324 (0.151)
25	− Rubber and plastic products	0.7364 (0.111)	0.6738 (0.117)	0.6439 (0.138)	0.6151 (0.162)	0.6220 (0.156)	0.6551 (0.157)	0.6166 (0.171)
23	− Coke, refined petroleum products	0.7878 (0.293)	0.7561 (0.124)	0.7293 (0.143)	0.7046 (0.118)	0.7010 (0.161)	0.7682 (0.086)	0.675 (0.173)
22	− Publishing and printing	0.7159 (0.104)	0.7015 (0.098)	0.6716 (0.112)	0.6292 (0.134)	0.6194 (0.139)	0.6762 (0.145)	0.657 (0.126)
	Machinery & technology-intensive goods	**0.7177 (0.130)**	**0.6697 (0.131)**	**0.6265 (0.151)**	**0.5853 (0.168)**	**0.5971 (0.163)**	**0.6353 (0.171)**	**0.6019 (0.171)**
29	− Machinery and equipment	0.7233 (0.138)	0.6724 (0.132)	0.6506 (0.131)	0.6059 (0.164)	0.6125 (0.153)	0.6524 (0.161)	0.6281 (0.159)
30	− Office, accounting and computing machinery	0.7040 (0.129)	0.7498 (0.069)	0.6176 (0.144)	0.6202 (0.182)	0.6007 (0.195)	0.5995 (0.206)	0.6145 (0.171)
31	− Electrical machinery and apparatus	0.7195 (0.117)	0.6911 (0.098)	0.6336 (0.153)	0.6142 (0.15)	0.6094 (0.145)	0.6597 (0.156)	0.6293 (0.159)
32	− Television and communication equipment	0.7276 (0.110)	0.6670 (0.120)	0.6258 (0.154)	0.596 (0.174)	0.5736 (0.184)	0.6382 (0.168)	0.5942 (0.183)
33	− Medical and optical instruments, watches	0.6942 (0.123)	0.6100 (0.172)	0.5839 (0.144)	0.586 (0.177)	0.5719 (0.129)	0.6283 (0.163)	0.6025 (0.134)
34	− Motor vehicles	0.7049 (0.132)	0.6863 (0.114)	0.6374 (0.146)	0.5781 (0.159)	0.608 (0.151)	0.6268 (0.165)	0.5836 (0.174)
35	− Other transport equipment	0.7206 (0.138)	0.6524 (0.147)	0.5967 (0.167)	0.5423 (0.179)	0.5753 (0.184)	0.6063 (0.189)	0.564 (0.184)
	Total manufacturing	**0.7243 (0.151)**	**0.6612 (0.146)**	**0.6163 (0.166)**	**0.5724 (0.181)**	**0.5794 (0.182)**	**0.6198 (0.177)**	**0.5936 (0.175)**

Notes: Standard errors are reported in parentheses; the codes of these sub-sectors are in accordance with the International Standards of Industrial Classification (ISIC) Rev. 3.

In regard to types of ownership, section 3.1 of this chapter highlighted a buoyant transformation of the manufacturing sector through which the FDI sector has steadily replaced the dominant role of the SOE sector in contributing to output and export growth of the manufacturing sector. Table 3.11 reports the average firm efficiency, according to the three main types of ownership: SOEs, FIEs, and DPEs. Although the number of SOEs decreased significantly over the period under consideration, the average technical efficiency of the SOEs remained generally higher than those of private firms (including DPEs and FIEs). It might partially be due to the positive impacts of the equitization process in which only efficient SOEs continue to exist. This performance of the SOE sector is better illustrated in figure 3.7, using the data reported in table 3.11.

Table 3.11 Technical Efficiency by Types of Ownership, 2000-2006

	Average		**SOEs**		**DPEs**		**FDIs**	
	Level	**Growth**	**Level**	**Growth**	**Level**	**Growth**	**Level**	**Growth**
2000	0.7243 (0.151)		0.7047 (0.152)		0.7481 (0.143)		0.6364 (0.147)	
2001	0.6612 (0.146)	-8.71	0.6636 (0.137)	-5.83	0.6806 (0.137)	-9.02	0.5622 (0.16)	-11.66
2002	0.6163 (0.166)	-6.79	0.6369 (0.16)	-4.02	0.6295 (0.157)	-7.51	0.5311 (0.183)	-5.53
2003	0.5724 (0.181)	-7.12	0.6027 (0.154)	-5.37	0.5818 (0.179)	-7.58	0.5027 (0.194)	-5.35
2004	0.5794 (0.182)	1.22	0.6272 (0.152)	4.07	0.5826 (0.182)	0.14	0.5319 (0.193)	5.81
2005	0.6198 (0.177)	6.97	0.7268 (0.139)	15.88	0.6159 (0.175)	5.72	0.5834 (0.184)	9.68
2006	0.5936 (0.175)	-4.23	0.6534 (0.132)	-10.10	0.5973 (0.174)	-3.02	0.5479 (0.189)	-6.09

Notes:

a. Standard errors are reported in parentheses;

b. ‘growth’ is the change of the mean value of the estimates of technical efficiency in current year compared to previous year, measure in percentage.

The finding that SOEs have outperformed private (domestic and foreign) manufacturing firms could be considered as a supportive evidence for the SOE reform process. More interestingly, it challenges the common understanding that although the SOE sector has been subject to important reforms and its dominant role has been eroded over time, there has been little evidence that those SOEs that survived the restructuring process improved their profitability substantially (GSO, 2004). The finding in this study provides evidence that the SOE reform agenda has been associated with a better performance of the SOE sector in comparison with manufacturing firms under other ownership types. However, it might be the case that these SOEs may be very selective SOEs having survived the reforms. Specifically, they may be the fittest and most efficient. Moreover, it is likely that these SOEs may have received preferential treatment through having a first-mover advantage.

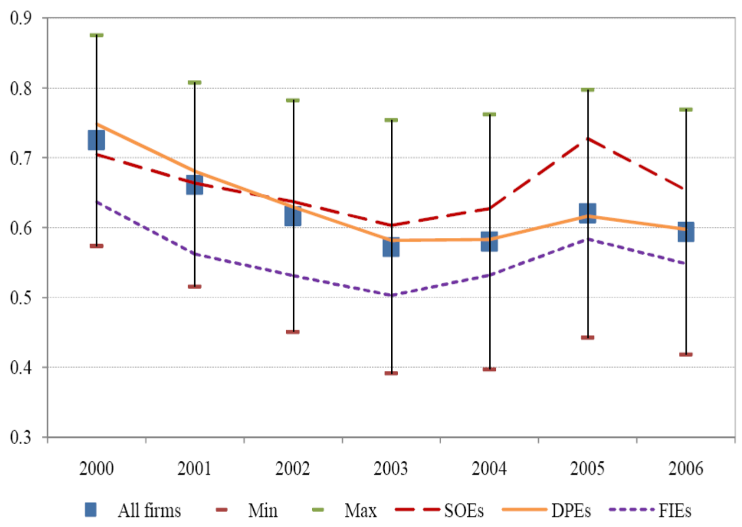
This is noted that the FDI sector has registered, on average, as the worst performer in terms of the distance to its production frontier. In the period 2000-2006, there has been a gap of between four to nine percentage points between the average technical efficiency of the FDI sector and the average level of the manufacturing sector as a whole. With the exception of the year 2000, the level of technical efficiency of FIEs was just slightly above 50 percent. This relatively poor performance of the FDI sector is better illustrated in figure 3.7, where the technical efficiency estimates of this sector are below the manufacturing average level and that of the SOE and domestic private counterparts.[24]

This estimated level of technical efficiency of FIEs is somewhat surprising since FIEs are generally expected to outperform SOEs and DPEs in terms of technical efficiency due to their advantages over other domestic enterprises in terms of capital resources, modern technology, marketing and management skills, and access to international market places. One possible explanation may lie in the fact that the average age of FIEs is considerable

[24] It should be noted that the above pattern of technical efficiency across different types of ownership is not evident from the estimation results obtained from exploring the limited panel in the period 2001-2006. As reported in table 3.8, the estimated levels of technical efficiency are essentially the same across SOEs, DPEs, and FIEs (at around 84 percent of their technical efficiency). Together with the very rapid growth of new establishment in the period under consideration, this could be taken to suggest that differences in technical performances of the manufacturing firms are largely driven by new entrants – who are in their early stages of their learning-by-doing processes.

younger compared to other domestic counterparts. In our sample, around 40 percent of FIEs were established within the last three years before the year of survey while the corresponding figures for the SOE and domestic private sectors are about seven and 25 percent respectively. In particular, nearly one third of FIEs that are the subject of the current empirical analysis were in the first year of their operation. Given this, a number of FIEs are still at the beginning stages of their 'learning curve'. Thus the presence of a large number of young firms is probably an important explanatory factor underlying the lower level of average technical efficiency detected among the foreign-invested sector.

Figure 3.7 Technical Efficiency by Ownership, 2000-2006



In addition, FIEs are reported to operate at less than their capacity. The automobile industry, which is dominated by a dozen or so foreign-invested assemblers, provides a typical example of under-capacity at times. JICA (2002) noted that joint-ventured car assemblers were operating at less than 20 percent of their capacities as they installed assemblies in anticipation of a leap in the domestic demand for automobiles in the near future. Notably, MUTRAP (2002) suggested that foreign investors tend to overstate the value of machinery and/or assembly lines imported as their contributions to the total investment capital. As capital was over-stated and the estimation procedure employed in this study is unable to take into account this overstatement, it would lead to a lower level of technical inefficiency than the actual level as the overstated value might represent a waste of resources. Unfortunately, determining the extent of this overstatement is not possible within the scope of the current research.

3.4.2.3 Other Aspects of Technical Efficiency

The technical efficiency estimates also exhibit a regional pattern. Table 3.12 reports the average efficiency levels obtained for the seven socio-economic regions of Vietnam, which are the Northern Uplands, Red River Delta, North Central Coast, South Central Coast, Central Highlands, Southeast and Mekong River Delta. It is important to note that manufacturing firms located in the Mekong River Delta are the most technically efficient enterprises. On average, the technical efficiency level obtained for this region is about ten percentage points higher than the manufacturing average. The Northern Uplands and Central Highlands have the lowest firm efficiency with a gap of six and nine percentage points, respectively. Compared to the other regions, these two regions are at a disadvantage in terms of access to infrastructure. In addition, it has been shown that the two regions are also the poorest among the country (VASS, 2007 for instance). Moreover, if the Central Highlands is not included, it seems that the average technical efficiency levels in the northern regions are slightly lower than those observed in the southern counterparts. This might be explained by the more-active and competitive business environment in the south in comparison to the north of the country. However, the difference in the technical efficiency levels between the two parts seemed to be narrowing over time.

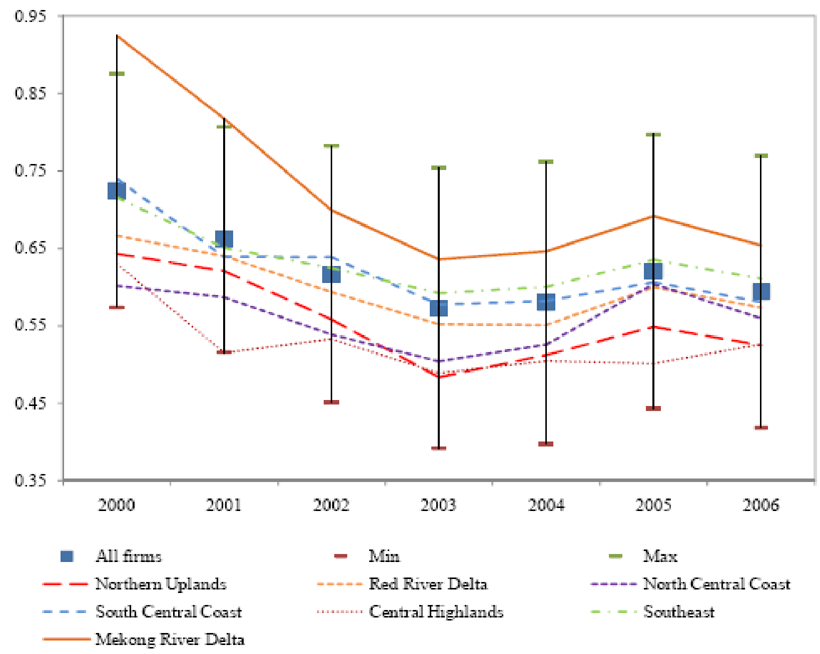
Table 3.12 Technical Efficiency by Regions, 2000-2006

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Northern Uplands	0.6427	0.6209	0.5580	0.4836	0.5119	0.5485	0.5246
	(0.131)	(0.132)	(0.165)	(0.184)	(0.189)	(0.200)	(0.190)
Red River Delta	0.6662	0.6400	0.5936	0.5519	0.5509	0.5996	0.5733
	(0.136)	(0.139)	(0.172)	(0.187)	(0.188)	(0.187)	(0.182)
- *Hanoi*	0.6833	0.6560	0.6174	0.5822	0.5743	0.6253	0.5969
	(0.128)	(0.128)	(0.162)	(0.171)	(0.179)	(0.171)	(0.165)
- *Red River Delta without Hanoi*	0.6524	0.6280	0.5749	0.5288	0.5341	0.5826	0.558
	(0.142)	(0.145)	(0.177)	(0.194)	(0.193)	(0.195)	(0.191)
North Central Coast	0.6018	0.5865	0.5384	0.5038	0.5254	0.6038	0.5597

	(0.159)	(0.149)	(0.170)	(0.178)	(0.175)	(0.173)	(0.169)
South Central Coast	0.7399	0.6389	0.6385	0.5772	0.5820	0.6062	0.5803
	(0.105)	(0.131)	(0.141)	(0.173)	(0.173)	(0.183)	(0.178)
Central Highlands	0.6298	0.5152	0.5325	0.4888	0.5044	0.5013	0.5259
	(0.147)	(0.168)	(0.175)	(0.187)	(0.193)	(0.206)	(0.185)
Southeast	0.7155	0.6508	0.6246	0.5919	0.6000	0.6352	0.6105
	(0.124)	(0.136)	(0.161)	(0.173)	(0.173)	(0.163)	(0.165)
- *Ho Chi Minh city*	0.7321	0.6673	0.6409	0.6088	0.6101	0.6445	0.6177
	(0.117)	(0.128)	(0.155)	(0.164)	(0.169)	(0.159)	(0.161)
- *Southeast without HCMC*	0.6906	0.6251	0.5971	0.5646	0.5827	0.6191	0.5992
	(0.131)	(0.143)	(0.168)	(0.183)	(0.180)	(0.168)	(0.169)
Mekong River Delta	0.9242	0.8177	0.6992	0.6353	0.6461	0.6913	0.6535
	(0.038)	(0.069)	(0.132)	(0.164)	(0.168)	(0.145)	(0.163)
Total manufacturing	0.7243	0.6612	0.6163	0.5724	0.5794	0.6198	0.5936
	(0.151)	(0.146)	(0.166)	(0.181)	(0.182)	(0.177)	(0.175)

Notes: Standard errors are reported in parentheses;

Figure 3.8 Technical Efficiency by Regions, 2000-2006



Notably, firms in the Red River Delta (where Hanoi is located) and in the Southeast (where Ho Chi Minh City (HCMC) is located) were not the best performers in the manufacturing sector. In particular, firms in the Red River Delta were operating at a lower level of technical efficiency compared to the average level of the sector while firms in the Southeast region were performing just slightly better than the average level of the sector. In fact, these two regions are commonly considered as the best endowed in the country in terms of access to infrastructure facilities and human resources. These two regions are also the main destinations for foreign investment. Using the data from GSO, it could be shown that Hanoi and HCMC, the two largest cities of the country, absorbed around half of the total FDI flow over the period from 1990 to 2006 (GSO Statistical Yearbook 1995, 2000, and 2007). As FIEs are found to be least technically efficient, the concentration of FIEs in these two regions probably relates to relatively low technical efficiency reported in these regions.

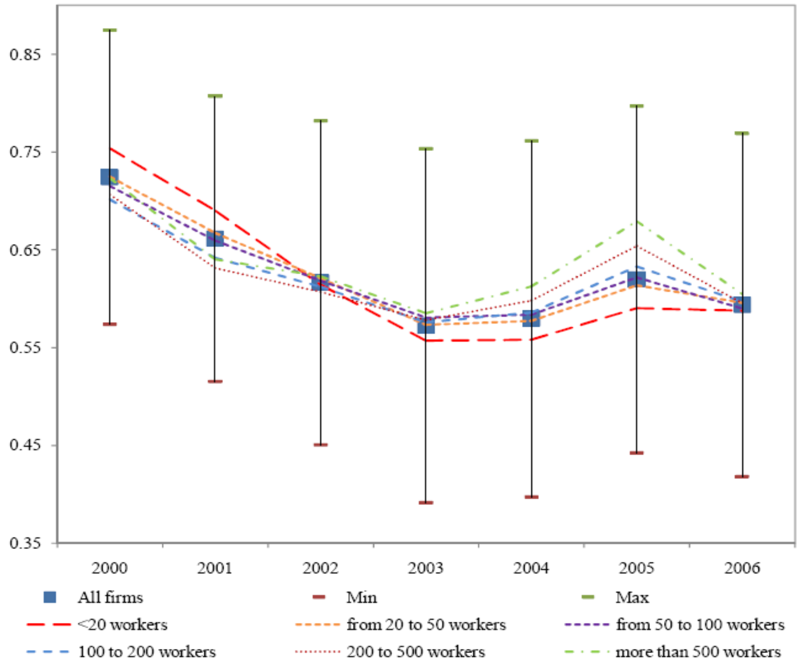
To make an account of the contribution of Hanoi and HCMC to the average level of firm efficiency in the Red River Delta and Southeast, respectively, these two cities are excluded from the two regions in order to compare the levels of technical efficiency with and without these two cities. As shown in table 3.12, enterprises located in Hanoi and HCMC have performed slightly better than the average manufacturing firm. Therefore, when these two cities are excluded from the corresponding regions, this exerts only small changes in the average levels of firm efficiency in these two regions. Figure A3.4 in the Appendix provides a better illustration of this direction.[25]

Finally, a tabulation of the technical efficiency estimates according to a firm's employment size is considered. Six types of manufacturing enterprises are classified according to their employment sizes, including those with less than 10 workers; from 20 to less than 50 workers; from 50 to less than 100 workers; from 100 to less than 200 workers; from 200 to less than 500 workers; and more than 500 workers. Figure 3.9 reveals some interesting results. Firstly, there are very small gaps in the firm efficiency levels of the enterprises which employed from 20 to 200 workers and the average manufacturing firm. As shown in figure 9, the technical efficiency lines for those categories overlap and cluster around the

[25] It is noted that this spatial pattern of technical efficiency obtained in the cross-sectional analysis is not observed from the empirical results using the restricted panel available from 2001 to 2006 (see Table 3.8). This could be taken to suggest that divergence of technical efficiency across regions (or types of ownership as discussed earlier) could be largely attributed to different between new entrants and bankrupt firms across regions. Given the rapid growth of new establishments, it is probably likely that it is the new entrants that drive such a trend.

average level of the technical efficiency estimates. Secondly, it is noted that the average firm efficiency of the smallest firms and the largest firms have evolved in an opposite direction. Before 2003, the average efficiency of the smallest group (i.e. those employed less than 20 workers) was higher than that of the largest group and these small firms were the best performer in terms of technical efficiency. But after this year, these small firms turned out to be the least technically efficient enterprises while those in the largest group became the best performers. However, as the gap in average efficiency levels between large firms and small ones are generally small in this period, there are no strong associations between employment size and firm efficiency.

Figure 3.9 Technical Efficiency of the Manufacturing Sector by Size, 2000-2006



3.5 Conclusions

Over the two decades of the *Doi moi*, Vietnam's manufacturing sector has become increasingly important for the country's economic growth prospects. The manufacturing sector has registered an annual growth of around ten percent during the period 1990-2006. This sector now accounts for nearly a half of the country's total exports. The rapid growth of manufacturing output and exports is associated with a significant growth in the number of establishments at 16 percent per annum since the Enterprise Law was enacted in 2000. Since that year, employment in the manufacturing sector has grown at an annual rate of 14 percent. Underlying these impressive growth rates, there has been a dramatic transformation in terms of ownership of the manufacturing sector. In association with the SOE restructuring agenda, a number of reform initiatives were introduced to support private sector development and attract foreign investors. As a result of this transition, the manufacturing sector has been transformed from a state-led to a (domestic and foreign-invested) private-led sector. While the SOE sector was pre-dominant in the early 1990s, the role of SOEs has been steadily eroded by a vibrant private sector. The FDI sector has currently surpassed their SOE counterparts in terms of contributions to output and exports.

This study employs a series of the VESs from 2001 and 2007 to investigate empirically technical efficiency in the manufacturing sector using the stochastic frontier approach within a cross-sectional estimation context. This focus on cross-sectional analysis is largely driven by the data availability for the current study. Being well aware of the fact that technical efficiency estimates could be sensitive to different assumptions regarding the structure of production, distribution of the technical efficiency and the presence of heteroscedasticity, the current chapter performed a set of statistical tests to verify the most appropriate assumptions for the empirical estimation. The test results provide a convincing basis for proceeding with the empirical estimation of technical efficiency within the manufacturing sector and provide some confidence in the reliability of the resultant estimates.

On the basis of the empirical analysis reported in this chapter, the manufacturing sector is reported to operate at 62 percent of its technical efficiency. This efficiency level declined

13 percentage points over the period under consideration (i.e. from 72.43 percent in 2000 to 59.36 percent in 2006). This could be partly attributed to the rapid growth of new establishments during the period under consideration. In fact, new entrants were found to be considerably less technically efficient than the average level that prevailed in the manufacturing sector as a whole. Using the limited panel of 5,880 firms available across 2001 to 2006, this chapter reported a considerably higher level of technical efficiency than those obtained from the cross-sectional analysis. On average, the manufacturing firms in the panel operated at around 84% of their technical frontiers.

The estimated technical efficiency (in the cross-sectional analysis) of this current study is compatible with those reported for some other transitional economies such as Bulgaria (Jones *et al.*, 1998), Czechoslovakia and Hungary (Brada *et al.*, 1997), and the former Soviet Union (Brock, 1999). In the context of Vietnam, our results are compatible with Dao *et al.* (2010) who reported an average technical efficiency level of nearly 62 percent in 2002 for around 11,000 manufacturing firms. Our results obtained from the cross-sectional analysis are higher than those reported in Hoang *et al.* (2008) and lower than the technical efficiency levels reported by Nguyen *et al.* (2002) and Vu (2003). The observed and marked decline in efficiency levels over time may be attributable to the entry of younger and more heterogeneous in the subsequent years of our analysis.

Analyzing the average firm efficiency across some important dimensions provides further insights on the efficiency of Vietnam's manufacturing sector. When dividing the manufacturing sector into four broad sub-sectors according to factor intensity, it is found that the average technical efficiency is lowest for labour-intensive firms, which have been the major export engine for Vietnam during the *Doi moi*. This could be taken to suggest that, on average, export-oriented labour-intensive manufacturing enterprises have not done better than the others in terms of their technical efficiency performance. Moreover, the study also reported that agricultural resource-intensive firms (i.e. food and beverage enterprises) are recorded as the best technical performers in the manufacturing sector.

More interestingly, this study found that the SOEs have outperformed private (domestic and foreign) manufacturing firms and this could be considered as supportive evidence for the SOE reform process. It challenges the common understanding that although the SOE sector has been subject to important reforms and its dominant role has eroded over time, there has been little evidence that those SOEs that survived the restructuring process improved their profitability substantially. The finding in this study provides some tentative evidence that the SOE reform agenda has been associated with a better performance of the SOE sector in comparison with manufacturing firms operating under other ownership types. The reasons for this are likely to be multi-faceted and clearly require further research beyond the scope of the current chapter. In contrast to the SOE sector, the FDI sector has been, on average, the worst performer in terms of distance from the production frontier. This is surprising as FIEs are generally assumed to have advantages over other domestic enterprises in terms of capital resources, modern technology, marketing and management skills, and access to international market places. Among possible explanations, this paper suggests that the average youthful age of FIEs and the fact that foreign investors tend to overstate the value of machinery and assembly lines could lend some explanation for the poor performance of this particular ownership sector. This ownership pattern, however, diminished when using the restricted panel available across the period 2001-2006.

Chapter 4: The Determinants of Technical Efficiency in Vietnam's Manufacturing Sector in an Era of Trade Reforms

The trade policy reform has been one of the pillars of the reform package of Vietnam since the early 1990s and has transformed the country from a near autarky into a highly open economy. Unlike many other countries where trade reforms started by liberalizing different trade barriers, the trade reform process has been undertaken by imposing restrictive measures in the early stages of the *Doi moi*, gradually removing these restrictions during the 1990s, and continuing a movement toward a more liberalized trade regime to date (Auffret, 2003; Athukorala, 2006). This trade reform process has exerted important impacts on economic growth, especially in terms of export growth and FDI attraction.

The primary motivation of this chapter is twofold. Firstly, the previous chapter provided informative empirical results on the technical efficiency of the manufacturing sector but did not investigate the determinants of technical efficiency. This chapter will examine empirically these determinants by estimating the level of technical efficiency of Vietnam's manufacturing sector using data over the period 2000-2006. As the technical efficiency estimates in the previous chapter do not seem to conform to a normal distribution, a quantile regression approach is adopted in conjunction with the mean regression technique in order to provide a better picture of the determinants of technical performance of Vietnam's manufacturing sector. To the author's knowledge, it represents one of the first applications of the quantile regression approach to the literature on technical efficiency in a manufacturing sector context.

Secondly, the impact of the trade reform in Vietnam has been investigated from different perspectives. Litchfield *et al.* (2008) investigates the rural poverty dynamics during the *Doi moi* with an emphasis on trade reforms. This link is also examined in Seshan (2005). Pham (2007) analyzes the rural labour market under a period of trade reforms and found important effects of trade liberalization on non-farm employment, wages, and household welfare. The impact of the trade reform has also been investigated using more descriptive types of analysis. For instance, MUTRAP (2002) associates the trade liberalization with FDI flows, which was then re-investigated in MUTRAP (2008). However, there has not been an empirical study to date that examines whether or how the trade reform impact on firm technical performance. The only exception is Dao *et al.* (2010) using data from 2002 to link technical efficiency in the manufacturing sector to some measures of trade reforms.[26] That study suggests a positive impact of trade liberalization on firm efficiency. The research undertaken in this chapter is expected to contribute to this gap in the current literature in Vietnam.

This chapter is structured as follows. The next section provides a contextualization for the empirical analysis through a review of Vietnam's trade reforms during the *Doi moi*. This is then followed by a literature review on trade liberalization and firm productivity. Ideally, a review of the relationship between trade liberalization and technical efficiency should be provided but this research is currently under-developed. Section 3 outlines the empirical strategy to be used in estimating the determinants of technical efficiency. Estimates obtained from applying this empirical strategy will be interpreted in the next section to inform the key determinants of technical efficiency for the Vietnamese manufacturing sector. As this study places an emphasis on the potential impact of trade reforms on

---

[26] This is part of the author's research in the early stage of this study using the first VES made available to the current research.

technical efficiency, this aspect will feature in the interpretation of the empirical results. The final section provides policy implications and some concluding remarks.

4.1 Overview of Trade Reforms in Vietnam

Vietnam's trade regime in the pre-transition period shared some common features with these of other transitional economies in Europe, including (i) monopoly of state corporations in foreign trade; (ii) limited uses of tariffs and other non-tariff tools as foreign trade was distorted by the planning systems; and (iii) trade relations mostly with other countries in the Council for Mutual Economic Assistance (CMEA). Before the 1990s, 13 state-owned foreign trading corporations effectively controlled Vietnam's exports and imports. Import transactions were planned to fill the gap between domestic demand and the supply of particular goods, while exports were set in order to finance the planned imports. Prices served as an accounting unit and had no signaling role in allocating resources. In addition, foreign transactions were not subject to any kind of export/import duties. Exports and imports were produced and exchanged according to state-to-state protocols between Vietnam and other CMEA countries, using a heavily distorted 'convertible rouble' exchange rate.

From this 'starting point', Vietnam initiated the trade reform process in the late 1980s to serve the two comprehensive objectives established at the Sixth National Congress of the Communist Party in 1986. The first objective was to make the transition from a centrally-planned economy toward a market-oriented one through liberalizing regulations on participation in foreign transactions and developing trade policy instruments. The second was to promote export-oriented industries while simultaneously protecting a wide range of industrial goods and sectors (CPV, 2001). Vietnam's first tariff law - the Law on Import and Export Duties Levied on Commercially Traded Goods - was promulgated on 29th of

December 1987 at the same time as the first Law on Foreign Investment in Vietnam. At that time, however, a significant share of Vietnam's foreign trade was still conducted under protocols signed by the Vietnamese government and, hence, was not taxed. Further, the tariff nomenclature still followed that of the CMEA. Four years later, the 1987 law was expanded to cover all trade transactions when Vietnam's first "proper" tariff law - the Law on Import and Export Duties - was issued (26 December 1991). At the same time, the tariff system was rationalized as the government adopted a harmonized system of tariff nomenclature based on that of the World Customs Organization. From that point onwards, tariffs were assessed on all traded goods (except those specifically exempted) on a CIF price basis. The new system imposed 36 tariff rates, ranging from 0 to 200 percent. Most essential goods[27] enjoyed duty-free status, while the highest tariff rate of 200 percent was applied to passenger cars. As there was little domestic production to protect, the overall tariff level was low. Many tariff lines were in the range of 0-5 percent; and the simple average tariff rate was about 10 percent.

After the accession to Association of South East Asian Nations (ASEAN), the tariff system was restructured in October 1995, the number of tariff bands were reduced but new tariff lines were also introduced. Following Vietnam's legal commitments to AFTA/CEPT tariff reduction in 1996, the government gradually began tariff restructuring. On December 1998, a new system of tariff rates was announced. As a result of the 1998 changes, there are now three categories of tariff rates: (i) the lowest preferential tariffs ("Special Preferential" rate); (ii) intermediate MFN tariff rate ("Preferential" rate); and (iii) the highest non-MFN tariffs ("Normal" rate). Since then, the tariff structure has been fine-tuned several times (Auffret, 2003; Athukorala, 2006).

[27] This "essential goods" concept is a vague notion employed by policy-makers to refer to raw materials, energy products, machinery, and basic consumer goods such as foods and medicines.

During the above process of tariff restructuring the average tariff rate has been, however, steadily increased and remain high to date (Table 4.1). The average un-weighted tariff rate has risen from 10.7 percent in 1992 to 16.3 percent in 1999. Since then, the average tariff rate has remained relatively stable at around 16 percent. Comparing the structure of tariffs between 1992 and 2006, it should be noted that the tariff structure in the latter year is higher than that of the earlier year. While 68 percent of tariffs were between zero and 10 percent and only two percent of tariffs were above 40 percent in 1992, the corresponding figures in 2006 were 56 and 11 percent, respectively. This could be explained by the introduction of new tariff lines. During that period, there has been a substantial increase in the total number of tariff lines from 2,913 lines in 1992 up to 5,224 lines at the end of the period. Nevertheless, the dispersion of rates with respect to the average simple tariff level declined to 110 percent in 2006 from 138 percent in the early 1990s.

Table 4.1. Evolution of Vietnam Import Tariffs, 1992-2006

	92	**95**	**98**	**99**	**‘00**	**‘01**	**‘02**	**‘03**	**‘04**	**‘05**	**‘06**
Shares of tariff lines											
0 to 10%	68	62	62	59	60	60	60	57	56	56	56
Above 10 - 20%	15	20	11	10	9	0	9	10	11	10	10
Above 20 - 40%	15	14	18	21	21	21	21	22	23	23	23
Above 40%	2	4	7	11	10	19	10	11	11	11	11
Average rate	10.7	12.3	13.6	16.3	16.2	15.7	15.4	16.6	16.8	16.8	16.7
Maximum rate	120	200	60	100	100	120	100	113	100	100	100
CVs	138	131	117	115	118	116	118	115	112	112	110
Total tariff lines	2,813	3,023	3,163	6,056	6,341	5,724	6,413	5,107	5,225	5,224	5,224

Source: CIEM (2001) for 1992-1998; MUTRAP (2002) for 1999-2002; and calculations from TRAINS data for Vietnam between 2003-2006.

Notes: ‘CV’ denotes for coefficient of variation, defined as the standard deviation of tariff rates divided by the mean of those rates;

Table 4.2 compares the estimates for nominal and effective rates of protection in some selected sectors extracted from MUTRAP (2002) and Athukorala (2006). It indicates that the nominal rates of protection (NRPs) have declined slightly by three percentage points between 1997 and 2003. In contrast, the evolution of effective rates of protection (ERPs) exhibits a big decline in both the level of effective protection (from nearly 72 percent in 1997 to 25 percent in 2003) and the degree of dispersion (measured by the coefficient of variation which decreased from 156 percent in 1997 to 135 percent in 2003). However, as the reduction in NRPs was modest, it is likely that the observed decline in the effective protection level could be attributed to an increase in input tariffs. At the sectoral level, the modest decline in the ERP of the agricultural sector in the late 1990s was reversed during the period 2001-2003. This is in contrast to a continuing and sharp decline in the manufacturing sector (the ERPs decreased from 121 percent to 44 percent between 1997 and 2003). In a cross-country comparison, Vietnam has far higher ERPs in 1997 and 2001 than other East Asian countries historically or even currently (Athukorala, 2006).[28]

Table 4.2 Shifts in Nominal and Effective Rates of Protection, 1997- 2003

	1997		2001		2003	
	NRP	**ERP**	**NRP**	**ERP**	**NRP**	**ERP**
Agriculture	8.12	7.74	6.28	7.43	11.06	12.52
Mining	9.42	6.05	8.91	16.39	3.55	-0.03
Manufacturing (average)	30.63	121.47	25.28	95.97	29.23	43.94
Manufacturing excluding motor vehicles	28.37	116.55	22.95	90.86	na.	na.
Total tradable	20.95	72.22	17.92	58.46	18.2	24.87
Simple Average	23.32	59.64	20.14	54.1	19.98	26.23
CVs	133.81	156.01	149.9	172.34	106.51	134.93

Source: MUTRAP (2002) for data in 1997, 2001; and Athukorala (2006) for data in 2003.

In addition to changes in the tariff regime, significant changes have been made in terms of other non-tariff barriers (NTBs). A range of NTBs was firstly introduced when the country shifted from CMEA member countries to other trading partners in the late 1980s and early 1990s. The employment of NTBs became a key component of Vietnam's trade policy. In general, Vietnam has six major categories of non-tariff trade-impeding measures, including (i) import prohibition, (ii) direct quantitative restrictions on imports, (iii) non-automatic

[28] Although a strict comparison of estimates listed in these studies are not possible due to differences in terms of the coverage given to various elements of the trade regime, Athukorala (2006) report that the ERPs had dropped to below 20 percent in most East Asian countries.

import licensing, (iv) special authority import regulation, (v) exchange/currency regulations and (vi) other measures (mainly non-transparent and inflexible bureaucratic and customs procedure). Most of the measures in this plethora of NTBs remained in less than one decade before being removed. Such liberalization of NTBs after the early 1990 could be considered as a key component of Vietnam's trade reforms. The essence of these NTBs and the related reforms are briefly described below.

Import prohibition is the category of NTBs which regulate the trade of some prohibited goods. Since the introduction of this NTB types, Vietnam has kept the list of prohibited goods small and its use justified by international legal standards (i.e. safety, health, security and similar matters). Though this list does exist, it has a modest impact on trade flows.

Regarding *direct quantitative restrictions on imports* and *import licensing,* Vietnam relied heavily on quantitative restrictions (QR) in the early stage of its trade reforms. These regulations have evolved substantially over time. In early 1998, import quotas were imposed on six categories of goods, and another 10 products were subject to non-automatic import licenses issued by the former Ministry of Trade (known currently as the Ministry of Trade and Industry – MoIT) and other related authorities. In 1999, eleven additional products were added to the list of MoIT licensed goods. Since 2000, QRs on imports have been substantially liberalized. Currently, QRs remain on two items including sugar and petroleum products.

Special authority import regulation is also referred to as the management of trade by "line" ministries, thus the term *the line management of trade*. Before 2001, importers required approval from the relevant 'owning' ministries or agencies to import many goods. This was considered as a way to control imports. Depending on their areas, some "line" ministries (e.g., trade, industry, agriculture and rural development) were responsible for imposing regulations and guiding the importation of relevant commodities under their authorities. However, this system was abolished in 2001. Since then, once goods meet certain standards, they can be imported upon demand and without approval requirements.

In addition, *exchange/currency regulations* have at times been used to restrict imports. For instance, after the East Asian financial crisis in 1997-98, Vietnam placed restrictions on foreign investors limiting the release of foreign exchange for imports to the amount of foreign exchange they brought into the country in a particular fiscal year. In early 1998, the State Bank of Vietnam initiated a foreign exchange surrender requirement for all exporters including foreign-invested firms. However, these measures have almost been eliminated since the end of 2003.

Finally, the most notable *other measures* in the early stage of the trade reform were the bureaucratic, complex and time-consuming customs procedures. These increased transaction costs significantly for some firms, especially private SMEs. However, customs procedures have been substantially simplified over time (MUTRAP, 2002) and they are now basically compatible with international standards.

In other words, the trade policy reform can be described as a combination of imposing restrictive measures in the early *Doi moi*, gradual liberalization of these restrictions especially during the 1990s, and continuing liberalization towards a more liberalized trade regime in more recent years. The general outcome of Vietnam’s trade reform is however mixed. Despite significant reforms to rationalize the tariff structure, tariffs remain relatively high. More importantly, complicated NTBs were significantly reduced in numbers and simplified in terms of their management mechanisms. Up to the present, there are few NTBs and these have a modest impact on international trade flows.

The above trade reform process, both in terms of tariffs and non-tariff barriers, has increasingly exposed the Vietnamese economy to international market forces and, as a consequence, the country has become remarkably open over the past two decades. As mentioned in chapter one, the growth rate of export turnover between 1990 and 2007 was nearly 20 percent per annum and the corresponding figure for imports is 22 percent. Compared to the average GDP growth rate, trade grew faster by a factor of 2.7 times.

4.2 Literature Review

There is a huge literature on the linkages between trade liberalization and economic performance in general and few questions have been more vigorously debated in the economics literature. The optimistic view argues that trade liberalization, and the implied elimination of barriers to competition, is the right road for developing countries to promote growth and eradicate poverty. This has been advocated by, for example, Dollar and Kray (2002, 2004), Frankel and Romer (1999), Sachs and Warner (1995) and World Bank (2001). In contrast, skeptics object that there can be no such progress without an active role for domestic institutions and policies to correct market failures (Rodriguez and Rodrik, 2001), and argue that liberalization may even be detrimental to growth, by inhibiting infant industries and the local accumulation of knowledge (see for instance, Haussman and Rodrik, 2002; Young, 1991; and Stiglitz, 2002). Given one of the focuses of this chapter is to examine potential impacts of trade liberalization on firm efficiency in Vietnam's manufacturing sector, this section will concentrate on the existing literature on trade and firm productivity.[29]

The theoretical literature on trade and productivity does not provide an unambiguous prediction of the impact of trade liberalization on firm productivity. On the positive side, the proponents of free trade argue that trade liberalization can increase overall domestic

---

[29] Ideally, this should be the literature on trade and technical efficiency – but this is an area of being under-researched. More importantly, the rationale underlying trade-firm productivity relationship should be very similar to those underlying trade-technical efficiency one.

productivity through several channels. In the presence of imperfectly competitive domestic markets, trade liberalization and concurrently foreign competition can improve allocative efficiency by forcing firms to lower cost-price mark-ups (i.e., the pro-competitive effects of trade) and thus allow them to move down their average cost curves, thereby effectively raising firm size and scale efficiency (i.e., scale efficiency gain of trade) (Epifani, 2003; Topalova, 2004). With firm heterogeneity, trade openness may also induce a reallocation of market shares towards more efficient firms and generate an aggregate productivity gain (Melitz, 2003). In this context, trade liberalization causes more productive firms to expand at the expense of less efficient firms (which either shrink or exit), thereby inducing additional efficiency gains.

Going beyond this reallocation effect of trade liberalization, Aghion, Burgess, Redding and Zilibotti (2008) suggest another mechanism through which trade liberalization might affect productivity. Accordingly, trade liberalization would induce more competition and this increased threat of foreign competition raises the innovation incentives to domestic producers as they seek to deter entry by foreign competitors. The higher level of innovation leads to productivity growth at the firm level. Moreover, trade liberalization and its induced investment, may foster technology advancement and productivity growth in developing countries through several channels, such as technology advancement embodied in imported capital goods and intermediate inputs, technology transfers accompanying FDI. This increasing exposure to trade and foreign investment could encourage the diffusions of know-how by introducing new technology and training workers who will be hired by domestic firms later. When these workers leave the foreign firms, they will become available to domestic firms, raising their measured productivity. Similarly, when domestic firms are exposed to new technology, production and marketing techniques, this knowledge of foreign firms will then spill-over to domestic counterparts. Another channel is through the increase of competition pressures or breaking down of monopolies, forcing local firms to enhance their competitiveness, managerial efforts, and to adopt new technology used by multinational corporations in order to improve their managerial capabilities (Blomström and Kokko, 2003).

One important potential effect of trade liberalization is mediated through the ‘learning from exporting’ effect. Exporting allows firms to ‘learn’ from foreign technological and managerial knowledge, which can then reinforce their productivity enhancements. In other words, there are potential ‘learning-from-exporting’ benefits for domestic firms after trade liberalization (Bernard and Jensen, 1999; Wagner, 2002, 2007). In the context of transitional economies, this ‘learning-by-exporting’ benefit has a large potential impact on productivity as after the trade liberalization, the state monopoly over international transactions was terminated. In this case, exporting to foreign markets for the majority of firms may be their first-hand experience in dealing with foreign customers. Consequently, it is reasonable to postulate potential improvements for exporters after trade liberalization.

However, whether domestic producers can take advantage of increased access to knowledge remains questionable. Trade liberalization has certainly its own costs. The main argument against trade reform in the developing countries that have opted for an import substitution industrialization strategy has often been that trade liberalization would exacerbate income inequality and hence deteriorate the conditions of the poor. In particular, concerns regarding higher unemployment among workers displaced by the contraction of import competing sectors, greater uncertainty and precariousness of job conditions, and the creation of new job opportunities only for the most qualified segments of the workforce have often been deemed inevitable consequences of trade liberalization (Epifani, 2003).

Some argue that trade liberalization in poor economies may have a detrimental effect on growth by preventing a country’s involvement in certain industries, thus potentially denying its knowledge accumulation and productivity growth (Young, 1991; Stiglitz, 2002). While acknowledging that trade liberalization could have pro-growth effect, Baldwin and Robert-Nicoud (2006) noted that the Melitz-model selection effects raise the expected cost of introducing a new variety and this tends to slow the rate of new-variety introduction and hence growth. Rodrik (1992) noted that in most countries that have undertaken radical trade reforms in the 1980s, the direct efficiency consequences of trade liberalization were uncertain and likely to be small. Rodrik further argues that poorly conceived trade reforms can be worse than none at all and that governments can complicate their macroeconomic stabilization efforts by placing too much emphasis on the potential benefits of trade liberalization.

One expected effect of trade liberalization is that greater openness would encourage FDI, which would then generate spillover effects to enhance the performance of domestic firms. However, this spillover effect is only a potential one and there are no guarantees that this effect could actually be realized. It is argued that foreign-owned firms are more efficient because they have taken over the more efficient domestic firms leaving those less efficient ones in the hand of local ownership. Foreign-owned firms are also accused of stealing markets from their domestic counterparts, forcing them into less efficient scales of production. This is because, as the market share declines, the domestic firms are forced to spread their fixed costs over a smaller market, leading to even higher average cost (Aitken and Harrison, 1999).

Regarding the potential ‘learning-from-exporting’ benefits, exporting to foreign market requires certain sunk costs in conducting market research, transportation costs, establishing distribution network, and other marketing efforts to make products responsive to the preferences of customers in relevant destination markets. As described in Bernard and Jensen (1999) and Clerides, Lach, and Tybout (1998), the existence of considerable sunk costs may exclude small and/or low-productive firms from exploiting export opportunities available after trade liberalization. In the context of developing countries or transitional economies, the presence of sunk costs provides one of several reasons to justify the traditional (and arguably outdated) 'infant industry argument'. Opponents of trade liberalization argue that domestic firms are not competitive enough in international marketplaces, and thus benefits from an expanded export market are marginal or, if they exist, unlikely to be realized.

Due to the ambiguity of the theory, the question of whether trade liberalization leads to higher firm productivity remains largely an empirical one. As the theoretical discussion ends up with a mixed answer, there has been a fertile empirical literature since the mid 1990s on impacts of trade liberalization on firm performance. However, this growing empirical literature has done little more than provide further ambiguous evidence on the impacts of trade liberalization on firm performance. Tybout, de Melo, and Corbo (1991) find scant support for productivity improvements in the Chilean manufacturing sector after trade liberalization. Using plant-level panel data from the Ivory Coast, Harrison (1994) finds a positive correlation between trade reform and productivity growth. Tybout and Westbrook (1995) report productivity improvements related to trade liberalization in Mexico. In the case of India, positive evidence on the impact of trade liberalization on productivity is reported in Krishma and Mitra (1997), Topalova (2004), and Aghion *et al.* (2008). Pavcnik (2002) used data from Chilean manufacturing firms and suggested that liberalized trade enhances plant productivity. With regard to improvements in firm performance through the 'learning-from-exporting' effect, Delgado, Farinas, and Ruano (2002) and Baldwin and Gu (2003) report strong supportive evidence for 'learning-by-exporting' for Spanish and Canadian manufacturing firms, respectively. Fernandez and Isgut (2005) also find evidence for 'learning-by-exporting' in the case of Columbia. Westphal (2002) documents the case of Taiwan and argues that participating in foreign market stimulate firms to improve their own technological capacities.

In contrast with the above positive evidence on impacts of trade liberalization on firm productivity, there have been a number of studies that either suggest differently or cast doubt on these positive results. As Rodrik (1995) notes, "since the conceptual issues are rarely sorted out as a prelude to empirical analysis, the hypothesized cause-and-effect are difficult to interpret" (p. 2935). This difficulty in identifying causality running from trade to productivity is also emphasized in Winters (2004). Even if a causal relationship could be determined, the next challenge is how to separate this impact of trade liberalization from other (sometimes compounding) factors that could also exert influences on firm productivity.

Another criticism of the empirical studies on trade-productivity linkages is that there has been a lack of reliable measures of trade policy changes. Edwards (1993) provided one of the most influential critiques on this issue. Rodrik (1995) further argues that in most studies on trade liberalization and economic performance "[…] the trade-regime indicator used is typically measured very badly" (p.2941). In earlier studies that have investigated the link between trade liberalization and productivity (such as Krueger and Tuncer, 1982), causality was attributed by association (i.e. if there was evidence that productivity increased in the post-reform period, then it must be due to the reforms). More sophisticated analyses in the same vein using dummy variables to delineate the post-reform period from the pre-reform one (such as Harrison, 1994) are open to the same criticism. More importantly, the use of dummy variables to measure trade reforms implicitly assumes (i) that the trade reforms were a once-and-for-all event, and (ii) that it was eventually completed. Neither of these two conditions may be satisfied in most trade liberalization episodes that one observes in developing countries. After reviewing a number of different measures for trade openness, Edward (1997) acknowledges that "[…] despite of significant efforts and ingenuity there hasn't been much progress in this area" (p.6) and suggests that empirical studies on impacts of trade liberalization should concentrate on determining whether their econometric results are robust to different measures of trade exposure.

Given this ambiguous picture of the impact of trade liberalization on firm performance, both theoretically and empirically, there is an obvious need for further country-specific studies (Hahn, 2004). In this regard, this current research is expected to provide an empirical analysis on the potential impact of the trade reform process on firm-level technical efficiency in the Vietnamese manufacturing sector. The next section will outline the empirical strategy to be used for this purpose.

4.3 Methodology and Data

4.3.1 Empirical Methodology

The previous chapter has outlined the details of the empirical methods used to estimate technical efficiency. Given the focus of this paper is to investigate empirically the determinants of technical efficiency, the basis of that method is very briefly re-produced here for convenience.

Following the method introduced by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977), a double-sided random error term is included in the specification of the production frontier function. In the simplest specification, a production function in a cross-sectional context as shown in chapter 3, can be expressed as

$$y_i = \beta_0 + \boldsymbol{x}_i'\beta + v_i - u_i \quad \text{with } i = 1, 2, \ldots n \qquad [4.1]$$

where y_i is a measure of (log) output of firm i, $\boldsymbol{x}_i$ is the vector of the logarithms of inputs, β is a vector of unknown parameters applicable to the vector $\boldsymbol{x}_i$. The term $(v_i - u_i)$ is a composed error term, where v_i represents randomness (i.e., statistical noise) and u_i

represents the technical inefficiency of firm i. With this expression of the production frontier function one can evaluate whether the difference between the actual output obtained and the potential frontier output is mainly because the firm did not use the best practice technique or attributable to external random or unobserved factors (Kalirajan and Shand, 1999).

In chapter 3, various tests were employed to find the most appropriate specifications for the production function, its distributional form, and the nature of the technical inefficiency error term. After performing the relevant tests, the chapter obtained technical efficiency estimates from the use of following translog production function.

$$lnY_i = \beta_0 + \beta_K lnK_i + \beta_L lnL_i + \beta_{KK}[lnK_i]^2 + \beta_{LL}[lnL_i]^2 + \beta_{KL}[lnK_i lnL_i] + v_i - u_i \quad [4.2]$$

where both u_i and v_i are heteroscedastic; u_i follows an exponential distribution in the period 2000-02, and 2004 while the truncated normal distribution is favoured for the remaining years of 2003, 2005, and 2006.

To investigate the determinants of technical efficiency, the technical efficiency estimates obtained from equation [4.2], $T\hat{E}_i$, are expressed as follows:

$$T\hat{E}_i = \alpha_0 + \boldsymbol{x}_i'\alpha_1 + \varepsilon_i \quad [4.3]$$

where $\boldsymbol{x}_i$ is the vector of firm-level and other characteristics assumed to affect the efficiency of firm i, ε_i is an error term for which standard OLS assumptions are upheld. As this chapter places a focus on whether the trade reform in Vietnam exerts impacts on firm efficiency, following the common method used in most of the empirical studies reviewed in section two, an additional variable for trade exposure is added to equation [4.3] to form the following relationship:

$$T\hat{E}_{ij} = \alpha_{0j} + \boldsymbol{x}_{ij}'\alpha_{1j} + \boldsymbol{T}_j'\alpha_{2j} + \varepsilon_{ij} \quad [4.4]$$

where j denotes sector j, and T_j is the trade variable of sector j. Then the coefficient estimate of $\hat{\alpha}_{2j}$ represents the potential impact of trade exposure on technical efficiency.

As discussed earlier, there is little consensus on the measurement of trade exposure. Edwards (1997) encourages researchers to test whether or not econometric results on the impact of trade liberalization are robust to different openness measures. However, the selection of this variable depends also on data availability. Winters, McCulloch, and McKay (2004) point out that effective openness requires predictability, transparency, and convenience of the trade regime, as well as low barriers *per se*. "[…] for example, tariff needs to be aggregated, quantitative restrictions assessed and then aggregated, and the levels of credibility and enforcement measured" (p.8) in order to derive an appropriate openness measure. Therefore, constructing a good measure for trade openness can be data demanding in practice. These arguments will be taken into account when discussing the construction of variables in a subsequent sub-section.

To provide insights on the effects of location and industry affiliation, the approach introduced by Haisken-DeNew and Schmidt (1997), which generalizes the conventional method originally developed by Krueger and Summers (1988), is employed in this chapter. This method has now become a popular application in the literature on trade and industry wage premia, for example (see Dutta, 2007 for a review). For simplicity, this approach will be used to examine effects of industrial affiliation and the same could be equally employed for an investigation of the regional effect. For that purpose, equation [4.4] could be re-expressed as

$$T\hat{E}_{ij} = \alpha_{0j} + \boldsymbol{x}'_{ij}\alpha_{1j} + \boldsymbol{T}'_{j}\alpha_{2j} + \boldsymbol{I}'_{ij}\alpha_{3j} + \varepsilon_{ij} \qquad [4.5]$$

where $\boldsymbol{I}$ is a ($(k\text{-}1)$x1) vector of the industry affiliation variables applying for $(K\text{-}1)$ industries. It should be noted that only $(k\text{ -}1)$ dummies for $(K\text{-}1)$ manufacturing sub-sectors are included in [4.5] as the K^{th} sub-sector is treated as the base category and hence excluded from this equation.

Given the estimates $\hat{\alpha}_{3j}$ from [4.5], a weighted average of industry dummy coefficients are defined similarly to Haisken-DeNew and Schmidt (1997) as (suspending the subscript *j* and $_3$)

$$\hat{\alpha}^* = Z\hat{\partial} - es'\hat{\partial} = (Z - es')\hat{\partial} \qquad [4.6]$$

where Z is a *(kxk)* identify matrix; e is a *(kx1)* vector of ones. s is a *(kx1)* vector with elements representing the sample shares of each of K manufacturing sectors; and $\hat{\partial}$ is a *(kxk)* matrix constructed as the stack of $\hat{\alpha}_{3j}$ (i.e. the *((k-1)x(k-1))* coefficient estimates matrix obtained from equation [4.5]) and a *(1x(k-1))* row of zeros and *(kx1)* column of zeros.

To inform statistical inferences, the variances of the estimated industry technical efficiency effects can be computed as per Haisken-DeNew and Schmidt (1997)

$$V(\hat{\alpha}^*) = (Z - es')V(\hat{\partial})(Z - es')' \qquad [4.7]$$

where $V(\hat{\partial})$ is a *(kxk)* matrix constructed as the stack of $V(\hat{\alpha}_{3j})$ which is a *((k-1)x(k-1))* variance-covariance matrix of $\hat{\alpha}_{3j}$ obtained from regressing equation [4.5] and a *(1x(k-1))* row of zeros and *(kx1)* column of zeros.

The framework expressed in [4.5] to [4.7] will be adopted in this study to investigate the pattern of the technical efficiency across different manufacturing sub-sectors. These technical efficiency effects are interpreted as the technical efficiency level of a firm in a specific sector relative to the ‘average’ firm in the whole manufacturing sector. This approach will also be employed to shed light on the regional effects on technical efficiency of the manufacturing sector.

The approach expressed from [4.2] to [4.7] focus exclusively on the mean. Such an exclusive focus on the average may provide a misleading picture as it does not provide an insight of the impact of covariates across the conditional technical efficiency distribution. In addition, the non-normality in distribution of technical efficiency may pose problems for the use of a mean estimator. As shown by Figure A3.2 in the Appendix of chapter 3, the distribution of technical efficiency estimates tends to be skewed to the right. Therefore, a quantile regression estimation approach is also adopted in this chapter to examine the determinants of technical efficiency at different points of the conditional technical efficiency distribution. As Chamberlain (1994) and Buchinsky (1998) argued, when a quantile regression model is used, the focus moves away from the mean to other selected points on the conditional distribution and the estimation procedure is formulated in terms of absolute rather than squared errors. The estimator is known as the Least Absolute Deviations (LAD) estimator.

For simplicity, equation [4.4] could be re-expressed as (the subscript *j* is suspended for convenience)

$$T\hat{E}_i = \delta_0 + \boldsymbol{z}_i'\delta_1 + \vartheta_i \qquad [4.8]$$

where $\boldsymbol{z}_i$ is the vector of all covariates, including firm characteristics, trade variables, dummies for regions, and dummies for manufacturing sub-sectors.

The median regression coefficients can be obtained by choosing the coefficient values that minimize *L*

$$L = \sum_{i=1}^{n}\left|T\hat{E}_i - \boldsymbol{z}_i'\delta_1 - \delta_0\right| = \sum_{i=1}^{n}\left(T\hat{E}_i - \boldsymbol{z}_i'\delta_1 - \delta_0\right)sgn\left(T\hat{E}_i - \boldsymbol{z}_i'\delta_1 - \delta_0\right) \qquad [4.9]$$

where *sgn(.)* is the sign of *(.)*, which is equal to *1* if *(.)* is positive, and *–1* if *(.)* is negative or zero.

The quantile regression could be expressed as

$$T\hat{E}_i = \delta_{\theta 0} + \mathbf{z}_i'\delta_{\theta 1} + \vartheta_{\theta i} \qquad [4.10]$$

where $Q_\theta(T\hat{E}_i|\mathbf{z}_i) = \delta_{\theta 0} + \mathbf{z}_i'\delta_{\theta 1}$ and $Q_\theta(\vartheta_{\theta i}|\mathbf{z}_i) = 0$, while θ denotes the particular quantile of interest.

Equation [4.10] potentially allows the delineation of a more detailed portrait of the relationship between the conditional technical efficiency distribution and its determinants. As shown in Koenker (2005) and Koenker and Bassett (1978), in contrast to the OLS approach, the quantile regression procedure is less sensitive to outliers and provides a more robust estimator in the face of departures from normality. In addition, this quantile regression models may also have better properties than OLS in the presence of heteroscedasticity (Deaton, 1997).

In this study, quantile regression functions will be estimated at the 10th, 25th, 50th, 75th and 90th percentiles of the conditional technical efficiency distributions to inform whether the relationship between technical efficiency and the chosen independent variables vary with the movement along the conditional distribution. In addition, inter-quantile regressions will also be estimated to compare the quantile coefficient estimates between 90th and 10th percentiles as well as between 75th and 25th percentiles of the conditional technical efficiency distributions over time.

4.3.2 Data and Construction of Variables

As discussed in chapter 2, this chapter will base its empirical analysis on the samples of the manufacturing sector drawn from the VESs 2001-2007, covering the data in the period 2000-2006. The estimated technical efficiency obtained from chapter 3 will be used as the dependent variable equation [4.4] and [4.10]. Technical efficiency-determining variables are defined following Dao *et al.* (2010). Accordingly, the set of explanatory variables includes types of ownership, firm-level characteristics such as the proportion of female employees, proportion of employees with contract, PC per employees, age of establishment; and regional dummies for the different economic regions of the country. These regressors are constructed as in chapter three (see section 3.2). In addition to these variables, a set of dummies for the manufacturing sub-sectors is also included to capture potential impact of enterprise affiliation to specific manufacturing sub-sectors.[30]

As this study places a focus on examining whether the trade reform has exerted an impact on technical efficiency, it is important to construct good proxies for trade exposure. As discussed earlier, this chapter takes the advice of Edwards (1997) and Winters *et al.* (2004) into account when constructing the proxy for trade openness. On the one hand, it is useful to test whether or not the econometric results are robust to different measures of trade openness. On the other hand, the construction of a trade exposure measure also needs to be driven by data availability. Given these considerations, tariff data at a sectoral level are first used to capture the trade reform in Vietnam. To ensure a sufficient variation in this tariff variable, the manufacturing sector is classified at the three-digit disaggregation using the United Nations' ISIC Revision 3. The tariff data used in this study are obtained from the TRAINS database of UNCTAD (see chapter 2).

As reviewed in section 3.1 above, the tariff is only one part of the trade reform in Vietnam and tariff data do not reflect the openness outcome. Empirical studies often adopt social accounting matrices or input-output tables to calculate an export ratio and/or an import

[30] One possible question is whether and how the estimated technical efficiency obtained in chapter 3 would change if these variables are also included in the production function using the same set of assumptions for functional form, heteroscedasticity, and distribution of the two error terms as selected in estimating the technical efficiency in chapter 3. The results, reported in table A4.2 in Appendix A4, reveal no material differences in the technical efficiency levels obtained from the two specifications of the production function.

penetration ratio of different sectors when examining the effect of trade liberalization on productivity (see, for instance, Fernandes, 2003). In the case of Vietnam, it is unfortunate that there is only one SAM for 2000 available during the period 2000-2006 (see CIEM and NIAS, 2004 for details). Therefore, this chapter employs the SAM 2000 to construct the export ratio and import penetration measures. This allows a sensitivity test for the impact of trade reforms on technical efficiency.

In a further attempt to inform the potential impact of the trade reform on technical efficiency, the information on whether a firm exports or not is also used as a proxy for export orientation. This information is available at the enterprise level and is based on a question asked in the survey. Ideally, the ratio of output exported by the firm would be a more accurate measurement for export orientation but this is not available in the VES series. Therefore, a simple dummy variable for exporter and non-exporter is used in the specification. A brief description and selected summary statistics of these variables are given in table A4.1 of the Appendix.

4.4 Empirical Results

This section reports the determinants of a firm's technical efficiency using the econometric methods of the mean and quantile regressions outlined above. The empirical results are obtained from regressing the technical efficiency measures estimated in chapter three on a set of firm-level and other characteristics in order to investigate the links between firm performance with respect to technical efficiency and a firm's characteristics. The results from the mean regression approach will be interpreted before embarking on those obtained from the quantile regression approach.

4.4.1 Empirical Results: Mean Regression Estimates

Determinants of Technical Efficiency

Table 4.3 reports the coefficient estimates obtained from regressing equation [4.3]. In addition to the above regressors, a set of dummies for different manufacturing sub-sectors is also included. This is to control for industry-level characteristics that may have effects on firm performance but cannot be captured by the set of firm-level characteristics. It is acknowledged that whether firms in different sub-sectors could be pooled together is subject to question. A version of Chow test was then performed to test the null hypothesis that different sectors could be pooled in one constrained model for estimation.[31] The results reported are understandably mixed: the null hypothesis of the constrained model specification is not rejected in three out of seven years, while the unconstrained models appear justified for the remaining four years. Therefore, it is not conclusive that pooling models for all years is statistically justifiable. For the years when pooling is not upheld, separation by industries is difficult given the problem of small cell sizes. In this circumstance, bearing in mind the research focus is on the manufacturing sector as a whole, it was inclined that the analysis in this chapter is retained to the pooling specification.[32]

In addition, it is also noted that due to data availability, some variables are not available for all the years under consideration here. This warrants some degree of caution when

---

[31] The Chow test, in its most general form, is given by:

$$F = \frac{(RSSC - RSSU)/(DFC - DFU)}{(RSSU/DFU)}$$

where RSSU is the residual sum of squares of the unconstrained models (i.e., the sum of the individual residual sum of squares for each sub-sector); RSSC is the residual sum of squares of the constrained model, which contains the industry specific intercept shifts. The DFU and DFC are respectively the degrees of freedom of the unconstrained and the constrained models.

[32] However, exploring the determinants of technical efficiency for separate sub-sectors, when data permitting, is a potential issue that perhaps merits consideration as part of a future research agenda, though a thorough analysis of this is likely to be constrained by small cell size problems in particular sub-sectors.

comparing the empirical results across years.[33] Before embarking on the interpretation of the estimated results, it should be noted that most the estimated coefficients are statistically significant from zero at conventional significance levels and the reported goodness-of-fit measures are, with the exception of 2006, satisfactory by the standards of cross-sectional analysis (although there is an apparent deterioration in the model fit over time).[34]

It is first noted that ownership is reported to be one important determinant of firm performance in the Vietnamese manufacturing sector. In particular, SOEs and DPEs are, on average and *ceteris paribus*, found to be more technically efficient than FIEs. With regard to SOEs, compared to FIEs as the base, SOEs are more technically efficient by between four to 17 percentage points in the period 2000-2006, on average and *ceteris paribus*. Considering the technical efficiency of SOEs in that period, there was a decline of 3.5 percentage points and this decline is found to be statistically significant at the 1% level. A more pronounced decline in the level of technical efficiency in the SOE sector relative to the FIE sector is reported between 2002 and 2005 (i.e., by nearly nine percentage points). Using a *t*-test, this difference is also statistically significant at the 1% level. As the set of explanatory variables are identical between 2002 and 2005, this comparison is more reliable than discussing the differences between 2000 and 2006. However, the narrative is broadly the same regardless of which years are the subject of comparison. Although the average technical efficiency of the SOE sector tends to decrease over time, the fact that the SOEs technically perform better than FIEs as well as DPEs represents supportive evidence

[33] In an attempt to test for functional form, a Ramsey RESET test was applied. Based on the test results, the null hypothesis of having no omitted values in the regression models is rejected in four out of the seven cases. The reasons why the functional form test results are not consistent across time remains an unsolved issue. However, the power of the Ramsey RESET is known to be questionable and has low power particularly in detecting for omitted variables. Therefore, confidence in the RESET results is limited.

[34] Following the discussion on other measures of efficiency, the Dollar and Wei's (2007) approach is also explored as an extra exercise when examining empirically the determinants of technical efficiency in this section. The estimated effects of the variables on the observed average revenue product of capital as a proxy for investment efficiency in Dollar and Wei (2007) are generally in comport with what was discussed in this sub-section 4.4.1. Therefore, the results of the Dollar and Wei's (2007) are not reported here for brevity but provided in table A4.3 of Appendix A4.

for the SOE reform process. More importantly, this finding challenges the common perception that, although the SOE sector has enjoyed some privileges over other types of ownership, there has been little evidence that those SOEs that survived the restructuring process improved their performance substantially (GSO, 2004; see also chapter one).

With respect to the DPE sector, the estimated results are different from what is commonly anticipated when taking into account the fact that the domestic private sector has been subject to certain disadvantages compared to its SOE counterpart, especially in terms of access to credit and land allocation (see, for instance, World Bank, 2005). In addition, DPEs are also subject to closer attention and scrutiny of the relevant authorities (e.g., tax and custom authorities etc.) on a more frequent basis than others, and which may incur significant ‘oiling’ costs (see Tenev, Carlier, Chaudry and Nguyen, 2003). Compared to FIEs, DPEs are supposed to have disadvantages in terms of capital strength, technological level, marketing and management skills, and access to international marketplaces. Despite these disadvantages, the DPE sector has not generally performed worse compared to the SOE sector. In comparison to the FDI sector, the DPE sector is estimated to be at between 3.6 to 16.8 percentage points more technically efficient, on average and *ceteris paribus*. As with the SOE sector, there has been also a decreasing pattern in the average technical efficiency of this sector relative to the FIE sector. Between 2000 and 2006, the relative advantage of being in this sector compared to the FDI sector has declined by 12 percentage points and this decline is statistically significant at the 1% level (i.e. $|t|$ = 20.82). When comparing 2002 and 2005, there was also a decrease of nearly ten percentage point ($|t|$ of this difference is about 15, suggesting this decrease is again statistically significant at a conventional level).

Most notably, the above results suggest that the FDI sector has performed worse in terms of technical efficiency and this is a surprise given the common understanding that FIEs, with their more advanced technologies and managerial skills, are more efficient than their domestic counterparts. This finding was also highlighted in chapter three when investigating the average technical efficiency of the FDI sector. One possible explanation may lie in the fact that the average age of FIEs is considerably younger compared to other sectors and they have not yet achieved a minimum efficient scale (see section 3.4 in chapter 3). Although we explicitly control for age in the empirical specification, this may provide a poor proxy for the time it may take enterprises to move along their 'learning curve', particularly when such enterprises are operating in a new business environment. In addition, FIEs are at times reported to operate at less than their capacity. JICA (2002) noted that some joint-ventured car assemblers were operating at less than 20 percent of their capacities.

Table 4.3: Determinants of Technical Efficiency: Mean Regression Results[35]

	2000	2001	2002	2003	2004	2005	2006
Types of ownership							
SOEs	0.1490***	0.1219***	0.1314***	0.1702***	0.1335***	0.0427***	0.1143***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
DPEs	0.1682***	0.1129***	0.1321***	0.1309***	0.0978***	0.0359***	0.0504***
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
Firm characteristics							
Proportion of female employees	-0.172***	-0.1083***	-0.1127***	-0.095***	-0.0889***	-0.0211***	-0.0609***
	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
Proportion of employees with contract	*f*	*f*	0.0882***	0.075***	0.0814***	0.0925***	*f*
			(0.005)	(0.005)	(0.005)	(0.004)	
PC per employees	*f*	0.108***	0.0995***	-0.0169	-0.0676***	-0.0674***	*f*
		(0.018)	(0.02)	(0.021)	(0.017)	(0.014)	
Age of establishment	-0.0001	0.0001	0.0005*	*f*	*f*	0.0091***	*f*
	(0.0002)	(0.0002)	(0.0002)			(0.0001)	
Regional effects							
Red River Delta	0.0176***	0.0243***	0.0334***	0.0667***	0.0363***	0.0528***	0.054***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)

[35] In the discussion on the selection of the distributional assumption of the technical inefficiency error terms in chapter 3 (section 3.4.1), it was reported that this selection was made on the basis of choosing the most data-coherent parametric distributions across years. One question that might arise from that discussion is whether the determinants of technical efficiency would be different if, for instance, an exponential distribution of the technical inefficiency error terms is assumed (instead of the truncated normal distribution) for 2003, 2005, and 2006. In an attempt to shed light on this issue, the technical efficiency measures obtained for these years using error terms that follow an exponential distribution are used as the dependent variable in the regression equation [4.3]. Results are reported in table A4.4 of Appendix A4. It was found that there are no significant differences between the coefficient estimates in table A4.4 and table 4.3 here.

North Central Coast	-0.0396***	-0.034***	-0.0267***	0.0146	0.0105	0.0437***	0.0365***
	(0.009)	(0.009)	(0.01)	(0.01)	(0.009)	(0.008)	(0.008)
South Central Coast	0.078***	0.0184**	0.0773***	0.0844***	0.0633***	0.0687***	0.0548***
	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)
Central Highlands	-0.026***	-0.1033***	-0.0264**	0.0109	-0.0077	-0.0298***	0.0003
	(0.01)	(0.013)	(0.013)	(0.012)	(0.012)	(0.011)	(0.011)
Southeast	0.0574***	0.0593***	0.0913***	0.1232***	0.1025***	0.1218***	0.1118***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
Mekong River Delta	0.2585***	0.1745***	0.1348***	0.1561***	0.1397***	0.1508***	0.1063***
	(0.006)	(0.007)	(0.008)	(0.008)	(0.008)	(0.006)	(0.007)
Export orientation							
Exporter	0.1433***	*f*	0.0471***	0.0814***	0.0787***	0.0355***	0.1192***
	(0.003)		(0.004)	(0.004)	(0.003)	(0.014)	(0.014)
Constant term	0.5281***	0.548***	0.3896***	0.3148***	0.3679***	0.3925***	0.4913***
	(0.007)	(0.008)	(0.01)	(0.01)	(0.009)	(0.008)	(0.007)
R^2	0.5958	0.3344	0.2017	0.1631	0.1367	0.2217	0.0853
No. of observations	7,691	8,866	11,029	12,834	15,534	17,731	19,105

Notes:

a) *f* denotes not applicable.
b) ***, **, and * refers to the variables of which the estimated coefficients are statistically significant at level of 0.01; 0.05; and 0.1 respectively;
c) Breusch-Pagan/Cook-Weisberg test for heteroscedasticity is adopted in this specification. The test results decisively reject the null hypothesis of homoskedascity in all cases. Therefore, Huber (1967) corrected standard errors are used and reported in parentheses;
d) Industry dummies are included but not reported here for brevity (see footnote 30 for more details);
e) Results from the panel framework estimation are reported in table A4.5 of the Appendix. Further discussion on these results are provided at the end of this sub-section.

The attention now turns to the other determinants of technical efficiency. There is a negative relationship between 'feminization' (i.e., the proportion of female employees) of the enterprise and its technical efficiency. On average and *ceteris paribus*, a one percentage point increase in the incidence of female employees induces between a 0.02 to a 0.172 of a percentage point decline in the average level of technical efficiency depending on the year. This negative and modest effect of feminization has decreased over time. In particular, a one percentage point increase in the proportion of female employees reduced the technical efficiency by 0.172 of a percentage point in 2000 but by only 0.061 percentage point in 2006. Using *t*-test, this fall is found to be statistically significant at the 1% level (i.e., $|t|$ = 13.09). The negative effect of feminisation might partially reflect the low levels of productivity within the textile and garment, footwear sub-sectors, as the majority of workers in these sub-sectors are female (Thoburn, Nguyen and Nguyen, 2003). However, this cannot be taken to provide a complete explanation given the specification already controls for such industry specific effects. In addition, Nguyen *et al.* (2002) using a small survey of 96 textile enterprises reported a high level of technical efficiency among the surveyed firms.

The Labour Code mandates that labour contracts must be issued to all workers (Chapter IV of the Labour Code 2002). Thus, the proportion of workers within an enterprise who have signed labour contracts can be used as a proxy for a firm's compliance with labour market regulations. The estimated coefficient on this variable suggests a positive effect of being compliant to labour regulations on technical efficiency. On average and *ceteris paribus*, a one percentage point increase in the incidence of work contract induces around a 0.08 of a percentage point improvement in the average level of technical efficiency. The impact of this variable on the technical efficiency has been relatively stable over the period 2002-2005 (the proportion of employees with contract is not available for other years). This highlights a positive relationship between compliance with labour market regulations and technical efficiency.

In this chapter, the number of PCs per employees is used as a proxy for technological advancement and it was expected that the higher incidence of PCs, meaning more advanced technologies, would exert a positive effect of technical efficiency. However, the estimated coefficients on this variable suggest a mixed story. While a positive effect of this factor on firm performance was detected for 2001 and 2002, the contrary was found for 2004 and 2005. In addition, there was a time gap (as reported in 2003) in the change of the sign (from positive to negative) of this variable in which the impact of this factor was not statistically significant. Assuming that this is an appropriate proxy for the technological level of the firm, it lends very tentative support to the notion reported in the previous chapter that the group of high-tech industries performed no better than medium-tech industries (see Figure A3.3 in Appendix of chapter three). On the other hand, the mixed result might reflect the fact that the number of PCs per employees is not a good proxy for technological advancement. Further investigation with the surveyors at the GSO reveal that no distinction was made between PCs used for administrative staff and PCs used in production lines. PCs used in production/assembly lines provide a better proxy for a firm's technological level but separating these PCs from those used for administrative purposes (e.g. accounting, personnel) is constrained by a lack of disaggregated data.

The final observed firm-level explanatory variable is the age of establishment. In the four years for which information on age of establishment is available, the estimated effect of this factor is positive and significant in 2002 and 2005. For the other years, the coefficient estimates are negative and statistically insignificant. Further fine-tuning efforts to refine this variable such as introducing a quadratic in the age of the establishment or specifying certain age intervals, did not improve the results and thus the impact of age of establishment on technical efficiency is thus inconclusive.

The estimated coefficients for the regional dummies reveal evidence of a spatial pattern of technical efficiency within the Vietnamese manufacturing sector.[36] Generally, firms in the South (except those in the Central Highlands, which account for roughly two percent of the total sample) were found to be more technically efficient than those in the North. Compared to the Northern Uplands (i.e., the base category), those located in the Southeast (including HCMC), on average and *ceteris paribus*, are more technically efficient by between six to 12 percentage points. Moreover, the effect of being in the Southeast has increased over time. Between 2000 and 2006, there was an increase in that effect of more than five percentage points for enterprises located in the Southeast compared to being located in the Northern Uplands (this is statistically significant using *t*-test as $|t| = 6.41$). It should be noted that the Southeast accounts for around 40 percent of total manufacturing

[36] A Chow test is performed to test for whether pooling manufacturing firms across regions is satisfactory (see the explanation of the Chow test in footnote 30). The rest results suggest that the null hypothesis of pooling the firms across regions together in constrained models is not rejected in six out of the seven cases. Therefore, the pooling models are statistically justified by the data for this analysis in the overwhelming number of cases.

firms and this has been the most dynamic and important economic clusters within the country. Manufacturing firms in the Mekong River Delta were found to be the most technically efficient in the early years of the period 2000-2006, but this relative advantage has declined over time. The difference between the Southern and Northern regions might be partially linked to the commonly recognized differences between the North and the South. In particular, it is sometimes argued that southerners are said to have had more exposure to a market economy prior to the country's re-unification. However, that interpretation requires some caution as such differences are likely to be eroded over time. For instance, the recent World Values Surveys, conducted in more than 65 countries to assess attitudes towards a market-based economy, revealed that northerners in Vietnam were more positive towards the market system than those from the South (see World Bank, 2005).

As highlighted in chapter three (see table 3.12), there were large differences in the average technical efficiency across regions. In the above analysis, the regional effect was analyzed using the Northern Uplands as the arbitrarily omitted region. Although this provides some insights on the regional differences in comparison to that omitted region, it does not allow any inferences on regional deviations relative to the national average level. Therefore, controlling for the regional differentials through use of single set of dummy variables is probably too austere to capture regional effects on firm performance. In order to overcome this shortcoming, this chapter adopts the approach used in Haisken-DeNew and Schmidt (1997), which generalizes the conventional method originally developed by Krueger and Summers (1988) (see section 4.3). The framework outlined from [4.5] to [4.7] is then used to estimate the relative technical efficiency effects for the different regions. These technical efficiency effects are interpreted as the technical efficiency level that a firm in a specific region obtained due to its affiliation to that region relative to the 'average' firm of the whole manufacturing sector. Results from this exercise are reported below.

Table 4.4: Technical Efficiency Effects of Seven Regions, 2000-2006

	2000	2001	2002	2003	2004	2005	2006
Northern Uplands	-0.0727***	-0.0536***	-0.0693***	-0.0966***	-0.0735***	-0.0907***	-0.0846***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Red River Delta	-0.0523***	-0.0273***	-0.035***	-0.0272***	-0.035***	-0.035***	-0.0253***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
North Central Coast	-0.109***	-0.0893***	-0.0972***	-0.0841***	-0.0679***	-0.0525***	-0.0556***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
South Central Coast	0.0122***	-0.0259***	0.0174***	-0.0034	-0.0039	-0.0171***	-0.02***
	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
Central Highlands	-0.0943***	-0.1576***	-0.0983***	-0.0863***	-0.0772***	-0.1178***	-0.0777***
	(0.008)	(0.011)	(0.011)	(0.01)	(0.01)	(0.01)	(0.009)
Southeast	-0.0118***	0.0057***	0.0218***	0.0268***	0.0271***	0.0319***	0.0313***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Mekong River Delta	0.1916***	0.1327***	0.081***	0.0679***	0.0713***	0.0712***	0.0357***
	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
Overall variability	0.0855	0.0596	0.0462	0.0442	0.0422	0.0464	0.0371

Notes:

(a) ***, **, and * denotes statistically significant at the 0.01, 0.05 and 0.1 levels respectively.

(b) The standard errors reported in parentheses and the overall variability measure are calculated as suggested in Haisken-DeNew and Schmidt (1997).

The technical efficiency effects for the seven regions suggest a relatively similar story as found when using the set of regional dummies. But instead of interpreting the regional effects relative to the Northern Uplands as the base, the estimated technical efficiency estimates now represent the regional variations from the overall weighted average level of technical efficiency of the whole manufacturing sector. The results generally reaffirm the spatial pattern reported earlier. Particularly, manufacturing firms located in the Southeast and Mekong River Delta have technically performed better than the weighted average efficiency of the manufacturing sector overall. It is important to note that these differences are obtained after controlling for observed firm characteristics. Therefore, such differences are considered as '*ceteris paribus*' for those manufacturing firms that are located in these two regions. While the estimated effects of the Mekong River Delta has decreased over time (by nearly 16 percentage point between 2000 and 2006 with $|t|$ = 43.3) that of the Southeast in contrast increased (by nearly 4.3 percentage points between 2000 and 2006 with $|t|$ = 30.7). Compared to the weighted average efficiency of the manufacturing sector, enterprises located in the other regions have been subject to disadvantages, which are most pronounced in the Northern Uplands and North Central Coast.

In order to investigate the separate positions of Hanoi and HCMC with respect to the average level of firm efficiency, these two cities are examined separately from the Red River Delta and Southeast in order to compare levels of their technical efficiency relative to the average. The technical efficiency effects for the seven regions, Hanoi, and HCMC are reported in table A4.6 of the Appendix. The results obtained from this investigation reveal a similar story as shown above. Without HCMC in the Southeast, there is still a positive effect of technical efficiency for manufacturing firms located in this region. For the Red River Delta, excluding Hanoi increases the absolute value of the relative technical efficiency in this region represent less disadvantages compared to being located in other provinces in the Red River Delta.

The results reported in table 4.3 are obtained by estimating expression [4.3] and controlling for the industry effects by including a set of dummies for the manufacturing sub-sectors. The inclusion of this set of industry controls is motivated by the fact that these dummies capture potential effects of affiliation to different sub-sectors on firm performance. In implementing the estimation, one industry was arbitrarily omitted and the industry effects are then interpreted relative to this arbitrary base. The framework outlined in [4.5] to [4.7] is again used to estimate the industry technical efficiency effects. These technical efficiency effects are reported in table 4.5 and should be interpreted as the technical efficiency level that a firm in a specific sector achieved relative to the 'average' firm within the whole manufacturing sector.

The estimated industry efficiency effect generally suggest that a firms in the labour-intensive sub-sector were characterized by a low level of technical efficiency compared to the weighted average efficiency level for the whole manufacturing sector in the period under consideration. The textile and garment sub-sectors exhibit the largest deviation below the mean in this broadly defined labour-intensive category. After controlling for observed firm-level characteristics, an average textile firm or garment firm has performed less efficiently than an average manufacturing firm by between four to eight percentage points, on average and *ceteris paribus*. With the exception of the non-metallic mineral products sub-sector, other capital-intensive industries exhibit higher levels of technical efficiency compared to the weighted average efficiency level of the manufacturing sector. In addition, it is notable that the average effects of these capital-intensive sub-sectors tend to increase over time with the largest increases found in metal products, both basic and fabricated (the *t*-test results generally suggest that these differences are statistically significant). Regarding the machinery and technology-intensive sub-sectors, the results provide a mixed story. While firms in the electrical machinery and apparatus or motor vehicles report above average levels of technical efficiency in the manufacturing sector, firms that produce other transport equipment are below the average.

It is noted that the overall variability of these estimated effects have increased over time, suggesting that widening variations across manufacturing sub-sector compared to the weighted average efficiency level. This may suggest a greater degree of heterogeneity among manufacturing firms over time. As highlighted in the previous chapter, the period under consideration experienced a very rapid growth of new establishments in responses to improved business environment (as in chapter 1). This is likely to contribute to such increasing heterogeneity among manufacturing enterprises in that period.

Table 4.5: Technical Efficiency Effects of the Manufacturing Sub-Sectors, 2000-2006

	2000	2001	2002	2003	2004	2005	2006
Agricultural resource-intensive							
15. Food and beverages	0.0032	0.0151***	0.022***	0.0048	0.0126***	0.0077***	0.0153***
	(0.002)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
Labour-intensive production							
17. Textiles	-0.0182***	-0.0251***	-0.0387***	-0.0486***	-0.0337***	-0.0534***	-0.0369***
	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
18. Wearing apparel	-0.0382***	-0.0574***	-0.0636***	-0.0881***	-0.0699***	-0.0841***	-0.0805***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.004)
19. Leather tanning and processing	-0.0275***	-0.0239***	-0.0506***	-0.0452***	-0.0552***	-0.0368***	-0.0421***

	(0.007)	(0.008)	(0.009)	(0.009)	(0.008)	(0.007)	(0.008)
20. Wood and wood products	-0.0022	-0.0002	0.0061	0.0243***	0.0091*	0.0201***	0.0079*
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
36. Furniture	-0.0154***	-0.0115**	-0.032***	-0.0465***	-0.0332***	-0.0344***	-0.0308***
	(0.004)	(0.005)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)
Capital-intensive production							
16. Tobacco products	0.0755***	0.0733***	0.1579***	0.0771***	0.0408	-0.0084	0.0099
	(0.016)	(0.026)	(0.016)	(0.021)	(0.045)	(0.019)	(0.031)
21. Paper and paper products	0.0321***	0.0256***	0.038***	0.0508***	0.0325***	0.0373***	0.0359***
	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)	(0.004)	(0.005)
22. Publishing and printing	0.0474***	0.0261***	0.0466***	0.0519***	0.0454***	0.0441***	0.0504***
	(0.006)	(0.006)	(0.006)	(0.007)	(0.006)	(0.005)	(0.005)
23. Coke, refined petroleum products	-0.1149	0.0466**	0.061**	0.074***	0.0599	0.1071***	0.0713**
	(0.106)	(0.02)	(0.026)	(0.022)	(0.04)	(0.021)	(0.031)
24. Chemicals and chemical products	0.0333***	0.0278***	0.0371***	0.0443***	0.0139***	0.0281***	0.0329***
	(0.004)	(0.006)	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)
25. Rubber and plastic products	0.0117***	0.0182***	0.0174***	0.0286***	0.0277***	0.0316***	0.0205***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
26. Non-metallic mineral products	-0.0152***	-0.0336***	-0.0407***	-0.031***	-0.0303***	-0.0283***	-0.0391***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
27. Basic metal products	0.0396***	0.0381***	0.0582***	0.0952***	0.0813***	0.0835***	0.0897***
	(0.006)	(0.008)	(0.008)	(0.009)	(0.009)	(0.008)	(0.007)
28. Fabricated metal products	0.0059	0.0154***	0.0211***	0.0445***	0.0316***	0.0341***	0.036***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
Machinery & technology-intensive goods							
29. Machinery and equipment	-0.004	-0.0069	0.009	0.0105	0.016**	0.0205***	0.0219***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)
30. Office, accounting and computing machinery	0.0526	0.0584**	0.0088	0.0393	0.0401	0.0203	0.0494
	(0.051)	(0.027)	(0.034)	(0.047)	(0.037)	(0.039)	(0.035)
31. Electrical machinery and apparatus	0.0124***	0.0417***	0.0201**	0.0447***	0.0294***	0.0371***	0.0369***
	(0.007)	(0.006)	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)
32. Television and communication equipment	0.0283***	0.0336***	0.013	0.0206	-0.0057	0.0205*	0.0076
	(0.009)	(0.012)	(0.014)	(0.015)	(0.014)	(0.011)	(0.013)
33. Medical and optical instruments, watches	0.0181	-0.0063	0.0014	0.0206	0.0109	0.0131	0.0335**
	(0.015)	(0.022)	(0.019)	(0.023)	(0.015)	(0.017)	(0.015)
34. Motor vehicles	0.0108	0.0332***	0.0338***	0.0155	0.0346***	0.0098	0.0016
	(0.009)	(0.008)	(0.009)	(0.01)	(0.009)	(0.008)	(0.012)
35. Other transport equipment	0.0018	-0.0059	-0.0179**	-0.028***	-0.0011	-0.0251***	-0.0308***
	(0.007)	(0.008)	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)
Overall variability	0.0199	0.026	0.0344	0.0433	0.0346	0.0389	0.0395

Notes: see table 4.4

Trade Reforms and Technical Efficiency

This sub-section focuses on the potential link between the trade reforms and technical efficiency in the manufacturing sector of Vietnam. In the first instance, this potential link is partly captured by including a dummy for whether or not the enterprise is an exporter to investigate possible effects of an enterprise's export orientation on technical efficiency. The estimated coefficient on this variable is given in table 4.3. The estimate suggests a positive effect of exporting on the estimated level of technical efficiency. On average and *ceteris paribus*, exporting firms are between 3.6 to 14.3 percentage points more technically efficient than non-exporting firms depending on the years under consideration. As suggested in Wagner (2007), exporting may allow firms to 'learn' from foreign technological and managerial knowledge, which can then reinforce their productivities. The causality running from exporting to firm performance is however questionable. As highlighted in section 4.3, Bernard and Jensen (1999), *inter alia*, argue that the existence of considerable sunk costs incurred when exporting suggests that only high-performing firms self-select into export activity. In the current study, the VESs allows us to identify whether a firm exports or not without any further information on export performance. Given this, a more thorough investigation of the potential effect of a firm's self-reported exporting status on its performance is limited by a lack of information in the various enterprise surveys used here.

In a further attempt to shed light on the potential relationship between trade reforms and technical efficiency, a tariff variable, expressed in fractional point, is added to the set of regressors in equation [4.4]. As this variable is only available for different manufacturing sub-sectors, the tariff variable is introduced in place of the industry controls. The results are now reported in table 4.6. In the interest of brevity, this sub-section will only focus on the trade variable. It is however important to emphasize that the estimated coefficients for other variables are essentially the same as those reported in table 4.3 in terms of both direction and magnitude. The tariff rate estimate reveals that, on average and *ceteris paribus*, a one percentage point decrease in the average tariff rate would increase technical efficiency by between 0.068 to 0.3 percentage points in the manufacturing sector. This implies that lower level of tariff protection exerts a statistically significant positive effect on technical performance of the manufacturing sector in Vietnam.[37] Moreover, it is noted that the impact of tariffs on technical efficiency has intensified over time. In a comparison of 2002 and 2005, the impact of trade tariffs on technical performance has deepened and this change is statistically significant at the 1% level using *t*-test (i.e. $|t|$ = 8.64). This could be attributed to trade-induced increasing competition that Vietnam's manufacturing firms have encountered. Improved accesses to imported inputs or technologies also lend a plausible explanation for such increasing effect of trade on technical efficiency in the manufacturing sector.

Table 4.6: Trade Reforms and Technical Efficiency

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Types of ownership							
SOEs	0.1536***	0.125***	0.1418***	0.1744***	0.1375***	0.0434***	0.116***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Domestic private enterprises	0.1648***	0.1109***	0.1344***	0.1326***	0.098***	0.0355***	0.0495***
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
Firm characteristics							
Proportion of female employees	-0.1852***	-0.1199***	-0.1221***	-0.1077***	-0.107***	-0.0305***	-0.0657***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Proportion of employees with contract	*f*	*f*	0.0906***	0.0777***	0.083***	0.0941***	*f*
			(0.005)	(0.005)	(0.005)	(0.004)	
PC per employees	*f*	0.1506***	0.1466***	0.0242	-0.0398***	-0.0544***	*f*
		(0.016)	(0.018)	(0.019)	(0.015)	(0.013)	
Age of establishment	-0.0001	-0.00002	0.0004	*f*	*f*	0.009***	*f*
	(0.0002)	(0.0002)	(0.0002)			(0.0001)	
Regional effects							
Red River Delta	0.0205***	0.0263***	0.0343***	0.0694***	0.0385***	0.0557***	0.0593***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
North Central Coast	-0.0362***	-0.0357***	-0.0279	0.0124	0.0056	0.0381***	0.029***
	(0.009)	(0.009)	(0.01)	(0.01)	(0.009)	(0.008)	(0.008)

[37] As reported in table 4.1, the average tariff rates steadily increased over time during the 1990s and remained relatively stable after 2000 (with a modest reduction of less than one percentage point between 2000 and 2002). Combining this with the results found on this section on the relationship between trade liberalization and technical efficiency, it could be taken to suggest that such an increase in the average tariff, on average and ceteris paribus, could result in a lowering of technical efficiency in the manufacturing sector. However, this does not necessary mean that trade reforms have resulted in a lowering of technical efficiency given 'trade reforms', as noted in 4.1, are not coincidental with changes in the tariff rates. In fact, while tariff rates remained stable after 2000, there were important reforms in terms of non-tariff barriers toward a more liberalized trade regime. Therefore, to reflect more fully the trade reforms, a trade exposure measure should be constructed in a manner that captures reforms in both tariff and NTBs. However, the construction of such an ideal trade exposure measure is near impossible in the current literature (as anticipated in 4.3.1 and 4.3.2).

South Central Coast	0.0849***	0.0277***	0.0867***	0.0932***	0.0696***	0.0736***	0.0646***
	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)
Central Highlands	-0.0215**	-0.104***	-0.029**	0.0102	-0.0036	-0.0272**	0.0069
	(0.01)	(0.013)	(0.013)	(0.012)	(0.012)	(0.011)	(0.011)
Southeast	0.0609***	0.0593***	0.0911***	0.1234***	0.1007***	0.1226***	0.1159***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
Mekong River Delta	0.2644***	0.1863***	0.1503***	0.1644***	0.1448***	0.1618***	0.1203***
	(0.005)	(0.006)	(0.007)	(0.008)	(0.007)	(0.006)	(0.007)
Export orientation, trade protection							
Exporter	0.1417***	*f*	0.0431***	0.0805***	0.0774***	0.0344***	0.1312***
	(0.003)		(0.004)	(0.004)	(0.003)	(0.013)	(0.015)
Trade variable	-0.0679***	-0.0886***	-0.1529***	-0.2577***	-0.1703***	-0.2814***	-0.2759***
	(0.009)	(0.01)	(0.011)	(0.01)	(0.01)	(0.01)	(0.01)
Constant term	0.5464***	0.5691***	0.4188***	0.3657***	0.4062***	0.4467***	0.5419***
	(0.007)	(0.008)	(0.009)	(0.009)	(0.009)	(0.008)	(0.007)
R^2	0.602	0.3454	0.2245	0.2151	0.1618	0.2748	0.1354
No. of observations	7,691	8,866	11,029	12,834	15,534	17,731	19,105

Notes:

a) *f* denotes not applicable due to data availability;

b) ***, **, and * refers to the variables of which the estimated coefficients are statistically significant at level of 0.01; 0.05; and 0.1 respectively;

c) Breusch-Pagan/Cook-Weisberg test decisively reject the null hypothesis of constant variance and thus suggest the presence of heteroscedasticity in all case. Therefore, the Huber's (1976) standard errors are reported in the parentheses.

It is important to test for the robustness of the trade-firm performance relationship. This is to take into account the sensible advice of Edwards (1997) that empirical studies on the impacts of trade liberalization should test for the sensitivity of the results using different measures of trade exposure. In the first instance, a one-year lagged tariff variable is used to avoid the possibility that inefficient and powerful firms could lobby to influence the current level of trade protection in their favour. This is not an unreasonable hypothesis given the presence of SOEs who possess the ability to exercise political patronage. Detailed results from this estimation for different years are reported in table A4.7 of the Appendix. There are two important inferences from these results. First, the effect of trade reforms on the technical performance of the manufacturing sector is still intact, suggesting a positive and statistically significant impact of lowering tariff protection levels on the average technical efficiency of the manufacturing sector. This effect has also increased over the period 2000-2006 and this increase is statistically significant using a *t*-test.

Second, the estimated coefficients of other factors are invariant to the use of this particular measure.

As further attempts to determine the robustness of the trade-firm performance linkage, the tariff variable is replaced by alternative trade variables that account for other channels through which trade protection may exert an impact on firm performance. As highlighted in section 3, the SAM 2000 developed and updated by CIEM and NIAS (see CIEM and NIAS, 2004) is exploited to construct import penetration and export ratio as alternative trade variables. Notably, as the SAM 2000 was disaggregated to 112 commodities, of which there were 68 manufacturing commodities, the export ratio and import penetration measures are calculated for the manufacturing sub-sectors using ISIC classification at a two-digit level of disaggregation. This allows relatively limited variations of these variables but a finer disaggregation is not feasible given the SAM available for this research. In addition, it is unfortunate that this is the only SAM version available for the period 2000-2006 and thus further efforts to construct export ratio or import penetration for the other years are constrained by data availability.

The results using either the export ratio or import penetration in replacement for the tariff rate variable are given in table A4.8 of the Appendix. Although the export ratio and import penetration were obtained for 2000, table A4.8 reports the results obtained by having these openness measures for 2000, 2001, and 2002 to inform the robustness of the results. This is a plausible strategy as it could be reasonably assumed that export ratio and/or import penetration adjust quite slowly over time. Using these results two important findings can be reported. First, there is a positive and statistically significant, albeit modest, impact of greater openness as captured by greater export ratio. On average and *ceteris paribus*, a one percentage point increase in the export ratio increases the technical efficiency level of the manufacturing sector in 2000 by 0.048 of a percentage point. However, the estimated impact of import penetration on technical efficiency is statistically insignificant. Second, it is notable that the other estimated coefficients are again broadly comparable to those reported in table 4.3 and 4.6.

The overall picture that emerges from the above empirical analysis is one of a positive relationship between trade openness and technical efficiency in Vietnam's manufacturing sector. The findings of this chapter represent additional evidence to support a positive linkage between trade liberalization and firm performance as reported for the case of Chile in Tybout *et al.* (1991) and Pavcnik (2002), India in Krishma and Mitra (1997), Topalova (2004), and Aghion *et al.* (2008), Mexico in Tybout and Westbrook (1995), or Ivory Coast in Harrison (1994). In the case of Vietnam, the positive impact of trade liberalization on technical efficiency of manufacturing firms is also consistent with evidence reported in Dao *et al.* (2010) using the data for 2002 and a similar methodology.

This positive impact of trade liberalization has important policy implications. It could be taken to suggest that a greater exposure to trade produces a positive effect on technical performance of the Vietnam's manufacturing sector. In this regard, the current WTO commitments by the Government could be considered good for the technical performance of the manufacturing sector. However, it should also be noted that in the Vietnamese context, improvement in firm performance is not necessarily a result of greater exposure to international trade. Instead, it might be linked to a greater potential for improving productivity at their early stages of industrialization where many of the more unproductive firms have long since exited (see Hallward-Driemeier *et al.*, 2002). This caveat thus suggests some caution in interpreting the results on trade openness reported here.

Before moving to the quantile regression analysis, it is finally noted that the determinants of technical efficiency are also explored in the panel framework using the restricted panel available across 2001 to 2006. The coefficient estimates and diagnostic tests are reported in table A4.5 of Appendix A4. It is noted that the direction of the effects of most of the variables on technical efficiency in the panel framework are largely similar to those reported in table 4.3 in this section (though the magnitude of the effects are understandably different). For instance, a negative relationship between the proportion of female employees and technical efficiency is detected and a positive relationship between the proportion of employees with contracts, PCs per employees and technical efficiency is found. With respect to trade effects, a positive effect of exporting on the estimated level of technical efficiency is reported. Similarities between the results could be taken to suggest that the panel framework is not considerably more informative than the cross-sectional analysis in terms of explaining the determinants of the technical efficiency in the manufacturing sector of Vietnam. The results from the panel framework are thus not discussed in further details (see table A4.5 for more information).

4.4.2 Empirical Results: Quantile Regression Estimates

As noted in chapter three, the kernel density plots of the technical efficiency estimates for different years suggest a skewed distribution (see figure A3.2 in the Appendix). Given this, an exclusive focus on mean regression results may be misleading and, moreover, does not fully capture what happens across the conditional distribution of technical efficiency in the Vietnam's manufacturing sector. An investigation of this latter issue may have some merit in its own right. Therefore, a quantile regression approach, as outlined in expressions [4.8] to [4.10], is adopted in this sub-section to examine the determinants of technical efficiency at different points of the conditional technical efficiency distribution. To the best of the author's knowledge, the current chapter represents one of the first application of quantile regression approach in the literature on technical efficiency. Yasar, Nelson and Rejesus (2006) use this approach to investigate the learning-from-exporting effect at different points of the conditional productivity distribution in Turkey, but that paper employs a different approach in its emphasis on productivity rather than technical efficiency.

In this study, quantile regression functions will be estimated at the 10th, 25th, 50th, 75th and 90th percentiles of the conditional technical efficiency distribution to inform whether the relationship between technical efficiency and the chosen explanatory variables vary with the movement along the conditional distribution. In addition, the 90th-10th and 75th-25th inter-quantile regression models were also estimated to inform whether the differences in the estimated effects of the covariates at the top and bottom end of the conditional technical efficiency distribution are statistically significant. These estimation results are reported separately for the seven years from table 4.7a to table 4.7g. Before embarking on analyzing these (inter-)quantile estimates, it is important to note that the quantile regression models perform relatively well for the data used in this chapter as the Pseudo-R^2 values are reasonably high in most cases. In addition, the estimation results at the median are basically in the same in direction as those obtained from using the mean regression approach, though the estimates at the median are generally lower than those obtained at the mean. This lends support to the use of a quantile regression approach in the current study as the mean regression estimates may be affected by the role of outliers or extreme values. Similar to the above, the attention will be first placed on determinants of technical efficiency at different quantiles before focusing on the impact of trade reforms on technical performance.

Table 4.7a: Quantile Regression Estimation Results, 2000

	10th	25th	50th	75th	90th	10th- 90th	25th- 75th
Types of ownership							
SOEs	0.2135***	0.1599***	0.1231***	0.1018***	0.0854***	-0.1281***	-0.0581***
	(0.013)	(0.007)	(0.003)	(0.002)	(0.002)	(0.014)	(0.006)
DPEs	0.229***	0.1654***	0.1337***	0.1149***	0.0979***	-0.131***	-0.0504***
	(0.011)	(0.006)	(0.002)	(0.002)	(0.002)	(0.012)	(0.005)
Firm characteristics							
Proportion of female employees	-0.2482***	-0.1944***	-0.1493***	-0.1177***	-0.0988***	0.1495***	0.0767***
	(0.009)	(0.005)	(0.003)	(0.003)	(0.003)	(0.009)	(0.005)
Proportion of employees with contract	*F*	*f*	*f*	*f*	*F*	*f*	*f*
PC per employees	*F*	*f*	*f*	*f*	*F*	*f*	*f*
Age of establishment	-0.0012***	-0.0004**	0.0003**	0.0006***	0.0009***	0.0021***	0.001***
	(0.0004)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0004)	(0.0001)
Regional effects							
Red River Delta	0.0271**	0.0253***	0.0286***	0.0167***	0.0135**	-0.0136	-0.0087
	(0.014)	(0.009)	(0.005)	(0.004)	(0.006)	(0.013)	(0.009)
North Central Coast	-0.1082***	-0.0513***	-0.0194**	-0.0166***	-0.0179*	0.0903***	0.0346*
	(0.026)	(0.019)	(0.008)	(0.006)	(0.009)	(0.025)	(0.019)
South Central Coast	0.1106***	0.1006***	0.0833***	0.0581***	0.0481***	-0.0625***	-0.0425***
	(0.014)	(0.01)	(0.005)	(0.004)	(0.006)	(0.013)	(0.009)
Central Highlands	-0.0287	-0.0272*	-0.0049	-0.0109**	-0.0095	0.0192	0.0162
	(0.026)	(0.015)	(0.008)	(0.005)	(0.008)	(0.022)	(0.015)
Southeast	0.0836***	0.0739***	0.0631***	0.0439***	0.0326***	-0.051***	-0.03***
	(0.012)	(0.01)	(0.004)	(0.004)	(0.006)	(0.012)	(0.009)
Mekong River Delta	0.3321***	0.2878***	0.248***	0.2077***	0.1785***	-0.1536***	-0.0801***
	(0.012)	(0.009)	(0.004)	(0.004)	(0.006)	(0.012)	(0.008)
Export orientation, trade protection							
Exporter	0.1861***	0.1493***	0.1168***	0.0942***	0.0796***	-0.1066***	-0.0551***
	(0.005)	(0.003)	(0.002)	(0.002)	(0.002)	(0.006)	(0.003)
Trade variable	-0.1014***	-0.0631***	-0.0375***	-0.0209***	-0.0041	0.0973***	0.0422***
	(0.018)	(0.01)	(0.005)	(0.004)	(0.006)	(0.021)	(0.009)
Constant term	0.3991***	0.5074***	0.5776***	0.6355***	0.6771***	0.2779***	0.1281***
	(0.018)	(0.012)	(0.005)	(0.005)	(0.007)	(0.018)	(0.01)
Pseudo-R^2	0.3896	0.4257	0.4834	0.5473	0.5616	0.5616	0.5473
						0.3896	0.4257
No. of observations	7,691	7,691	7,691	7,691	7,691	7,691	7,691

Notes:

a) *f* denote not applicable due to data availability. This is still included in the table to keep it consistent and easy to compare with the mean regression results report earlier;

b) ***,** and * denote statistical significance at the 1%, 5% and 10% level, respectively;

c) Figures in parentheses are standard errors obtained by bootstrapping with 200 replications.

Table 4.7b: Quantile Regression Estimation Results, 2001

	10th	25th	50th	75th	90th	10th- 90th	25th- 75th
Types of ownership							
SOEs	0.2163***	0.1559***	0.1039***	0.0779***	0.0642***	-0.1521***	-0.078***
	(0.018)	(0.009)	(0.005)	(0.003)	(0.003)	(0.017)	(0.008)
DPEs	0.1775***	0.1333***	0.0941***	0.083***	0.0771***	-0.1004***	-0.0503***
	(0.016)	(0.008)	(0.005)	(0.003)	(0.003)	(0.016)	(0.008)
Firm characteristics							
Proportion of female employees	-0.1886***	-0.1411***	-0.1169***	-0.0769***	-0.0586***	0.13***	0.0642***
	(0.016)	(0.008)	(0.005)	(0.004)	(0.003)	(0.017)	(0.007)
Proportion of employees with contract	*F*	*f*	*f*	*f*	*f*	*f*	*f*
PC per employees	0.1733***	0.1959***	0.1475***	0.1215***	0.1009***	-0.0724**	-0.0744***
	(0.034)	(0.02)	(0.009)	(0.014)	(0.008)	(0.031)	(0.019)
Age of establishment	-0.0018***	-0.0005**	0.0002	0.0009***	0.0014***	0.0032***	0.0014***
	(0.0005)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0005)	(0.0002)
Regional effects							
Red River Delta	0.0204	0.0405***	0.0316***	0.0198***	0.0179***	-0.0025	-0.0207**
	(0.016)	(0.009)	(0.006)	(0.005)	(0.006)	(0.018)	(0.008)
North Central Coast	-0.0738**	-0.0395***	-0.0364***	-0.0261***	-0.0125	0.0613*	0.0134
	(0.03)	(0.012)	(0.009)	(0.008)	(0.009)	(0.032)	(0.012)
South Central Coast	0.0339	0.0388***	0.0312***	0.02***	0.017**	-0.0169	-0.0189*
	(0.021)	(0.011)	(0.007)	(0.005)	(0.007)	(0.022)	(0.01)
Central Highlands	-0.1873***	-0.1392***	-0.0896***	-0.0638***	-0.0544***	0.1329***	0.0754***
	(0.045)	(0.023)	(0.017)	(0.011)	(0.009)	(0.044)	(0.023)
Southeast	0.087***	0.0816***	0.0596***	0.0365***	0.0293***	-0.0577***	-0.0451***
	(0.016)	(0.009)	(0.006)	(0.004)	(0.006)	(0.018)	(0.008)
Mekong River Delta	0.2519***	0.2142***	0.1719***	0.1379***	0.1187***	-0.1333***	-0.0763***
	(0.015)	(0.008)	(0.006)	(0.004)	(0.006)	(0.017)	(0.008)
Export orientation, trade protection							
Exporter	*F*	*f*	*f*	*f*	*f*	*f*	*f*
Trade variable	-0.2069***	-0.1205***	-0.0632***	-0.037***	0.0018	0.2088***	0.0835***
	(0.031)	(0.015)	(0.007)	(0.007)	(0.007)	(0.03)	(0.014)
Constant term	0.4159***	0.5034***	0.601***	0.6556***	0.6841***	0.2681***	0.1522***
	(0.022)	(0.012)	(0.007)	(0.006)	(0.007)	(0.022)	(0.011)
Pseudo-R^2	0.2271	0.2293	0.2456	0.2668	0.2929	0.2929	0.2668
						0.2271	0.2293
No. of observations	8,866	8,866	8,866	8,866	8,866	8,866	8,866

Notes: see notes in table 4.7a.

Table 4.7c: Quantile Regression Estimation Results, 2002

	10th	25th	50th	75th	90th	10th- 90th	25th- 75th
Types of ownership							
SOEs	0.2445***	0.1788***	0.1264***	0.09***	0.0707***	-0.1737***	-0.0889***
	(0.023)	(0.01)	(0.005)	(0.004)	(0.004)	(0.021)	(0.009)
DPEs	0.2153***	0.1637***	0.1202***	0.0982***	0.0851***	-0.1302***	-0.0654***
	(0.018)	(0.008)	(0.004)	(0.003)	(0.004)	(0.017)	(0.007)
Firm characteristics							
Proportion of female employees	-0.1938***	-0.1514***	-0.1176***	-0.0824***	-0.0582***	0.1356***	0.069***
	(0.018)	(0.011)	(0.005)	(0.005)	(0.005)	(0.02)	(0.01)
Proportion of employees with contract	0.1507***	0.1248***	0.086***	0.0493***	0.0314***	-0.1194***	-0.0754***
	(0.015)	(0.007)	(0.005)	(0.004)	(0.003)	(0.014)	(0.007)
PC per employees	0.0633	0.1806***	0.1504***	0.1204***	0.1013***	0.038	-0.0601***
	(0.068)	(0.02)	(0.011)	(0.012)	(0.01)	(0.059)	(0.02)
Age of establishment	-0.0014***	-0.0006	0.0005**	0.0014***	0.0019***	0.0033***	0.0019***
	(0.001)	(0.0005)	(0.0002)	(0.0002)	(0.0001)	(0.001)	(0.0004)
Regional effects							
Red River Delta	0.0319	0.0528***	0.038***	0.0365***	0.0283***	-0.0036	-0.0164
	(0.022)	(0.015)	(0.007)	(0.005)	(0.005)	(0.024)	(0.013)
North Central Coast	-0.0482*	-0.0333*	-0.029**	-0.0122	-0.0121	0.0361	0.0211
	(0.028)	(0.018)	(0.012)	(0.01)	(0.011)	(0.031)	(0.018)
South Central Coast	0.1214***	0.1124***	0.079***	0.0676***	0.0557***	-0.0658**	-0.0448***
	(0.025)	(0.015)	(0.008)	(0.007)	(0.007)	(0.026)	(0.014)
Central Highlands	-0.0552	-0.0305	-0.0281**	-0.0162*	-0.004	0.0512***	0.0142
	(0.047)	(0.025)	(0.014)	(0.008)	(0.012)	(0.046)	(0.024)
Southeast	0.137***	0.1235***	0.0889***	0.0679***	0.0499***	-0.087***	-0.0556***
	(0.022)	(0.014)	(0.007)	(0.004)	(0.005)	(0.024)	(0.013)
Mekong River Delta	0.1999***	0.1767***	0.1396***	0.1212***	0.1015***	-0.0984***	-0.0555***
	(0.023)	(0.015)	(0.007)	(0.005)	(0.006)	(0.025)	(0.013)
Export orientation, trade protection							
Exporter	0.0798***	0.0579***	0.0356***	0.0271***	0.0198***	-0.06***	-0.0308***
	(0.01)	(0.005)	(0.003)	(0.002)	(0.002)	(0.011)	(0.004)
Trade variable	-0.358***	-0.2443***	-0.113***	-0.0563***	-0.0165*	0.3415***	0.188***
	(0.033)	(0.02)	(0.011)	(0.008)	(0.009)	(0.038)	(0.019)
Constant term	0.1521***	0.3106***	0.461***	0.5597***	0.6247***	0.4725***	0.2491***
	(0.031)	(0.017)	(0.009)	(0.007)	(0.007)	(0.032)	(0.016)
Pseudo-R^2	0.162	0.1523	0.1404	0.126	0.1217	0.1217	0.126
						0.162	0.1523
No. of observations	11,029	11,029	11,029	11,029	11,029	11,029	11,029

Notes: see notes in table 4.7a.

Table 4.7d: Quantile Regression Estimation Results, 2003

	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}	10^{th}- 90^{th}	25^{th}- 75^{th}
Types of ownership							
SOEs	0.3229***	0.228***	0.1462***	0.0991***	0.0704***	-0.2525***	-0.1289***
	(0.017)	(0.01)	(0.007)	(0.005)	(0.004)	(0.018)	(0.01)
DPEs	0.2215***	0.1638***	0.1182***	0.0905***	0.0728***	-0.1487***	-0.0734***
	(0.014)	(0.008)	(0.005)	(0.004)	(0.004)	(0.014)	(0.008)
Firm characteristics							
Proportion of female employees	-0.1254***	-0.124***	-0.1062***	-0.0751***	-0.0511***	0.0743***	0.0489***
	(0.017)	(0.009)	(0.007)	(0.005)	(0.004)	(0.017)	(0.009)
Proportion of employees with contract	0.1207***	0.1122***	0.0781***	0.0464***	0.0234***	-0.0973***	-0.0658***
	(0.015)	(0.008)	(0.006)	(0.005)	(0.004)	(0.015)	(0.008)
PC per employees	-0.0423	0.0263	0.0649***	0.0647***	0.0609***	0.1032	0.0384
	(0.062)	(0.026)	(0.017)	(0.015)	(0.014)	(0.068)	(0.024)
Age of establishment	*f*	*f*	*f*	*f*	*f*	*f*	*f*
Regional effects							
Red River Delta	0.0762***	0.0925***	0.0803***	0.058***	0.0512***	-0.025	-0.0345***
	(0.014)	(0.012)	(0.011)	(0.006)	(0.006)	(0.016)	(0.011)
North Central Coast	0.0322***	0.0273*	0.0156	-0.0004	0.0116	-0.0206	-0.0277*
	(0.017)	(0.016)	(0.014)	(0.011)	(0.009)	(0.02)	(0.016)
South Central Coast	0.1108***	0.1199***	0.108***	0.0706***	0.0656***	-0.0453**	-0.0494***
	(0.018)	(0.016)	(0.011)	(0.007)	(0.007)	(0.018)	(0.014)
Central Highlands	0.0393	0.0252	0.0006	0.0067	0.0085	-0.0309	-0.0185
	(0.03)	(0.026)	(0.017)	(0.012)	(0.015)	(0.029)	(0.024)
Southeast	0.1753***	0.1663***	0.1323***	0.0885***	0.0695***	-0.1057***	-0.0778***
	(0.013)	(0.013)	(0.011)	(0.006)	(0.006)	(0.013)	(0.011)
Mekong River Delta	0.206***	0.1947***	0.1666***	0.1385***	0.1247***	-0.0813***	-0.0561***
	(0.016)	(0.014)	(0.012)	(0.007)	(0.006)	(0.016)	(0.013)
Export orientation, trade protection							
Exporter	0.1472***	0.1079***	0.0683***	0.0418***	0.0237***	-0.1235***	-0.0662***
	(0.01)	(0.005)	(0.003)	(0.003)	(0.003)	(0.01)	(0.006)
Trade variable	-0.3574***	-0.3285***	-0.2676***	-0.2055***	-0.158***	0.1994***	0.123***
	(0.031)	(0.018)	(0.013)	(0.009)	(0.008)	(0.031)	(0.017)
Constant term	0.0067	0.2102***	0.4082***	0.5542***	0.642***	0.6352***	0.344***
	(0.021)	(0.016)	(0.013)	(0.008)	(0.009)	(0.022)	(0.014)
Pseudo-R^2	0.1361	0.1476	0.1346	0.113	0.1027	0.1027	0.113
						0.1361	0.1476
No. of observations	12,834	12,834	12,834	12,834	12,834	12,834	12,834

Notes: see notes in table 4.7a.

Table 4.7e: Quantile Regression Estimation Results, 2004

	10th	**25th**	**50th**	**75th**	**90th**	**10th- 90th**	**25th- 75th**
Types of ownership							
SOEs	0.2678***	0.1747***	0.1117***	0.0782***	0.0549***	-0.2129***	-0.0964***
	(0.016)	(0.009)	(0.005)	(0.004)	(0.003)	(0.015)	(0.007)
DPEs	0.1716***	0.1161***	0.084***	0.0696***	0.0583***	-0.1134***	-0.0465***
	(0.014)	(0.007)	(0.004)	(0.003)	(0.003)	(0.013)	(0.007)
Firm characteristics							
Proportion of female employees	-0.1366***	-0.1345***	-0.1096***	-0.0699***	-0.0527***	0.0839***	0.0646***
	(0.015)	(0.009)	(0.006)	(0.004)	(0.004)	(0.014)	(0.009)
Proportion of employees with contract	0.1401***	0.1282***	0.084***	0.042***	0.026***	-0.1141***	-0.0862***
	(0.01)	(0.008)	(0.005)	(0.004)	(0.003)	(0.01)	(0.008)
PC per employees	-0.1579***	-0.0293	-0.0164	0.004	0.0011	0.159***	0.0333
	(0.045)	(0.025)	(0.011)	(0.009)	(0.01)	(0.05)	(0.028)
Age of establishment	*f*	*f*	*f*	*f*	*f*	*f*	*f*
Regional effects							
Red River Delta	0.0474***	0.0521***	0.0344***	0.0284***	0.0286***	-0.0188	-0.0237**
	(0.018)	(0.011)	(0.007)	(0.005)	(0.007)	(0.017)	(0.011)
North Central Coast	0.0211	0.0037	-0.0084	-0.0002	0.0038	-0.0173	-0.0039
	(0.025)	(0.014)	(0.009)	(0.009)	(0.009)	(0.025)	(0.015)
South Central Coast	0.095***	0.0955***	0.0661***	0.0464***	0.0469***	-0.0481**	-0.0492***
	(0.021)	(0.013)	(0.008)	(0.006)	(0.008)	(0.022)	(0.011)
Central Highlands	-0.0214	0.0064	-0.0107	-0.0133	0.0045	0.0258	-0.0197
	(0.039)	(0.021)	(0.012)	(0.009)	(0.014)	(0.038)	(0.019)
Southeast	0.1505***	0.1368***	0.0916***	0.0661***	0.0526***	-0.0979***	-0.0707***
	(0.018)	(0.011)	(0.006)	(0.005)	(0.007)	(0.018)	(0.01)
Mekong River Delta	0.1929***	0.1778***	0.1306***	0.1111***	0.1061***	-0.0869***	-0.0667***
	(0.021)	(0.012)	(0.007)	(0.005)	(0.007)	(0.02)	(0.011)
Export orientation, trade protection							
Exporter	0.1531***	0.1054***	0.0637***	0.0393***	0.0255***	-0.1276***	-0.0661***
	(0.009)	(0.005)	(0.003)	(0.002)	(0.003)	(0.01)	(0.004)
Trade variable	-0.3895***	-0.2975***	-0.1467***	-0.0459***	0.0123*	0.4018***	0.2516***
	(0.027)	(0.017)	(0.012)	(0.009)	(0.008)	(0.025)	(0.018)
Constant term	0.0694***	0.2742***	0.4623***	0.5773***	0.6461***	0.5767***	0.3031***
	(0.025)	(0.014)	(0.009)	(0.007)	(0.008)	(0.024)	(0.014)
Pseudo-R^2	0.1305	0.1269	0.0954	0.0721	0.0684	0.0684	0.0721
						0.1305	0.1269
No. of observations	15,534	15,534	15,534	15,534	15,534	15,534	15,534

Notes: see notes in table 4.7a.

Table 4.7f: Quantile Regression Estimation Results, 2005

	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}	10^{th}- 90^{th}	25^{th}- 75^{th}
Types of ownership							
SOEs	0.0733***	0.0402***	0.0317***	0.0266***	0.017***	-0.0563***	-0.0135
	(0.013)	(0.009)	(0.004)	(0.003)	(0.003)	(0.013)	(0.009)
DPEs	0.0618***	0.0338***	0.0275***	0.0256***	0.0216***	-0.0402***	-0.0082
	(0.01)	(0.007)	(0.003)	(0.002)	(0.002)	(0.011)	(0.007)
Firm characteristics							
Proportion of female employees	-0.02	-0.043***	-0.0308***	-0.0233***	-0.0227***	-0.0027	0.0197**
	(0.015)	(0.01)	(0.004)	(0.003)	(0.003)	(0.014)	(0.008)
Proportion of employees with contract	0.1565***	0.1342***	0.0839***	0.0517***	0.0333***	-0.1232***	-0.0825***
	(0.012)	(0.009)	(0.004)	(0.003)	(0.003)	(0.012)	(0.008)
PC per employees	-0.143***	-0.066***	-0.0182	0.0006	-0.0026	0.1405***	0.0666***
	(0.041)	(0.022)	(0.012)	(0.007)	(0.007)	(0.042)	(0.022)
Age of establishment	0.0113***	0.0086***	0.0067***	0.0054***	0.0044***	-0.0069***	-0.0032***
	(0.0003)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0003)	(0.0002)
Regional effects							
Red River Delta	0.0681***	0.0644***	0.0557***	0.0322***	0.026***	-0.0421***	-0.0322***
	(0.015)	(0.011)	(0.006)	(0.004)	(0.005)	(0.013)	(0.01)
North Central Coast	0.0767***	0.0565***	0.0343***	0.0175***	0.0129**	-0.0638***	-0.039***
	(0.02)	(0.013)	(0.008)	(0.006)	(0.006)	(0.021)	(0.012)
South Central Coast	0.0844***	0.0939***	0.0776***	0.0475***	0.0381***	-0.0463**	-0.0464***
	(0.021)	(0.012)	(0.007)	(0.005)	(0.005)	(0.022)	(0.012)
Central Highlands	-0.015	-0.0671***	-0.0258**	-0.0176***	-0.0111	0.0039	0.0494**
	(0.026)	(0.024)	(0.013)	(0.007)	(0.008)	(0.023)	(0.024)
Southeast	0.2017***	0.158***	0.1128***	0.0701***	0.0484***	-0.1534***	-0.0879***
	(0.014)	(0.01)	(0.006)	(0.004)	(0.005)	(0.013)	(0.01)
Mekong River Delta	0.2578***	0.1969***	0.1431***	0.1051***	0.097***	-0.1609***	-0.0918***
	(0.016)	(0.011)	(0.006)	(0.004)	(0.005)	(0.016)	(0.011)
Export orientation, trade protection							
Exporter	0.0458	0.0425*	0.0147	0.0084	0.0094	-0.0364	-0.0341
	(0.029)	(0.025)	(0.011)	(0.011)	(0.007)	(0.029)	(0.022)
Trade variable	-0.4041***	-0.3492***	-0.26***	-0.1807***	-0.1374***	0.2667***	0.1684***
	(0.025)	(0.019)	(0.009)	(0.007)	(0.008)	(0.024)	(0.018)
Constant term	0.132***	0.3516***	0.5112***	0.6216***	0.6941***	0.5621***	0.2701***
	(0.02)	(0.014)	(0.008)	(0.005)	(0.006)	(0.02)	(0.014)
Pseudo-R^2	0.182	0.1771	0.168	0.1612	0.171	0.171	0.1612
						0.182	0.1771
No. of observations	17,731	17,731	17,731	17,731	17,731	17,731	17,731

Notes: see notes in table 4.7a.

Table 4.7g: Quantile Regression Estimation Results, 2006

	10th	25th	50th	75th	90th	10th- 90th	25th- 75th
Types of ownership							
SOEs	0.2492***	0.1583***	0.0855***	0.0596***	0.0372***	-0.212***	-0.0987***
	(0.016)	(0.007)	(0.004)	(0.003)	(0.004)	(0.017)	(0.007)
DPEs	0.1149***	0.0639***	0.0329***	0.0334***	0.0323***	-0.0825***	-0.0305***
	(0.014)	(0.007)	(0.004)	(0.002)	(0.003)	(0.014)	(0.006)
Firm characteristics							
Proportion of female employees	-0.0607***	-0.0726***	-0.0729***	-0.0522***	-0.0388***	0.0219	0.0205**
	(0.015)	(0.008)	(0.006)	(0.004)	(0.004)	(0.015)	(0.009)
Proportion of employees with contract	*f*	*f*	*f*	*f*	*f*	*f*	*f*
PC per employees	*f*	*f*	*f*	*f*	*f*	*f*	*f*
Age of establishment	*f*	*f*	*f*	*f*	*f*	*f*	*f*
Regional effects							
Red River Delta	0.0841***	0.0775***	0.0622***	0.0397***	0.0316***	-0.0525***	-0.0378***
	(0.019)	(0.014)	(0.006)	(0.006)	(0.005)	(0.017)	(0.013)
North Central Coast	0.0725***	0.0401**	0.0193*	0.0119	0.0178**	-0.0547***	-0.0281*
	(0.018)	(0.017)	(0.009)	(0.009)	(0.007)	(0.017)	(0.016)
South Central Coast	0.1063***	0.077***	0.0609***	0.0425***	0.0409***	-0.0654***	-0.0346**
	(0.022)	(0.016)	(0.007)	(0.007)	(0.005)	(0.019)	(0.014)
Central Highlands	0.0425*	-0.0121	0.0041	-0.0077	0.0013	-0.0412*	0.0044
	(0.025)	(0.025)	(0.011)	(0.011)	(0.008)	(0.023)	(0.024)
Southeast	0.2012***	0.1671***	0.1114***	0.0728***	0.0531***	-0.1481***	-0.0943***
	(0.017)	(0.014)	(0.005)	(0.006)	(0.005)	(0.016)	(0.013)
Mekong River Delta	0.1899***	0.16***	0.1117***	0.0904***	0.09***	-0.0999***	-0.0697***
	(0.021)	(0.014)	(0.006)	(0.007)	(0.005)	(0.019)	(0.013)
Export orientation, trade protection							
Exporter	0.1848***	0.1507***	0.1078***	0.0955***	0.0781***	-0.1066*	-0.0552**
	(0.036)	(0.02)	(0.015)	(0.023)	(0.01)	(0.043)	(0.026)
Trade variable	-0.3843***	-0.338***	-0.3074***	-0.2212***	-0.1556***	0.2287***	0.1168***
	(0.029)	(0.015)	(0.012)	(0.01)	(0.009)	(0.028)	(0.016)
Constant term	0.2185***	0.441***	0.6078***	0.6851***	0.733***	0.5146***	0.244***
	(0.023)	(0.016)	(0.007)	(0.007)	(0.006)	(0.022)	(0.014)
Pseudo-R^2	0.0787	0.0963	0.09	0.075	0.0688	0.0688	0.0752
						0.0787	0.0963
No. of observations	19,105	19,105	19,105	19,105	19,105	19,105	19,105

Notes: see notes in table 4.7a.

Regarding types of ownership, the quantile regression estimates on the ownership dummies reveal a broadly similar story to that reported for the mean regression approach. There are two notable issues. First, the SOE and DPE sectors are found, on average and *ceteris paribus*, to be more technically efficient compared to their foreign-invested counterparts at all points of the conditional distribution of technical efficiency. This reaffirms the earlier finding that FIEs performed no better than the domestic firms. More interestingly, the relative advantages of the DPE and SOE sectors compared to the FDI sector decrease over time only for firms at the higher end of the conditional distribution of technical efficiency. For the least technically efficient firms, these relative advantages have remained stable during the period 2000-2006. Second, the relative advantages of being in the SOE or DPE sectors compared to the FDI sector decrease with movement along the conditional technical efficiency distribution. An investigation of the inter-quantile regression estimates reveals that such decreases are statistically significant at conventional levels. It means that the difference in efficiency between the SOE and the FDI sectors (also between the DPE and FDI sectors) are most pronounced among the least technically efficient firms.

Similar to the results reported earlier in the mean regression analysis, the estimated results using the quantile regression approach also reveal a negative relationship between feminization and technical efficiency at different quantiles of the conditional technical efficiency distribution. Notably, this negative effect of feminization tends to decrease with movement from the lowest to the highest quantile. Inter-quantile estimates suggest that these differences are statistically significant at the 1% level in all the years under consideration. In 2002 for instance, a one percentage point increase in the incidence of female employees induced a *ceteris paribus* 0.2 percentage point decline in the technical efficiency of firms located at the bottom end of the conditional distribution while it generates only 0.06 percentage point decrease in technical efficiency of the most technically efficient firms located at the top end of the conditional distribution of technical efficiency. The same story is also observed for the other years, through differences in the impact of feminization when moving up the conditional distribution of technical efficiency are different in magnitudes. This could be taken to suggest that feminization is not an important determinant of technical performance for the most efficient manufacturing firms.

With respect to compliance of firms with labour market regulations, as proxied by the employee share of work contracts, the quantile regression estimates also reveal a positive effect on technical efficiency when data are available, as revealed in the mean regression approach. Although the impact of this variable on firm technical efficiency is relatively stable over time, the fact that this positive impact is declining with movement up the conditional technical efficiency distribution is noteworthy. On average and *ceteris paribus*, a one percentage point increase in the incidence of work contracts induces between 0.12 and 0.15 percentage point improvement in the efficiency of the least efficient firms located at the bottom end of the distribution, while it only produces a 0.03 percentage point increase at the top end of the conditional distribution, where most technically efficient firms are located. Notably, inter-quantile estimates reaffirm that these differences are statistically significant between the 10^{th} and 90^{th} as well as 25^{th} and 50^{th} quantiles. This is probably because more efficient firms tend to follow labour market regulations better than the less efficient ones.

Regarding the number of PCs per employee, the quantile regression estimates reveal a mixed picture. For 2001 and 2002, there was a positive impact of this variable on firm performance across the conditional distribution of technical efficiency and this impact decreased with movement up the conditional distribution. For the years 2004 and 2005, the impact of technological advancement, as proxied by number of PCs per employee, is negative and only statistically significant at the lower end of the conditional distribution of technical efficiency. The impacts of this variable on technical efficiency thus remain inconclusive. A similar conclusion is also apparent for the potential impact of age of establishments.

The quantile regression results using the set of regional dummies are generally consistent with the regional effects found in the mean regression analysis. Compared to the Northern Uplands, manufacturing firms located in other regions rather than the Central Highlands and North Central Coast are more technically efficient. Moreover, with the exception of the Central Highlands, accounts for two percent of total manufacturing firms, enterprises located in the South perform technically better than those located in the North. Notably, the regional effect is most pronounced at the lower end of the conditional distribution of technical efficiency (differences in the regional effect between the top and bottom quantiles are statistically significant in most cases, using inter-quantile estimates). This could be taken to suggest a convergence in technical performance among the most technically efficient firms in the manufacturing sector.

Attention now turns to the link between the trade reforms and technical performance in Vietnam's manufacturing sector at different quantiles. It was expected that the impact of trade reforms and export orientation would vary across the conditional distribution of technical efficiency and it is indeed the case. Regarding export orientation, there is a positive and statistically significant effect of exporting on technical efficiency and this effect is observed across time and the conditional distribution of technical efficiency. Though the causality cannot be verified in this current study (as noted above), this could be taken to suggest at least a close association between exporting and technical performance of manufacturing firms. The estimated effects of the tariff rate on technical efficiency are reported at the end of table 4.7a to 4.7g. These reveal a positive effect of tariff liberalization on technical efficiency and this positive link is observed across both time and the conditional distribution of technical efficiency. The quantile regression results provide a further support to the positive effect of trade liberalization on technical performance of the Vietnam's manufacturing sector as found in the mean regression context.

More interestingly, the trade effect of technical performance tends to decrease with the movement up the conditional distribution of technical efficiency and the same tendency is found for the effect of export orientation. Using inter-quantile estimates, it is clear that these differences are statistically significant in most cases. This decreasing trade effect when moving from the lower to the higher end of the conditional distribution has important implications. First, it suggests that trade liberalization and export orientation could be most beneficial for the least technically efficient firms. Second, this finding conveys an important policy message. As suggested in the literature, the least technically efficiency firms located at the bottom end of the conditional distribution would be most vulnerable to trade liberalization as these firms would find it most difficult to compete with imported goods and cope with increasing competition. In fact, opponents of trade liberalization often rely on potential costs that those weak domestic firms have to encounter when facing greater openness as an argument against trade liberalization. In contrast to this, the finding using quantile regression analysis in this study provides empirical evidence that the least technically efficient firms in Vietnam's manufacturing sector would benefit most (in terms of improvements in technical efficiency) from trade liberalization. It provides some positive evidence to support the recent and strong commitments of Vietnam's government to secure WTO accession.

4.5 Conclusions

Using the technical efficiency estimates for the manufacturing firms over the period 2000-2006, this chapter investigates empirically the determinants of technical efficiency. As the technical efficiency estimates do not exhibit a normal distribution by construction, a quantile regression approach is adopted in this study in conjunction with mean regression technique in order to provide a more complete portrait of the determinants of technical efficiency of Vietnam's manufacturing sector.

It was found that ownership plays an important role in determining the level of technical efficiency of manufacturing firms. Surprisingly, the FDI sector, with more advanced technologies and managerial skills, has technically performed worst compared to its domestic counterparts. The SOE sector, which is undertaking an on-going reform process, turned out to be the most technically efficient in the manufacturing sector. Interestingly, the advantages of SOEs and DPEs over FIEs in terms of technical performance are more pronounced for the least technically efficient firms located at the bottom end of the conditional distribution of technical efficiency. In addition to ownership, feminization, incidence of work contract are also important determinants of technical performance and notably the effects of these factors tend to decrease with movement along the conditional distribution of technical efficiency.

This chapter reports a positive, albeit modest, impact of trade liberalization on technical performance of Vietnam's manufacturing sector. This effect proved to be generally insensitive to the use of alternative measures for trade openness. The finding represents additional evidence to support a positive linkage between trade liberalization and firm performance in the current literature on the impact of trade liberalization on firm performance in developing countries. More interestingly, the trade effect of technical performance tends to decrease with movement up the conditional distribution of technical efficiency and the same tendency is found for the effect of export orientation. It suggests that trade liberalization and export orientation could be most beneficial for the least technically efficient firm. This positive impact of trade liberalization has important policy implications. First, it could be taken to suggest that greater exposure to trade produces a positive effect on technical performance of the Vietnam manufacturing sector especially those at the bottom end of the efficiency distribution. In this regard, the current commitment by the Government in regards to WTO agreements could be considered good for technical performance and development of Vietnam's manufacturing sector. Second, as least technically efficient firms would benefit most from trade liberalization, further trade reforms would not cause substantial costs (in terms technical performance) in the manufacturing sector.

Finally, it is noted that the findings on the determinants of technical efficiency obtained from the cross-sectional analysis in this chapter are invariant to the use of the panel of 5880 firms available across the period 2001-2006. In addition, these relationships also remain intact when exploring the determinants of investment efficiency as proxied by the average revenue product of capital as per Dollar and Wei's (2007).

Chapter 5. Workplace Injuries in Vietnam's Manufacturing Sector

Since the official launch of the *Doi moi* reform process in 1986, Vietnam's GDP has grown at an annual average of 7.5% over the period 1990-2006. The rapid manufacturing growth has been, among others, one of the most important drivers of this impressive performance. Over the past fifteen years, the manufacturing sector has grown at an annual average of 10.5 percent per year, while the corresponding figures for agriculture and services are 3.8%, and 7.2%, respectively (GSO Statistical Yearbook, *various years*). While the contribution of industrial growth to the country's achievements is beyond question, there is also emerging an increasing concern with health and safety issues at the workplace, particularly with regard to workplace injuries. By some conservative estimates, the incidence of work-related injuries nearly doubled between 1995 and 2003 (MOLISA, 2004a).

In this context, this paper is probably the first attempt to investigate empirically the factors underlying workplace injuries in the manufacturing sector of Vietnam. The chapter is structured as follows. The next section provides an overview on workplace injuries in Vietnam. A review of the literature on workplace injuries is produced in the second section to assist in situating the current empirical work in a broader context. Section three outlines the econometric methodologies used and a brief description of the data and variables is also provided. Empirical results are discussed in section four. The final section discusses some conclusions and policy implications.

5.1 Overview of Workplace Injuries in Vietnam

The overall economic growth in the post-*Doi moi* era has lead to remarkable changes in the economic structure of Vietnam. Though the agricultural growth rate was exceptionally high compared to the world average, its contribution to economic growth decreased considerably over the past decade (World Bank, 1998 and 2006). This fall in the GDP share of agriculture mirrored industrial growth, as the share of manufacturing output in total GDP almost doubled. Such structural changes have made the manufacturing sector the main driver of economic growth (see chapter one). However, there have been concerns on whether bad working conditions, low awareness of occupational health and workplace safety represent some of the more adverse consequences of the country's industrial growth trajectory. As a result, the rapid industrial growth has been associated with increased workplace injuries (MOLISA, 2004a; Anh, 2004).

Like other developing countries, the issues of labour standards in general, and occupational health and workplace safety in particular, have not been considered as important concerns in the development agenda for Vietnam. Legal background for occupational health and workplace safety started to emerge with the labour market reforms during the 1990s (see ADB, 2004; Brassard, 2004), which were marked by the promulgation of the 1994 Labour Code (and its amended versions in 2002, 2006, and 2007). For instance, the Labour Code incorporates the importance of ensuring decent working conditions. Accordingly, "[an] employee shall be paid a wage … (that) is not less than the minimum wage (…); shall be entitled to labour protection, and safe and hygienic working conditions; shall be entitled to stipulated rest breaks and holidays, paid annual leave, and social insurance" (Article 7 – SRV, 2007). This article and many other articles related to working conditions and workplace safety (for instance, Chapter IX on occupational safety and hygiene; Chapter XIII on trade unions), reflect the essence of the ILO's core labour standards.

In addition to the Labour Code, there are other legal documents on occupational health and workplace safety, including Decree 06/1995 dated 20 January 1995 and its amended Decree 110/2002 dated 27 December 2002 by the Prime Minister on workplace safety. These two decrees serves as guidelines for the Labour Code in the areas of occupational health and workplace safety. In addition to these two decrees, there are circulars issued by ministries concerned, including (i) Circular 10/2003/TT-BLĐTBXH on compensation for workplace injuries and occupational health; (ii) Circular 01/2007/TTLT/BLĐTBXH-BCA-VKSNDTC that specifies the procedures to deal with fatal workplace injuries and other injury cases that could be considered as crime; and (iii) Circular 14/2005/ TT-BLĐTBXH which provides detailed instructions associated with enforcement measures for enterprises to inform the authorities in cases of work-related injuries.

However, the compliance by enterprises to these limited legal guidelines is reported to be poor. The MOLISA's Annual Report on Workplace Safety and Occupational Health repeatedly emphasize the lack of compliance to regulations on work-related injuries (see MOLISA 2003; 2004a,b; 2005a). According to these reports, lack of compliance with workplace safety regulations was identified as a major reason leading to workplace injuries. Notably, there is a tendency that firms do not report workplace injuries and occupational health to the authorities as regulated by Decree 110/2002 and Circular 14/2005. As a result, reported figures on workplace injuries are generally subject to serious under-reporting (MOLISA, 2005a).

As the industrial growth has taken place under the poor enforcement of regulations on labour standards, it is reasonable to assume a considerable level of workplace risk has emerged in Vietnam. An accurate narrative is not possible as secondary data on workplace injuries in Vietnam is extremely limited. To date, the only published data on workplace safety was maintained by the MOLISA through its annual reports on workplace safety and occupational health over the period 1995-2006. These reports provide figures on number of workplace injuries reported from MOLISA's provincial departments. Another source of data on workplace injuries could be obtained from the VES series (when the rotating module on workplace injuries was included). Both of these two sources are subject to limitations (as discussed below). However, as these are probably the only sources available, using these sources as an exploratory exercise might provide, for the first time, a useful narrative on workplace injuries in Vietnam.

5.1.1 Workplace injuries in Vietnam: a narrative from MOLISA's reports

This sub-section provides a descriptive analysis of workplace injuries in Vietnam using the MOLISA's annual reports on workplace safety and occupational health over the period 1995-2006. The reports were compiled on the basis of MOLISA's provincial departments, who collected their data from the reports filed by enterprises located in their provinces. It should be noted that until the Circular 14/2005/TT-BLĐTBXH, there was no clear guideline on how enterprises should report workplace injuries to the authorities, and thus it remains unclear how these reports were collected at the provincial DOLISAs. However, MOLISA has claimed this as its only official reports on workplace safety and occupational health so these might serve as a starting point to provide some insights on this issue. As these reports reflect the number of injuries reported for all sector, this might be considered as a general narrative for workplace injuries in Vietnam during the period 1995-2006.

Table 5.1 reports the absolute number of reported injuries in Vietnam extracted from the MOLISA data for all economic activities over the period 1995-2007. Most notably, the number of injury cases and the number of injured workers has generally increased over time. Compared to the number of 1,104 reported injury cases in 1995, the total number of injuries cases rose more than fivefold, and was up to 5,951 cases by 2006. Of the total injury cases, fatal cases accounted for nearly 10 percent. With regard to the number of injured persons, the total number of injured persons has increased from 2,127 in 1995 to 6,337 in 2007.

Figure 5.1a reports the rate of reported injuries per 1,000 workers. The incidence of reported injuries was on the rise during the 1990s, and has fluctuated around the rate of 0.8 injuries per 1,000 workers since 2000. But the incidence of workplace injuries has generally increased between the start and the end of the period 1995-2007. It is however noted that the rate of fatal cases has experienced a steady decrease during the period under consideration (from 0.12 to 0.08 fatal cases per 1,000 workers). An increasing number of workplace accidents impose direct costs on enterprises in the number of working days lost. Figure 5.1b shows an increasing trend of direct expenses of workplace accidents reported over time, with a substantial increase in 2005. It is difficult to understand this '2005 break', especially as it coincides with the reduction in workplace injuries (both in number and rate). The Annual Report 2005 of the MOLISA's Labour Inspectorate does not suggest any obvious reasons. In a further effort to explain this finding, this chapter initiated a desk investigation of e-newspaper headlines during 2004 and 2005 but no big accidents were detected. Similarly, the figure on number of day off in 2007 is striking. But there is no straightforward explanation that could be found. This '2005 break' in terms of injury cost and significant number of day off in 2007 are left unresolved due to data constraints and a lack of information confronting the current study.

Table 5.1 Reported Workplace Injuries in Vietnam, 1995-2007

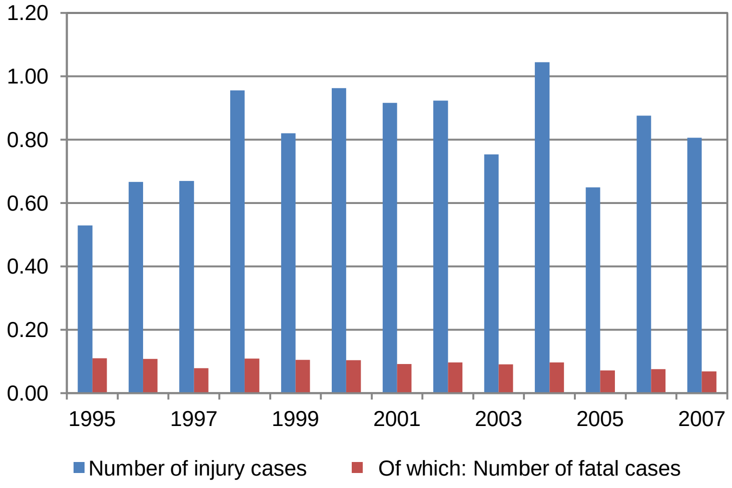
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total injury cases reported*	1,104	1,545	1,725	2,737	2,611	3,405	3,601	4,298	3,896	6,026	4,050	5,881	5,951
Of which: Number of fatal cases**	230	249	202	312	335	368	362	449	469	561	443	505	505
Number of injured persons reported*	2,127	1,665	2,072	2,228	2,813	3,530	3,748	4,521	4,089	6,186	4,164	6,088	6,337
Of which: Number of dead	264	285	320	362	399	403	395	514	513	575	473	536	621
Estimated Direct expenses for accidents (mil. VND)	1,691	4,051	5,283	13,216	12,729	16,214	12,025	17,807	20,741	19,865	47,107	46,597	48,035
Day offs due to accidents (days)	na	na	na	na	na	46,296	87,139	196,504	59,796	64,961	49,571	56,122	382,313

Source: Compiled from the Annual Workplace Accident Reports of the Labour Inspectorate of MOLISA (various years).

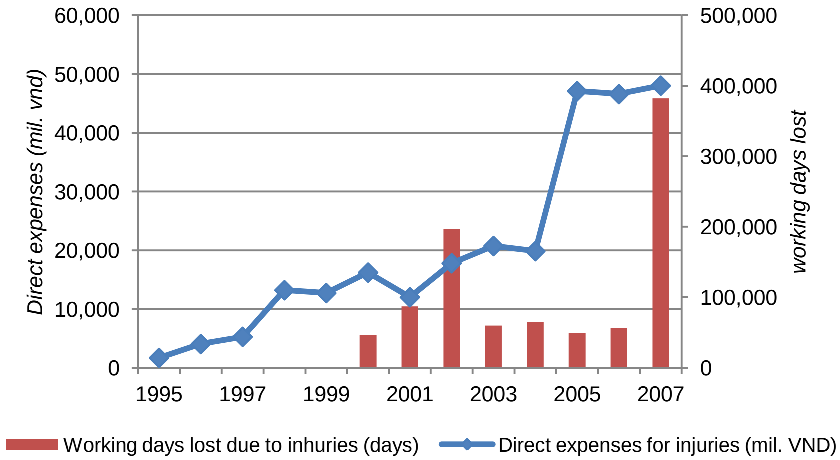
Notes: * each case might have more than one person injured; ** the reports defined the “Number of fatal cases” are the number out of the “Total injury cases” with dead.

Figure 5.1 Workplace Injuries in Vietnam, 1995-2007

(a) Reported number of injury cases and fatal cases per 1,000 worker



(b) Reported direct expenses and working days lost from injuries



Source: compiled from the Annual Workplace Accident Reports of the Labour Inspectorate of MOLISA (*various years*). Number of workers in the period 1997-2007 are from GSO Statistical Yearbooks (*various years*).

In addition to the aggregate data on reported workplace injuries, the Annual Workplace Accident Reports of the Labour Inspectorate of MOLISA also provide data for Hanoi, Quangninh, Haiphong (in the North), Danang (in the Central), Dongnai and HCMC (in the South). These six provinces accounted for nearly a half of the total manufacturing output in the period 1996-2007 (GSO Statistical Yearbook, 2008). As the provincial data on reported injuries are only available from the MOLISA's Labour Inspectorate between 1998 and 2003, Figures 5.2a to 5.2d use these data to provide some further descriptive figures on workplace injuries. Over the period 1998-2003, HCMC and Dongnai in the South, contributed nearly 36 percent of the total manufacturing output and 38 percent of FDI, and accounted for one third of the total workplace injuries throughout the country. In the same period, Hanoi, Haiphong, and Quangninh in the North, which form the country's second largest industrial base, accounted for 24 percent of the reported injuries (MOLISA, 2004a).[38]

As reported in Figures 5.2a to 5.2d, HCMC has recorded the highest level of injuries reported over the recent years. In 2000, the number of injury cases in HCMC accounted for nearly 15 percent of the total reported cases but decreased significantly to 9.5 percent in 2006. On the contrary, the share of the number of fatal cases reported in this province increased from 9.3 percent in 2000 to 14.4 percent in 2006. The highest level of injuries reported in HCMC coincides with the fact that this city accounted for around 26 percent of industrial output and was the largest FDI recipient destination within Vietnam. Nguyen (2006), using a small-scale survey conducted in the Southeast, reported 70 percent of fatal injuries which were observed in HCMC. In addition, Dongnai province, located in the Southeast, records the highest growth rate of workplace injuries. It should be noted that Dongnai province is one of the most attractive destinations for FDI in Vietnam and has exhibited a very rapid industrialization process in recent years.[39]

---

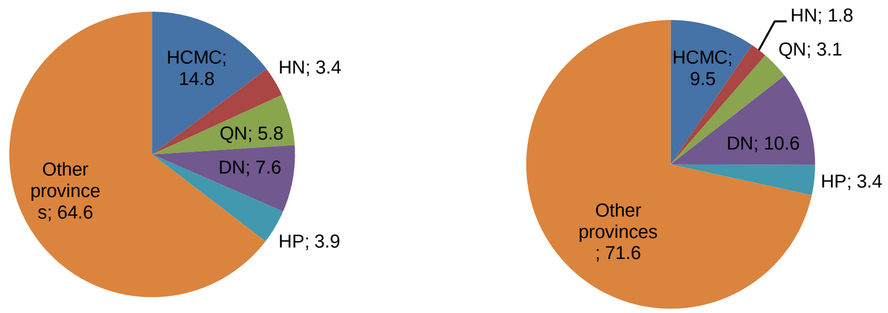
[38] HCMC and the surrounding provinces including Dongnai form the country's most important industrial cluster producing 38% of the total industrial output in 2005. Hanoi, Haiphong, and Quangninh, which is commonly referred to the 'Northern Development Triangle', comprises the second largest industrial base and contributes nearly 13% of the total industrial output in the same year. These figures are own calculations from the GSO Statistical Year Book 2000, and 2005.

[39] According to the data provided on the website of Dongnai's Department of Industry and Trade, in the period 1995-2007, the industrial share in GDP has increased 1.5 times (from nearly 39 percent in 1995 to 59 percent in 2007) and the number of industrial establishments doubled in just 10 years, from nearly 6,400 units in 1997 to over 11,400 units by2007.

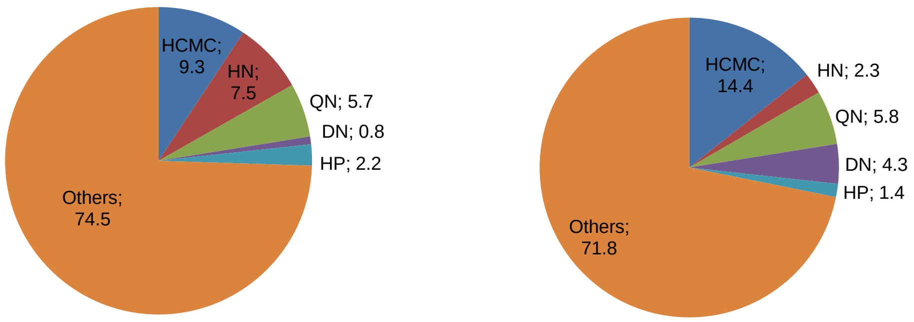
Figure 5.2 Workplace Injuries Reported by Provinces, 2000-2006

2000 **2006**

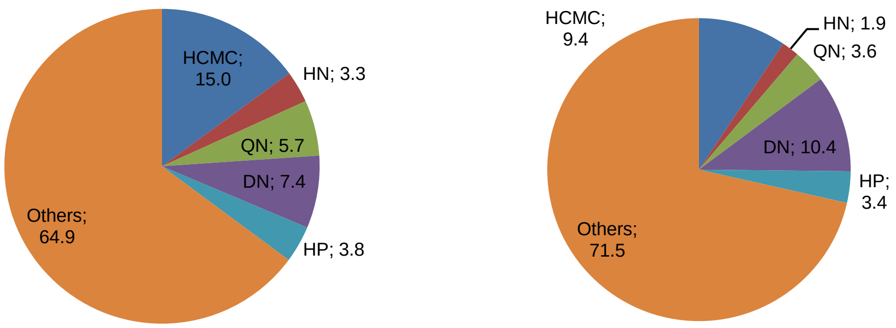
(a) Number of injury cases



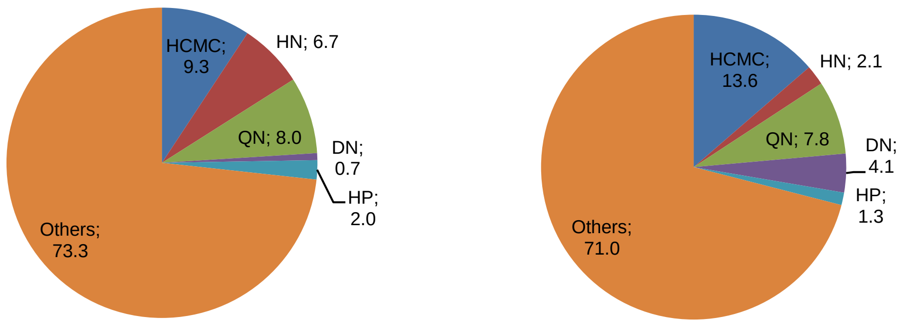
(b) Number of fatal cases



(c) Number of injured persons



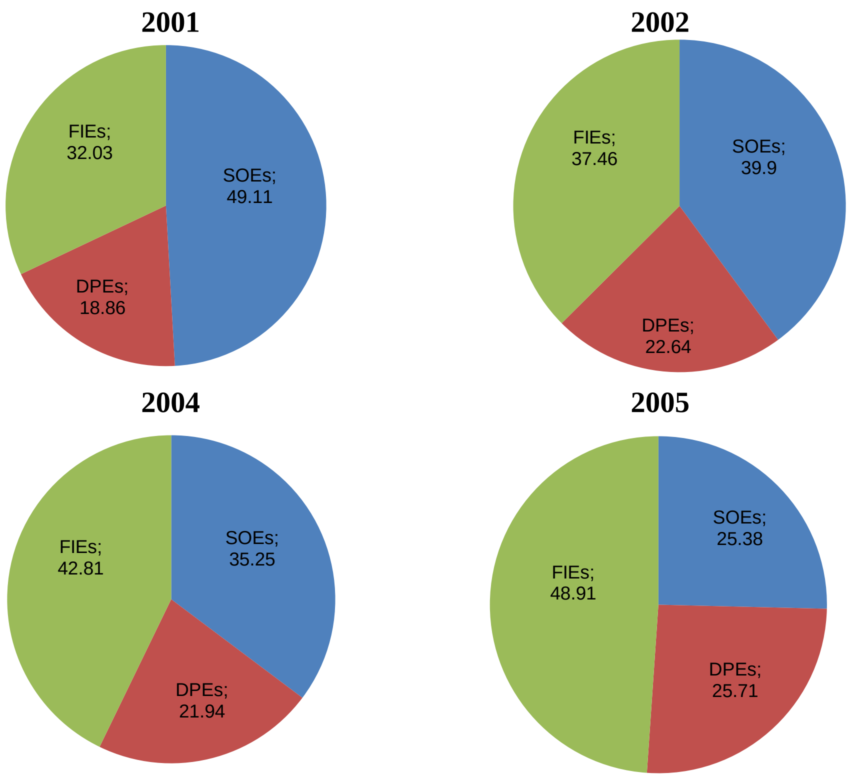
(d) Number of fatalities



Source: see Figure 5.1;
Notes: HCMC, HN, QN, DN, HP denote for Ho Chi Minh City, Hanoi, Quangninh, Dongnai, Haiphong provinces, respectively. The details are reported in table A5.1 of the Appendix.

In the series of the Annual Workplace Accident Reports, there were a few years where the data were disaggregated into types of ownership, including SOEs, FIEs, and DPEs. Figure 5.3 represents the structure of workplace injuries reported according to these categories. The share of SOEs in the total injuries reported has decreased from nearly one-half to over 25 percent between 2001 and 2006. In contrast, the FIE sector has contributed an increasing share of the total injuries reported. The FIE sector became the largest source of workplace injuries. An increasing share of the FIE sector (by nearly 20 percentage points between 2001 and 2006) is observed during the period when Vietnam experienced rapid growth in its FDI flows (see chapter 1). In a comparison between 2001 and 2006, the number of FDI projects doubled, while the volume of total FDI registered grew by a factor of four.

Figure 5.3 Workplace Injuries Reported by Types of Ownership, 2001-2005



Source: see Figure 5.1

The DPE sector has experienced a rapid growth in the number of establishments since the promulgation of the Enterprise Law 2000. This growth is, however, not associated with increases in the number of workplace injuries reported. The share of the DPEs in the total number of injury cases has increased slightly from 19 percent in 2001 to 26 percent in 2005. However, this lowest share of the DPE sector compared to the SOE and FIE sectors needs to be interpreted with caution. As noted earlier, when using the MOLISA statistics for this analysis, the narrative reported here could represent a serious underestimate of the actual level of workplace injuries. While this could be observed for all enterprises, DPEs may be most reluctant to report compared to SOEs or FIEs (MOLISA, 2005a).

There has been some qualitative evaluation on the reasons for work-related injuries. The Annual Workplace Accident Reports in recent years and MOLISA, 2006 identified six causes of workplace injuries, including (i) unsafe work conditions or equipment; (ii) the unavailability of or the failure to use protective tools or equipments; (iii) knowledge on workplace safety training not present at the workplace; (iv) the absence of sound workplace safety procedures or methods; (v) violation of safety procedures or methods; and (vi) other miscellaneous reasons. Using this classification, the violation of work safety regulations, that accounted for 36 percent of the total injuries reported, was identified as the major cause (see table 5.2). Unsafe work conditions or the lack of safety procedures accounted for nearly five percent each; while the two remaining reasons (i.e. unavailability or failure to use protective tools or equipment, lack of training on safety at workplace) contributed to nearly 2.6 percent each of the total injuries reported. This suggests that poor compliance of employers with workplace safety regulations and the lack of attention to workplace safety are the most important causes of workplace injuries in Vietnam.

Table 5.2 Workplace Injuries by Causes, 2000-2004

Year	Unsafe work conditions or	Unavailability or not using	Safe workplace	Without safety procedures or	Violation of safety	Others

	equipment		protection tools		untrained		methods		procedures or methods			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
2000	185	5.43	61	1.79	40	1.17	163	4.79	1320	38.77	1636	48.05
2001	132	3.67	113	3.14	76	2.11	230	6.39	1274	35.38	1776	49.32
2002	321	7.47	129	3.00	99	2.3	240	5.58	1613	37.53	1896	44.11
2003	274	7.03	61	1.57	132	3.39	213	5.47	1405	36.06	1811	46.48
2004	354	5.87	201	3.34	206	3.42	215	3.57	2074	34.42	2976	49.39
Total	1,266	5.96	565	2.66	553	2.61	1,061	5.00	7,686	36.21	10,095	47.56

Source: compiled from the Annual Workplace Accident Reports of the Labour Inspectorate of MOLISA (various years) and National Profile on Occupational Safety and Health in Vietnam (MOLISA, 2006).

Before moving to the next sub-section, it is important to note the shortcoming of this MOLISA data and provide some cautionary notes in interpreting the estimates calculated from these statistics. It is first noted that these reports were compiled during a period where guidelines on reporting injuries were not available. Therefore, the quality of this data is subject to question. In addition, as stated in MOLISA (2005a), the proportion of firms reporting injuries is implausibly low (around one percent of the total enterprises registered). This might be partially attributed to the lack of reporting guidance as well as compliance to (general) regulations on workplace injuries. In fact, workplace injuries incurred, especially in the private sector, are rarely reported (see Lan, 2006). Moreover, it should be emphasized that MOLISA's reports cover only the formal sector, which is largely wage employment. As noted in Pham and Reilly (2007), the wage employment sector accounted for 27.6 percent of the total employment in 2002. Under such circumstances, it might be reasonable to argue that the actual level of workplace injuries could be substantially higher than what reported in this sub-section.

5.1.2 Workplace injuries in the manufacturing sector: a narrative from the VESs

This sub-section describes the situation of workplace injuries in the manufacturing sector using the data available from the VESs for the year 2001, 2002, 2004, and 2005, when the information on workplace injuries was included as a rotating module in the VES questionnaires (see chapter 2). Table 5.2 presents an overview of workplace injuries in the manufacturing sector based on the data available. It is first noted that the prevalence of firms with injury cases reported was very small. In 2001, there are 281 firms out of 8,866 manufacturing firms found with injuries at the workplace (i.e. around 3.2%). The rates of manufacturing firms with reported workplace injuries in the subsequent two years were slightly higher (i.e. 5.6 percent, 4.3 percent in 2002 and 2004, respectively). But in 2005, the prevalence of injuries was broadly similar to 2001. In this year, out of 17,731 firms, there were 595 firms where injuries were found at their workplace (i.e., 3.4 percent).

Table 5.2 Workplace Injuries in the Manufacturing Sector, 2001-2005

	2001	2002	2004	2005
Number of firms available from VESs	8,866	11,029	15,534	17,731
Number of injury cases	281	614	661	595
Of which:				
– Number of fatal cases	26	55	57	51
– % of fatal cases	9.25	8.96	8.62	8.57
% of firms with injury cases	3.17	5.57	4.26	3.36
Number of persons injured	2,435	5,792	7,106	7,967
Of which:				
– Number of persons dead	34	65	72	62
– % of dead per injured	1.40	1.12	1.01	0.78
Number of persons injured per 1000 workers	1.37	2.66	2.41	2.49

Source: calculations from VES 2002, 2003, 2005, and 2006 (for the data in the year 2001, 2002, 2004, and 2005)

In terms of number of workers injured, there was a sharp increase in the total number injured across these years. In the initial year of the period under consideration, there was 2,425 workers injured, this number rose to 5,792 workers in 2002, 7,106 workers in 2004, and 7,967 workers in 2005. It implies an increase by an order of nearly 3.3 times in the number of workers injured between 2001 and 2005.[40] In the period under consideration,

[40] Except for the year of 2001, the numbers of workers injured in this table (based on the VESs) are considerably higher than the total number of persons injured in table 5.1 (based on the

the manufacturing sector also experienced a rapid growth in terms of employment (see figure 3.2 in chapter 3). Therefore, with the exception of the year 2001, the average number of workers injured per 1000 of employees was relatively stable at between 2.4 to 2.66. In addition, it is also noted that the incidence of fatal injury cases is not very high. Of the total number of reported injury cases, the fatal cases accounted for between 8.6 to 9.3 percent. Of the workers injured, between 0.8 to 1.4 percent (depending on years) sustained fatal injuries.

Based on the data from VESs, table 5.3 reports the incidence of workplace injuries found in the manufacturing sector according to types of ownership, export orientation, and regions. It is first observed that the number of injuries is very small amongst DPEs compared to that of SOEs and FIEs. For instance, around 1.1 percent of DPEs were found with injures in 2005 while the corresponding figures for SOEs and FIEs are around 11 percent. In addition, both the SOE and FIE sector exhibited an incidence of injuries found in VESs that was higher than the average level by an order of between 2.5 to 3.5 times in the years under consideration. Comparing across these two sectors, the figures suggest that the prevalence of workplace injuries found in FIEs is slightly higher than in SOEs in the manufacturing sector.

Table 5.3 Percentage of Firms with Workplace Injuries found in the Manufacturing Sector, 2001-2005

	2001	2002	2004	2005
Average	3.17	5.57	4.26	3.36
By types of ownership				
SOEs	7.22	15.95	12.06	11.09
DPEs	0.86	1.76	1.23	1.11
FIEs	9.30	14.49	16.58	11.44
By export orientation				
Non-exporter	*f*	3.33	1.72	3.35
Exporter	*f*	9.58	8.86	4.76

MOLISA's reports). This appears contradictory given that what was reported from MOLISA was assumed to cover all sectors while the VES-based figures refer to the manufacturing sector alone. In fact, this reflects a very limited level of data availability on workplace injuries in Vietnam. This also warrants caution when interpreting the results from this chapter. This issue will be discussed in detail in section 5.3 and 5.4.

By regions/locations				
Northern Uplands	3.86	3.20	4.67	3.09
Red River Delta without HN	4.62	5.36	3.33	3.64
North Central Coast	3.99	4.97	3.95	3.22
South Central Coast	3.05	3.23	5.23	4.95
Central Highlands	2.62	4.80	2.37	2.56
Southeast without HCMC	4.68	9.55	8.70	6.54
Mekong River Delta	0.35	2.00	2.27	1.80
Hanoi	4.75	4.04	3.84	3.68
HCMC	4.90	4.23	3.51	3.21

Source: calculations from VES 2002, 2003, 2005, and 2006 (for the data in the year 2001, 2002, 2004, and 2005)
Note: '*f*' denotes 'not applicable' as there was no data on export orientation collected in this year

With regard to export orientation, there was a considerable gap in workplace safety between exporters and non-exporters with the advantage of the former. In 2002 for instance, nearly 9.6 percent of exporters was found with workplace injuries in the VESs available for this study while the corresponding figure was only 3.3 percent for non-exporters. However, this gap decreased between 2002 and 2005 (from a gap of 6.3 percentage point to a gap of 1.4 percentage point). In terms of locations (as captured by the regions), the Red River Delta (without Hanoi) and Southeast (without HCMC) generally exhibited a higher level of workplace injuries in the period 2001-2005. The reason for excluding Hanoi from the Red River Delta and HCMC from the Southeast was to assess whether workplace injury is a particular issue in these two large industrial cities. However, it seems that the prevalence of workplace injuries in the VESs in both Hanoi and HCMC were slightly lower than those in the Red River Delta and Southeast, respectively.

Table 5.4 provides figures on the percentage of firms with workplace injuries found in the VESs according to different manufacturing sub-sectors. Of these sub-sectors, tobacco products, tanning and dressing of leather, manufacture of basic metals, machinery and equipment, electrical machinery and apparatus, motor vehicles, and other transport equipment exhibited a higher level of workplace injuries. The 'best performers' were manufacturers of coke, refined petroleum products, publishing and printing, food and beverage, wearing apparel, and manufactures of wood and wooden products. However, it should be noted that figures reported in table 5.4 are affected by small sample sizes of the firms with workplace injuries (as in table 5.2). Hence, the comments on the scale of injuries in the sub-sectors drawn from table 5.4 should be taken as exploratory.

Table 5.4 Percentages of Firms with Workplace Injuries found in the Manufacturing Sub-Sectors, 2001-2005

	2001	2002	2004	2005
Average	3.2	5.6	4.3	3.4
By sub-sectors				
Food and beverage	2.2	3.0	2.5	2.1
Tobacco products	7.4	13.6	10.8	12.5
Manufacture of textiles	5.4	6.9	5.8	3.9
Wearing apparel	1.9	3.0	2.9	2.4
Tanning and dressing of leather	3.9	8.2	8.5	6.4
Manufacture of wood and products of wood	1.8	4.3	3.1	1.6
Paper and paper products	2.2	4.9	4.9	3.9
Publishing, printing	0.7	1.6	0.5	1.2
Manufacture of coke, refined petroleum products	0.0	0.0	0.0	0.0
Chemicals and chemical products	2.6	6.2	5.0	1.9
Manufacture of rubber and plastics products	3.7	5.5	4.6	3.7
Other non-metallic mineral products	2.6	7.3	4.2	3.9
Manufacture of basic metals	9.9	14.2	7.9	5.7
Fabricated metal products	3.2	5.0	3.9	3.4
Machinery and equipment	6.5	8.3	6.1	1.4
Office, accounting and computing machinery	7.5	6.5	8.1	5.0
Electrical machinery and apparatus	5.5	11.4	7.4	5.9
Radio, television and communication equipment and apparatus	1.2	3.9	1.9	4.2
Medical, precision and optical instruments, watches and clocks	2.4	5.9	0.0	2.9
Motor vehicles, trailers and semi-trailer	5.5	7.4	7.6	7.6
Other transport equipment	5.2	11.8	7.7	7.5
Manufacture of furniture	4.8	7.4	5.4	4.8

Source: calculations from VES 2002, 2003, 2005, and 2006 (for the data in the year 2001, 2002, 2004, and 2005)

The descriptive analysis provided in this section has important implications for the empirical analysis of the current chapter. First, it should be noted that secondary data on workplace injuries are extremely limited. The two sources used in this section are probably the only sources available to date. The narrative on workplace injuries depicted here is thus very exploratory. Second, due to lack of both ‘operational’ regulations and enforcement of work safety-related rules, the data available are the ‘reporting’ data and it is near impossible to judge the quality and accuracy of these sources. Third, due to these data constraints, empirical analysis in the current chapter should be best interpreted as exploratory rather than conclusive, and best interpreted as providing a useful starting point for further studies in this important but under-documented area of research.

5.2 Literature Review on Workplace Safety

Workplace safety is a multi-faceted issue that has been considered within different areas of the social sciences literature. Workplace safety represents a growing issue in business operation management (Kaminski, 2001). Brown (1996) notes “[…] in spite of the increasing importance of this topic, and in spite of its relevance to research issues in our field, it (workplace safety) has been almost completely absent from the literature in (management) operations” (p.157). In this literature, most of the recent push towards improved safety has been motivated by cost reduction goals, regulatory pressures, and a growing acceptance of social responsibility or corporate codes of conduct that incorporates the responsibility of creating decent working conditions for employees. Workplace safety is now recognized as an element of a new set of customer expectations about social responsibility. Although social responsibility is not a tangible element of the products that they purchase, both domestic and foreign customers are increasingly concerned about the conditions under which products are manufactured, including the consideration of workplace safety and health (see McCutcheon and Meredith, 1993 for a survey). This new market force intensifies the pressure for workplace safety and health to become an operating priority.

The causality between firm performance and workplace safety is relatively blurred. Shannon, Mayr, and Haines (1997) review 61 studies in this area and conclude by listing a group of organizational factors (management philosophy, managerial style, characteristics of the workforce *etc.*) that are associated with low accident rates, and those with high workplace risks. Kaminski (2001) emphasizes the effect of operational practices (for instance human resource management, hazard control) on accident rates at workplace in the United States. There is little empirical work to date that examines the relationship between organizational practices and safety (Kaminski, 2001). On the one hand, better firm performance may improve safety condition and occupational health. On the other, improvements in workplace safety and health are productive for the firm by reducing cost of injuries and other financial losses from workplace injuries. The available empirical evidence found does not provide an unambiguous answer to either the former or the latter (see Shannon *et al.*, 1997 for a survey). Bauer (2004) argues that the adoption of a High Performance Workplace Organization (HPWO) which promotes workplace safety has had a considerable impact on firm-level productivities in most of European countries, and that HPWOs assist firms achieve higher flexibility, higher product quality, and higher performance while remaining cost competitive. In addition, the popularity of International Labour Organization (ILO)'s Occupational Safety and Health (OSH) guidelines has also contributed to an improvement in firm performance in certain countries (see Shannon *et. al*. 1997).

For this chapter, workplace safety is best contextualized as a subject within the labour economics discipline. One strand of this literature suggests that workers are compensated for the level of risk they face at the workplace. Therefore, there is generally a positive relationship between earnings and job-related hazards (Causineau, Laxcroix and Girard, 1992). This theory of compensating wage differentials states that workers in hazardous jobs will receive some form of wage premium. Compensating wages are an *ex ante* payment for workplace risk, whereas workers' compensation provides an *ex post* benefit based on actual injury experience. This implies that workers should be willing to trade-off wages for insurance benefits of this kind. This clearly implies that workers' compensation replacement rates should have a negative effect on their wages (Meng and Smith, 1999). Empirical evidence generally confirms this relationship such as Moore and Viscusi (1990), Gunderson and Hyatt (2001), Thomason and Pozzebon (2002), Silvestre (2006).

The other strand of (the labour economics) literature on workplace risk empirically investigates the determinants of workplace safety using firm-level data. The current chapter follows this direction. This strand is related to the theory of operation management as management practices are also important determinants of workplace injury. It is argued that workplace injuries are associated with the characteristics of the work environment and work practices (Harell, 1990; Sherry, 1991; Brown, 1996) and certain characteristics of the individuals (Dahlback, 1991; Sutherland and Cooper, 1991). Stemming from this literature, Maiti and Bhattacherjee (1999) model risks of occupational injuries among coal mine workers in India and conclude that both the individual and workplace characteristics of the miners have significant effects on the risk of sustaining injuries. Bennett and Passmore (1986) examined the relationship between workplace characteristics and injury severity in coal mines in the US and reported the same evidence. Reilly, Paci, and Holl (1995) reveal considerable effects of workplace characteristics, including employment size, work-force composition, roles of union safety representatives and safety committees, on workplace injuries in the UK. This finding is reaffirmed by Fenn and Ashby (2004) who emphasize the role of firm size and union density in determining workplace injuries in the UK.

The labour economics literature also suggests that concerns on workplace safety are more pronounced in the informal sector. Workers in the informal sector are at high risk relative to their industry and occupation. It is due to the small scale of enterprise, the general absence of preventive accident measures, and hazard controls, and poor living standards among informal workers, and the fact that informal firms are outside or beyond the control of government regulation (see Dorman, 2000 for a review). The literature also highlights the gender-specific issues in occupational health and workplace safety debates. Forastieri (2001) emphasizes different types of workplace risks that are women-specific. In industry, female workers predominate in micro-electronics, food production, textile and footwear, chemical and pharmaceutical industries and handicraft workshops. In the service sector they are mainly engaged in teaching, office work, hospitals, banks, commerce, hotels, and domestic work. According to Forastieri (2001), the incidence of workplace injury in these sectors could be higher for women rather than men. In addition, other studies suggest that immigrants and ethnic minority workers are often subject to certain discrimination at the workplace and such discrimination could be then translated into exposing such workers to more risky jobs and/or operations. This relationship is documented in Bollini and Siem (1995) for the case of immigrants and Robinson (1989), Bollini and Siem (1995) for the case of racial and ethnic minority workers.

Recently, occupational health and workplace safety have been linked to intensive discussion on international trade and labour standards. Some developed countries have regarded low foreign wages and poor working conditions as a threat to their own workers' living standards and as a moral outrage (Golub, 1997). The combination of rising imports of manufactures from developing countries, real wage stagnation in the United States, and high unemployment in Western Europe during the 1990s exacerbated the so-called 'social dumping' or a 'race to the bottom'. In this context, there has been increasing pressure from developed countries, especially from the US, to incorporate labour standards in the WTO's negotiation agenda and, in many cases, calls for trade sanctions against violations of labour standards (see Brown, 2000; Brown, Deardorff, and Stern, 2002).

However, according to Stern (2003), "[…] labour standards are multi-faceted and may vary from country to country depending on the stage of development, per capita income, and political, social, and cultural conditions and institutions" (p.2). Efforts have been made to identify a group of core labour standards that ideally should apply universally. These are notably the core standards defined by the ILO Conventions (ILO, 1998), and the OECD that essentially covers the ILO's ones (OECD, 1996). In addition to these core labour standards, there are also other standards that are less universally accepted, and that relate to 'acceptable or decent working conditions'. Occupational health and workplace safety is currently considered under the umbrella of these non-core labour standards (see Brown, Deardorff, and Stern, 1996). To date, the current literature and debate on trade and labour standards largely concentrates on core labour standards (Stern, 2003) and as a result, the literature on international trade and workplace safety remains largely unexplored.

In summary, workplace injuries are a subject for intensive research in the developed world. Workplace injuries are determined by both characteristics of the work environment and work practices as well as the behaviour of individual workers. The recent emergence of this literature for the developing world largely relates to the recent debate on international trade and labour standards. However, empirical evidence in developing countries on workplace injury is still very limited. In the light of this, the current chapter attempts to provide some empirical evidence on the determinants of workplace injuries in the manufacturing sector of Vietnam covering a very recent period of the country's economic reforms.

5.3 Methodology and Data

5.3.1 Empirical Methodology

In the empirical literature on workplace injuries, several methodological approaches have been used. One common approach is to use the Poisson distribution and its variants in modeling accident counts in workplace safety (see Bailer, Reed, and Stayner, 1997; Quintana and Pawlowitz, 1999; Carrivick, Lee and Yau, 2003; Lord, Washington, and Ivan, 2005). Cameron and Trivedi (1990) refer to this model as the benchmark for the analysis of discrete count data. However, the Poisson regression model is usually too restrictive and overdispersion is a common problem encountered with this type of model (see Maddala, 1983; Hausman, Hall, and Griliches, 1984). Overdispersion may arise because the process generating the first event may differ from that generating the later events or due to failure of the assumption of independence of events which is implicit in the Poisson process. Given this, the Negative Binomial (NB) model can be considered as a next best alternative. Although the NB model relaxes the assumption of equidispersion of the Poisson distribution, Cameron and Trivedi (1999) show another fundamental problem, which is known as the excess zeros problem of the Poisson model as "[…] Poisson density may predict the probability of a zero count to be considerably less than is actually observed in the sample" (p.5). This happens when zero and non-zero observations are governed by separate mechanisms. This issue is sometimes referred to as the partial observability phenomenon (see Shankar *et al*., 2003). In such circumstances, either the Poisson or NB models are inappropriate as they implicitly assume a common mechanism by which the outcome of interest is generated. The Zero-Inflated count data models should be considered as alternatives (see Lambert, 1992; Mullahy, 1996). These approaches, including Poisson and NB models (and their zero-inflated counterparts, e.g. ZIP and ZINB) were experimented within in this chapter when exploring the appropriate empirical strategy for explaining the determinants of workplace injuries. However, they are not chosen for the empirical analysis reported in this current study as they are not found to adequately fit the data (further details are discussed in a subsequent section).

In this chapter, the number of injuries of a firm *i* can be expressed as a function of firm-level variables, which capture various characteristics of the work environment, work practices and workforce composition. The general form of this function could be expressed as:

$$ln\boldsymbol{wi}_i = \beta_0 + \boldsymbol{x}_i{'}\beta_{1i} + \boldsymbol{g}_i{'}\beta_{2i} + \boldsymbol{ind}'\beta_{3i} + \mu_i \qquad [5.1]$$

where $\boldsymbol{wi}_i$ is the number of workplace injuries at firm *i*; $\boldsymbol{x}_i$ is the vector consisting of various variables of work environment and firm characteristics; $\boldsymbol{g}_i$ is the vector of characteristics of individual workers; ***ind*** is the vector of industry-specific effects.

Unfortunately, as this thesis uses the firm-level data available from the VESs, where information on individual characteristics of workers that could exert effects on injuries is not available. Given this, individual characteristics of workers must be dropped from equation [5.1] to yield:

$$ln\boldsymbol{wi}_i = \beta_0 + \boldsymbol{x}_i{'}\beta_{1i} + \boldsymbol{ind}'\beta_{2i} + \mu_i \qquad [5.2]$$

If firms report all workplace accidents or all firms 'randomly' report accidents occurring at their workplace, estimating equation [5.2] using the simple OLS will result in unbiased estimates. However, if there are mechanisms that some enterprises may 'select' to report accidents or not, then estimating [5.2] using the simple OLS is not appropriate.

In the case of Vietnam, it might be a likely that DPEs try to avoid attention from authorities and thus are reluctant to report injuries. Meanwhile, SOEs could be generally more compliant to regulations, including those on workplace accidents due to, for instance, their political patronage. Reviewing the limited literature on workplace injuries in Vietnam does not provide any evidence on the above observations. Nevertheless, it is not unreasonable to question whether there is a selection process in reporting workplace accidents. In addition, there may be unobservable factors that govern the reporting of injuries that are correlated with unobservable factors that determine the number of workplace injuries. If there is indeed selection in terms of the unobservables, then the OLS estimators are biased and Heckman's (1979) two-stage procedure provides a more commonly common remedy for this type of problem.

In the first stage, a probit model which captures the probability of having non-zero accidents in a workplace is estimated to compute the selection bias correction term. The selection equation can be expressed as:

$$\boldsymbol{y_i^*} = \propto_0 + \boldsymbol{z}_i{}' \propto_{1i} + \boldsymbol{ind}' \propto_{2i} + \epsilon_i \qquad [5.3]$$

where $\boldsymbol{y_i^*}$ is a latent (i.e. unobservable) continuous variable; if $\boldsymbol{y_i^*} > 0$ then $\boldsymbol{y}_i = 1$, and if $\boldsymbol{y_i^*} \leq 0$ then $\boldsymbol{y}_i = 0$; the disturbance term $\epsilon_i \sim N(0, \sigma^2)$ and $\boldsymbol{y_i^*} \sim N\left(\propto_0 + \boldsymbol{z}_i'^{\propto_{1i}} + \boldsymbol{ind}'^{\propto_{2i}}, \sigma^2\right)$. Thus, if the latent dependent variable equals or exceeds zero, firm *i* reports workplace accidents that have occurred. If not, firm *i* does not report accidents occurred. The continuous variable can be then replaced by a discrete dependent variable to yield an estimatable equation:

$$Prob(\boldsymbol{y}_i = 1) = Prob(\boldsymbol{y_i^*} \geq 0) = \propto_0 + \boldsymbol{z}_i{}' \propto_{1i} + \boldsymbol{ind}' \propto_{2i} + \epsilon_i \qquad [5.4]$$

Estimating the probit model will provides information of the variables that influence the probability of workplace injuries. The probit model as in equation [5.4] is estimated in the first stage to calculate the selection bias correction term or the inverse of the Mill's ratio, $\boldsymbol{\lambda}$, which could be defined as:

$$\lambda = \frac{\phi(\Gamma_i)}{\Phi(\Gamma_i)}$$

where $\phi(\Gamma_i)$ is the probability density function, $\Phi(\Gamma_i)$ is the cummulative distribution function, and $\Gamma_i = \propto_0 + \boldsymbol{z_i}' \propto_{1i} + \boldsymbol{ind}' \propto_{2i} + \epsilon_i$. This correction term is then added to form a corrected OLS regression equation of the following form:

$$ln\boldsymbol{wi}_i = \beta_0 + \boldsymbol{x}_i'\beta_{1i} + \boldsymbol{ind}'\beta_{2i} + \lambda i\beta_{3i} + \varpi_i \qquad [5.5]$$

In this Heckman two-stage framework, specifying the vector ***z*** is the most challenging task. The explanatory variables included in vector ***z*** should be those that exert influence on the probability of firms with injuries found in the data source but not the number of injuries reported. Unfortunately, reviewing the current literature on workplace injuries (as above) does not provide a straightforward guidance on which factors are likely to meet that requirement. In practice, resolving this identification problem could be constrained by data availability as finding variables that satisfy the above requirement is not always feasible.

In the above framework, the industry specific effects will be included in the vector of covariates (i.e. ***ind***). As the incidence of workplace injuries may vary substantially across industries due to different industry-specific characteristics, having the industry-fixed effects in the regression model captures potential industry specific differences. The estimate of each industry dummy is then interpreted relative to the base industry which is arbitrarily omitted. Given this consideration, this chapter will adapt the approach which is due to Haisken-DeNew and Schmidt (1997). This approach was already outlined in chapter four and is thus not explained here for brevity.

5.3.2 Data and Construction of Variables

As with the earlier chapters, the series of VESs conducted annually by GSO over the period 2001-2007 is used as the major data source for the current empirical analysis. It is noted that VESs only provide information on workplace injuries in four years within the period 2001-2007 (the section on workplace injuries was not included in the VES questionnaire in the VESs of the other years) but, as noted earlier, this is the only source of data available in Vietnam that could permit some empirical estimation specified in the current chapter. [41]

In the four years where data on injuries is available, the information is provided on both the number of injury cases (e.g. there could be more than one worker injured in a case) and the number of injured workers. As the latter is more informative in representing the level of risk at a workplace, this chapter will use the information on the number of injured workers reported to measure the prevalence of workplace injuries.[42] It should be noted that according to the definition of workplace injury employed in the VESs, only 'serious' injuries are included. This severity is defined in the survey as injuries leading to death or a wound to the body that requires medical treatment in one way or another. Other kinds of occupational diseases or minor accidents that do not lead to the above 'serious' injuries were not included in the questions. Bearing in mind this definition, table 5.5 provides information on the number of firms which were found with workplace injuries.

Table 5.5 Sample sizes of the manufacturing sectors, 2000-2006

Year	Number of manufacturing firms (1)	Number of firms with injuries (2)	% of total (3)=(2)/(1)
2002	8,866	281	3.2
2003	11,029	614	5.6
2005	15,534	661	4.3
2006	17,731	595	3.4

Source: calculations from VES 2002, 2003, 2005, and 2006 (for the data in the year 2001, 2002, 2004, and 2005)

[41] It should be noted that the MOLISA's dataset used in section 5.1.1 is given in aggregate terms in the Annual Workplace Accident Reports of the Labour Inspectorate of MOLISA (e.g., total number of injuries over times with some disaggregate figures at sectoral level). There is no firm-level data was available from this series and thus this data source is not suitable empirical estimation in this chapter.

[42] The number of workers injuired was also adjusted by the workforce size as dependent variable in the regression equation [5.2]. Further discussion on this experiment will be provided in sub-section 5.4.2.

The very low proportion of manufacturing firms that appears to have workplace injuries in the VESs warrants some caution in the use of these data. As noted earlier, there could be incentives for firms not to report workplace accidents to avoid the scrutiny of the authorities. If this happens, then it is unlikely to distinguish between firms those experienced no injuries and those who suffered from workplace injuries but chose not to report that information in the VESs. Given this is arguably the first empirical study on workplace injuries in Vietnam, using this dataset could be informative, though the shortcomings of the data are readily acknowledged. In addition, we would stress that although the injury levels reported are low, they are the most serious ones and thus clearly worthy of analysis in these terms alone. Further discussion on this issue will be provided in sub-section 5.4.1 below.

In addition to data on injuries, this chapter also utilizes other variables that capture firm-level characteristics. The selection of the explanatory variables in equation [5.2] is guided by the literature on workplace injuries (as in section 5.2) that attaches importance to characteristics of individual workers and the work environment as key determinants of workplace injuries. As data on individual characteristics of workers are not available from the VES dataset, this chapter employs the characteristics of the workplace environment as determinants of workplace injuries. The set of regressors used includes the two groups of variables as follows:

Firm-level characteristics include the size of firm, the age of establishment, the number of personal computers (PCs) per employees, the proportion of female employees out of total employment, and the proportion of workers with contracts. The selection of these variables are guided by the literature on workplace injuries (as above), such as Reilly *et al.* (1995), Shannon *et al.* (1997), or Fenn and Ashby (2004). The number of injuries might be expected to increase with the number of employees (i.e., size of the firm) and with the age of machines (and thus age of establishment). Level of technological advance or automation (and its proxy as number of PCs per employees) is likely to be negatively correlated with the number of workplace injuries. In the case of Vietnam, feminization (captured by the share of female employees) is expected to decrease with workplace injuries as high feminization is usually observed in labour-intensive light manufacturing such as garment or seafood processing where injury risk exposures might be low. The proportion of workers having work contract could be taken as compliance to labour market regulations. Therefore, a higher share of workers having work contracts might reflect firms which are more safety conscious, holding other things constant.

Other injury explaining variables include types of enterprise ownership, firm locations, and export orientation. Types of ownership might play an important role in determining workplace injuries in Vietnam. Earlier chapters have suggested that SOEs could perform systematically different from FIEs or DPEs. Therefore, a set of dummies for the type of ownership will be included in equation [5.2]. It could be expected that workplace injuries in SOEs could be lower than in FIE or DPEs. However, whether the work environment in the FIEs is riskier than that in DPEs is subject to empirical investigation. Given the geographical concentration of manufacturing activities (as highlighted in the previous chapters), it is likely that workplace injuries may also vary across different regions. Thus, the third set captures potential location effects, which are introduced through a set of regional dummies. The export orientation of the firm is controlled by inserting an exporter dummy into the workplace injuries equation in order to capture the potential effect of exporting on injuries. Finally, a set of two-digit industry dummies are also included in the specifications to capture inter-industry differences in injury levels. Summary statistics of these variables are given in table A5.2 of the Appendix.

5.4 Empirical Results

5.4.1 Some Specification Issues

As argued in section 5.3, there are some reasons to question whether there are some mechanisms that imply enterprises may 'select' to not report accidents. Though this possibility is purely speculative, it is important to explore whether this could be solved given the data available by finding relevant instruments to explain the potential selection process.[43]

Ideally, these variables should impact the probability of a firm with injuries occurring but not exert influences on the level of injuries occurring at the workplace. Finding these variables is however challenging given the content of the VESs and the nature of this issue. After several explorations with the data available, a set of five variables that might affect the probability of a firm having and/or reporting injuries, but not influencing the level of injuries, were constructed as follows:

First, a variable on whether firms contributed to social insurance, health insurance, and Trade Union fund is specified. This appears to be a poorly defined variable. But the VES questionnaires asked only one question of "whether the firm contributed for social insurance, health insurance, and Trade Union?" without separating between these types of contributions.[44] Therefore, it is not possible to identify these factors separately.[45] For this

---

[43] In fact, there might be four possible cases for a firm with respect to availability of data on workplace injuries. (i) The firm does not suffer from any injuries. (ii) The firm suffered from injuries but 'select' not to report – which is the issue of selection bias. (iii) The firm suffered from injury but decided to under-report – which an 'under-reporting' issue. And finally (iv) the firm suffered from injuries and report all information related. The current thesis does not deal with the 'under-reporting' issue. To the best of the author's knowledge, there are no convincing approaches or models to deal with 'under reporting' issues. This is therefore considered in the future research agenda and not covered in the current study. The discussion below is on the case (ii), where firms select not to report.

[44] In fact, the contribution to social insurance or pension (i.e '*bảo hiểm xã hội*' in Vietnamese language) is equal to 22 percent of the total wage bill (Article 92, Law on Social Insurance). Heath

variable, it is expected that firms that complied with these contributions might also be more likely to adhere to work safety regulations and thus are less likely to suffer from workplace injuries.

Second, a variable is constructed based on whether firms paid social insurance for their employees. This variable appears to be a variant of the above but it is actually not. The Law on Social Insurance (Article 92) stipulates that in the total of 22 percent of wage bill for social insurance, the employers are required to contribute 16 percent and employees six percent. In fact, firms might choose to pay (and are encouraged to do so) the whole 22 percent for social insurance, depending on their own practices. This variable then captures whether firms contributed that six percent for their employees or not (i.e., employees pay themselves that six percent contribution). It could thus be expected that firms that paid all the social insurance for employees are more caring about their employees and thus more conscious about work safety measures and thus less likely to incur injuries.

Third, there are additional three variables on the uses of internet, local network, and having a webpage – as a proxy for technological advancement at the work environment. It might be speculated that firms using either of these facilities are more conscious of the application of advanced tools and technologies and thus more conscious on issues relating to workplace safety.

It should be noted that the use of these variables is exploratory and the arguments for the use of these variables to exert impacts only on the probability of having non-zero rate of

insurance (i.e. '*bảo hiểm y tế*') contribution is regulated by Decree 62/2009/NĐ-CP dated 27/7/2009 of the Prime Minister, in which health insurance is equal to 4.5 percent of the total wage bill. The Law on Trade Union defines 2 percent of the total wage as Trade Union contribution (i.e. '*công đoàn phí*') by employers.

[45] This also prevents the current chapter from exploring the relationship between union density and workplace injuries – an area of intensive research in other countries in the literature on work safety (see Fenn and Ashby, 2004).

injuries occurring but not the level of injuries remain an explorative ones. Therefore, this exercise should be viewed as suggestive. Given this, the probit regression function as in the equation [5.4] is estimated using the set of these five identification variables in the first instance.

Using the probit estimates, the inverse of the Mill's ratio is calculated and subsequently inserted into equation [5.5] to correct for the potential selection bias. The results however suggest that, with exception of the year 2001, the estimated coefficients for the selection bias correction term are not statistically significant (see table A5.3 of the Appendix). Therefore, the existence of the potential selection bias is not conclusive for the data used in this study. Given the results, the usage of the framework given in [5.4] and [5.5] to correct for the potential selection bias is not pursued in this chapter.[46]

In further attempts to examine empirically the determinants of workplace injuries, the various types of count data models were also investigated. The nature of having excess zero in the data suggested that using either a Poisson or a Negative Binomial is not appropriate. Consequently, the ZIP and the ZINB models were used. One essential requirement of estimating these ZIP and ZINB models is to control for the process generating the excess zeros. This is essentially the same as what was required in modeling the selection process using the Heckman (1979) two-stage procedure. In other words, it is also necessary to identify the mechanisms generating excess zero in the samples.

[46] However, this might not necessarily mean that there is no selection process at work here. In this case, though, we are not able to draw conclusive inferences for two reasons. First, as noted earlier, it is not possible to determine from the VES data those who experienced non-zero injuries but choose not to report and those who actually experienced non-zero injuries. Second, the instruments used are constrained by data and may not be appropriate to the task at hand. In an attempt to further explore this issue, the above identifying variables are included in the set of injury-level explanatory variables in [5.2]. The OLS estimation results, not reported here for brevity, suggest that the estimates of these variables are statistically significant in nearly 40 percent of the total number of estimates. It implies that some of the identifying instruments also determine the injury level and hence are not relevant instruments to resolve the identification problem of the Heckman's two-stage procedure adopted in this chapter.

After several explorations, the ZIP and ZINB are not adopted in the current chapter for two reasons. Firstly, it is necessary to find a set of relevant identifying instruments that govern the process generating excess zero. To a certain extent, this requires identification of variables that determine this process of generating zero. As highlighted above, given the data used in the current research, it is unlikely to provide a satisfactory solution to this problem. Secondly, estimates obtained using this ZIP and ZINB models (which are reported in table A5.4 of the Appendix) are of the same signs compared to the OLS estimates (which are reported in table 5.5 below), suggesting similar relationship between the explanatory variables and injury levels. In terms of statistical significance, the results using the ZIP and ZINB models are similar to that of the OLS in about two-thirds of the cases. Therefore, it is not unreasonable to suggest that using the ZIP and ZINB models are no more informative than the OLS estimates. Therefore, the ZIP and ZINB models are not adopted in this chapter but the results were provided in table A5.4 of the Appendix.

Given these considerations in the context of data constraints, the empirical analysis of this chapter will largely focus on the probit estimates as in [5.4] in order to inform the factors that affect the probability of having injuries and use of the uncorrected OLS procedure as described in equation [5.2] to inform the determinants of workplace injuries.[47]

5.4.2 Empirical Results for the Determinants of Workplace Injuries

Determinants of Workplace Injuries: Probit Results

Although the original purpose of estimating the probit model in [5.4] is to test for the potential selection bias, this estimation is also useful to inform the determinants of the

[47] It is acknowledged that these specifications might not be most empirically plausible but given the data constraints and extensive trials with other alternative models (e.g. Heckman's (1979) two-stage procedure, count data models), these are likely the only empirical strategy option left for pursuing this current research on workplace injuries in Vietnam.

probabilities of having injuries occurring.[48] The estimated marginal effects of the above variables on the probability of having injuries occurring obtained from estimating equation [5.4] are reported in table 5.4. It should be noted that as the numbers of firms with injuries found in the VES sample available to this study are quite small (i.e., from three to six percent of the total sample as in table 5.3), the estimated marginal effects should be interpreted taking into account this feature. It is also noted that the Pseudo R^2 values are relatively high compared to standards of cross-sectional estimations suggesting that the explanatory variables used provide reasonably good fits to the data. In addition, as very small percentage of firms were found with injuries in the VESs (i.e. the probability of injuries occurring in the VESs is very small), most of the marginal effects reported below are quite modest.

In regard to the determinants of the probability of having injuries occurring, ownership is found to be a fairly important factor determining the risk of workplace injuries. Compared to FIEs, firms in the SOE sector are less likely to have injuries by between 0.3 to one percentage point; and firms in the DPE sector by an order of between 1.4 to 1.9 percentage point. This suggests that FIEs are most likely to experience injuries in the manufacturing sector. Dao *et al.* (2006) suggest that the FIEs in Vietnam have concentrated in some capital-intensive activities. It is likely that these capital-intensive activities require workplace safety procedures that could be relatively new for the Vietnamese workers. This provides a partial explanation for the higher probability of workplace injuries found in the foreign-invested firms compared to those in the SOE or domestic private sectors.

[48] Since it is not possible to identify which firms in the VESs fall into one of the four cases as outlined in footnote 41, the term ‘probability of having injuries occurring’ is used to express the probability of a firm having injuries found in the VESs regardless the nature of whether the firm select to under report or to correctly report workplace injuries incurred at its workplace.

Among other firm characteristics, firm size and age of establishment are positively associated with the probability of having injuries occurring. In 2002, for instance, a ten percent increase in the firm size exerts an increase by 0.15 of one percentage point in the probability of having injuries occurring, on average and *ceteris paribus*. For the other years, the same increase results in a lower probability of injuries by between 0.06 to 0.08 of one percentage point. This is in line with the view that larger establishments are more likely to be targeted by health and safety inspectors, and more likely to have their liability insurance premiums adjusted to reflect their safety records. The resulting incentive effects should make management more safety conscious in larger firms, holding other things constant (see Fenn and Asbhy, 2004 for a discussion). In addition to firm size, the age of establishment is found to positively affect the probability of having injuries occurring.

In contrast to the marginal effects of size and age, feminization is found to be an injury decreasing factor. On average and *ceteris paribus*, one percentage point increase in feminization (i.e. the proportion of female employees, given in fractional points, increases by 0.01) will reduce the probability of injuries occurring by between 0.01 to 0.03 of one percentage point, which is relatively small in terms of effects. The proportion of PCs per employees is found to be workplace safety enhancing in 2004 and 2005. But over the period under consideration, the impact of this variable on the probability of having injuries is inconclusive.

Table 5.4: Determinants of Injury Probabilities: Estimated Marginal Effects

	2001	**2002**	**2004**	**2005**
Types of ownership				
SOEs	-0.0029*	-0.0099***	-0.0016	-0.005***
	(0.001)	(0.002)	(0.001)	(0.001)
Domestic private enterprises	-0.0124***	-0.0191***	-0.0169***	-0.0157***
	(0.004)	(0.004)	(0.003)	(0.003)
Firm characteristics				
Firm size	0.0074***	0.0146***	0.0085***	0.0061***
	(0.001)	(0.001)	(0.001)	(0.001)
Proportion of female employees	-0.0157***	-0.0294***	-0.0176***	-0.0123***
	(0.004)	(0.005)	(0.003)	(0.002)

Proportion of employees with contract	*f*	0.0044	0.0021	0.0016
		(0.003)	(0.002)	(0.002)
PC per employees	0.0006	-0.0194	-0.0231***	-0.0099*
	(0.011)	(0.013)	(0.008)	(0.006)
Age of establishment	0.0002**	0.0003***	*f*	0.0002***
	(0.00)	(0.00)		(0.00)
Identification variables				
Employers paid insurance for employees	0.005***	0.0163***	0.0099***	0.0063***
	(0.002)	(0.003)	(0.002)	(0.001)
Employers make contribution for employees in terms of insurance/Trade Union fund	-0.0007	0.0043	0.0036**	0.004***
	(0.002)	(0.003)	(0.002)	(0.001)
Having website	0.0011	0.007**	0.0013	0.002*
	(0.002)	(0.004)	(0.002)	(0.001)
Having local computer network (LAN)	-0.0004	0.0013	0.0049***	0.0031***
	(0.001)	(0.002)	(0.002)	(0.001)
Having internet connection	0.0019	0.0039*	0.0023	0.0016
	(0.002)	(0.002)	(0.002)	(0.001)
Regional effects				
Red River Delta	0.0013	-0.0089***	-0.0005	-0.0035**
	(0.003)	(0.002)	(0.003)	(0.001)
North Central Coast	-0.0014	-0.0048	0.0021	0.0001
	(0.003)	(0.003)	(0.004)	(0.002)
South Central Coast	0.0032	-0.0074**	0.0027	0.0038
	(0.004)	(0.002)	(0.004)	(0.003)
Central Highlands	-0.0029	-0.008*	-0.0039	-0.0007
	(0.003)	(0.003)	(0.003)	(0.003)
Southeast	-0.002	-0.0085***	0.0024	-0.0023
	(0.002)	(0.002)	(0.003)	(0.001)
Mekong River Delta	-0.0079***	-0.0112***	0.0002	-0.0013
	(0.001)	(0.002)	(0.003)	(0.002)
Export orientation				
Exporter	*f*	0.0013	0.0018	-0.0038
		(0.002)	(0.001)	(0.002)
Industry fixed effects	yes	yes	Yes	yes
Pseudo R^2	0.2955	0.3358	0.3322	0.3230
No. of observations	8866	11029	15534	17730

Notes:

a) *f* denotes not applicable;
b) ***, **, and * refers to the variables of which the estimated coefficients are statistically significant at level of 0.01; 0.05; and 0.1 respectively;
c) The use of regional dummies are justified on the basis of the Chow test (the null hypothesis of pooling forms across regions is decisively accepted in all cases).
d) The use of industry dummies is also tested using the Chow test. Based on the F-test results, the null hypothesis of the pooling model was rejected in one year (i.e. 2002) out of the four years.
e) Robust standard errors are reported in parentheses.

With respect to the marginal effects of the potential identification variables, the estimated effect of whether employers paid social insurance for employees (this is the six percent of the wage bill that firms are not required to pay - see above) is the only well determined effect in all the four years under consideration. It is expected that firms that choose to pay social insurance for their employees are more conscious of workplace safety and thus more likely to report workplace injuries occurred in their factories. In fact, the results suggest that a firm that paid social insurance for their employees are more likely to experience a higher risk of injuries of between one-half to 1.5 of one percentage point. Similarly, the estimated effect for whether firms contribute to social insurance payments, health insurance, and Trade Union on workplace injuries also suggests the same effect in terms of sign but with smaller magnitude.

Determinants of Workplace Injuries: OLS Results

Table 5.5 reports the coefficient estimates obtained using the uncorrected OLS method for the sub-sample of firms reporting injuries. As discussed in sub-section 5.3.2, number of workers injured (given in natural logarithm) is used as the dependent variable. In addition to the injury explaining variables, a set of dummies for different manufacturing sub-sectors is used to control for industry-level characteristics that may have effects on workplace injuries but cannot be captured by the set of firm-level characteristics. Before embarking on the interpretation of the estimated results, it should be noted that although the reported goodness-of-fit measures are satisfactory in all years under consideration, not all the estimated coefficients are statistically significant from zero at conventional significance levels. When the estimated coefficients are statistically significant, the signs are consistent across the probit (as above) and the OLS results. In addition, as some variables are not available across all the years under consideration, some caution is thus required when comparing the empirical results over time.

It is first notable that ownership is revealed to be a very important determinant of the number of workplace injuries in the Vietnamese manufacturing sector. In particular, SOEs and DPEs are, on average and *ceteris paribus*, found to have less workplace injuries than FIEs. Compared to FIEs as the base, SOEs are found with less injuries by between 32 to 46 percent in the period 2001-2005. The impact of being an SOE decreased by ten percentage points in this period but this decline, however, is not found to be statistically significant. This is a very strong impact of ownership on workplace injuries with state ownership reducing injuries. This might reflect the root of the former centrally planned economy when welfare of employees were emphasized, and thus employees were subject to several non-wage benefits such as having healthcare facilities, kindergartens and schools for children, though these benefits have steadily disappeared with the increased emphasis on market reform (see Pham and Reilly, 2007)

Table 5.5: Determinants of Workplace Injuries, 2001-2005

	2001	2002	2004	2005
Types of ownership				
SOEs	-0.4454**	-0.3917***	-0.5902***	-0.6123***
	(0.191)	(0.129)	(0.132)	(0.131)
Domestic private enterprises	-0.2845	-0.0055	-0.3152**	-0.268**
	(0.243)	(0.129)	(0.125)	(0.13)
Firm characteristics				
Firm size	0.5025***	0.5231***	0.5371***	0.4900***
	(0.062)	(0.045)	(0.038)	(0.041)
Proportion of female employees	-0.7282*	0.0946	-0.1307	-0.6830***
	(0.43)	(0.238)	(0.249)	(0.208)
Proportion of employees with contract	*f*	0.0359	0.114	0.2429
		(0.188)	(0.17)	(0.201)
PC per employees	-1.3266	-0.1691	-0.175	-0.8678
	(1.464)	(0.655)	(0.774)	(0.628)
Age of establishment	0.0066	-0.004	*f*	-0.0048
	(0.006)	(0.004)		(0.004)
Regional effects				
Red River Delta	-0.3265	-0.0735	-0.0453	0.0755
	(0.205)	(0.13)	(0.152)	(0.155)
North Central Coast	-0.1889	0.0119	-0.0073	0.1285
	(0.305)	(0.172)	(0.23)	(0.263)
South Central Coast	-0.0433	0.0561	0.1633	0.3121*
	(0.245)	(0.18)	(0.2)	(0.186)
Central Highlands	-1.0009***	-0.0181	-0.2131	0.3639
	(0.313)	(0.241)	(0.283)	(0.346)
Southeast	0.2135	0.4102***	0.5219***	0.5207***
	(0.2)	(0.137)	(0.155)	(0.155)
Mekong River Delta	0.5605	-0.0006	0.0931	0.2655
	(0.616)	(0.252)	(0.212)	(0.204)
Export orientation				
Exporter	*f*	0.1358	-0.2424**	-0.0438
		(0.099)	(0.101)	(0.104)
Constant term	-1.0487**	-1.8834***	-1.9484***	-1.4842***

	(0.46)	(0.33)	(0.313)	(0.31)
R^2	0.421	0.3956	0.3917	0.4112
No. of observations	281	614	661	595

Notes:

a) *f* denotes not applicable;
b) ***, **, and * refers to the variables of which the estimated coefficients are statistically significant at level of 0.01; 0.05; and 0.1 respectively;
c) Breusch-Pagan/Cook-Weisberg test for heteroscedasticity is adopted in this specification. The test results decisively reject the null hypothesis of homoskedascity in all cases. Therefore, Huber (1967) corrected standard errors are used and reported in parentheses;
d) Industry dummies are included but not reported here for brevity;

Regarding the DPE sector, the estimates are different from what is commonly anticipated as DPEs are assumed generally to be the dominant sector causing workplace injuries. Although the DPE sector experienced impressive growth in terms of the number of establishments, output contribution and employment creation, they are found to have less injuries in comparison to FIEs, on average and *ceteris paribus*, in 2004 and 2005 (when the estimated effects are statistically significant). In particular, compared to FIEs as the base, DPEs are found to have less injuries than FIEs by between 24 to 27 percent in these two years. The results generally suggest that FIEs experienced more injuries than domestic firms. Combined with the findings reported in the previous chapters, it could be suggested that the FDI sector has performed worst in terms of both technical efficiency and workplace safety.[49] Pham *et al.* (2009) investigate the determinants of industrial pollution using the same series of the VESs. Their findings suggest that FIEs in the manufacturing sector are also more polluting than SOEs. Together, this represents a surprising finding given the common understanding that the FIE sector, with its more advanced technologies and managerial skills (see Dao *et al*. 2006), is generally assumed to out-perform their domestic counterparts in regard to these types of outcome.

[49] Given the importance of the ownership effect on workplace injuries, it is important to examine whether ownership might also have an impact on workplace injuries though other variables. In other words, the test for whether it is statistically plausible to pool firms across types of ownership in the regression equation [5.5]. A Chow test is then performed and the test results suggested that the null hypothesis of pooling model is not rejected in three out of four years.

Attention now turns to the other determinants of workplace injuries. There is a positive and relatively strong relationship between the size of enterprise and injuries and this relationship is statistically significant over time. On average and *ceteris paribus*, a ten percent increase of the firm size will increase the level of injuries by nearly five percent. This strong impact of firm size on workplace injuries was observed across all the years under consideration. This positive relationship is understandable as firm size is measured here by the number of employees. Therefore, a larger size is likely to be transmitted into higher level of injuries at the workplace. The strong impact of firm size on workplace injuries in Vietnam is also observed in the literature. For instance, Fenn and Ashby (2004) reported that double the firm size is associated with 33 percent reduction in the risk of reported injuries in the UK. Askenazy (2006) using the data on the French private sector reported that compared to small firms (having from 1-50 workers), larger firms are exposed to between a 35 to 87 percent increase in the risk of injuries. Unfortunately, the literature on workplace injuries in transitional economies has not been subject to intensive research to date so comparison to the experiences of such economies is not feasible in this chapter.[50]

The literature on workplace injuries suggests a gender dimension in injury determination in favour of firms or industries with a high feminization rate. Hersch (1998) reported a ratio of 0.65 between the female rate of workplace injuries and illness and the male rate in the US private sector. Forastieri (2000) reviews a number of forces making the process of workplace injury determination different across the two gender groups. In the case of Vietnam's manufacturing sector, table 5.5 reports a negative and fairly strong relationship

[50] To examine further the relationship between firm size and injuries, the dependent variables in [5.5] are adjusted for firm size and converted into average injuries per employees. This dependent variable is then regressed on the set of injury determining variables as used in obtaining the OLS estimates reported in table 5.5 (except the firm size variable is dropped). The results generally suggest the effects of the injury-determining variables are the same sign compared to those reported in table 5.5. The estimates from this exercise is not reported here for brevity but provided in table A5.5 of the Appendix.

between ‘feminization’ and injuries. On average and *ceteris paribus*, a one percentage point increase in the incidence of female employees (which is given in factional points) induces a *ceteris paribus* decline in the average level of injuries by approximately 0.7 percent (in 2001 and 2005 when the estimated effects of this variable are statistically significant) at a conventional level. This might reflect a better compliance and work safety consciousness of female workers at workplace compared to male counterparts.

The proportion of employees with a work contract, which is used as a proxy for a firm’s compliance with labour market regulations, is reported to have no effect on workplace injuries as the estimated coefficients of this variable are not statistically significant for all the years. This is in contrast to the expectation that firms which comply with the Labour Code might invest in workplace safety procedures to ensure a safe and decent work environment for workers. It was expected that firms with more advanced technologies (as being a proxy by firms with higher usage of PCs), would exert a positive effect on workplace safety. However, most of the estimates are not statistically significant, though all the point estimates are negative. In the three years for which information on the age of the establishment is available, the estimated effect of this factor is statistically insignificant. Therefore, as with the proportion of PCs per employees, the impact of the age of the establishment exerts no influence on workplace safety.

There seems to be little regional variation in firm-level injuries. Almost all the estimated coefficients for the regional dummies are not statistically significant, except for the Southeast where a positive impact is detected. Compared to the Northern Uplands (the base category), firms located in the Southeast (including HCMC and Dongnai), on average and *ceteris paribus*, are found to record higher rate of injuries of between 51 to 68 percent – which represents a very strong effect of being in the Southeast, compared to that of other regions relative to the Northern Uplands. This difference is however not statistically significant over time, suggesting that the impact of the Southeast remains stable. It should be noted that the Southeast accounts for around 40 percent of manufacturing firms and this has been the most dynamic economic cluster within the country. Manufacturing firms located in the Southeast are found to be the most technically efficient in the previous chapter. Moreover, among the five provinces reporting high rates of injury cases (as in section 5.2), there are Dongnai and HCMC located in the Southeast region.

In the above analysis, the regional effects were analyzed relative to the arbitrarily omitted Northern Upland region. Although this provides some insights on the regional differences in comparison to the omitted region, it does not allow inferences on regional deviations relative to the national average level. Therefore, this chapter adopts the approach used by Haisken-DeNew and Schmidt (1997) as used in chapter 4 to estimate the workplace injury effects for the different regions. These workplace injury effects are interpreted as the injury level that a firm in a specific region encountered due to its affiliation to that region relative to the national 'average' firm in the manufacturing sector. The estimates using this method are reported in table 5.6 below.

Table 5.6: Workplace Injury Differentials, 2001-2005

	2001	**2002**	**2004**	**2005**
Northern Uplands	-0.1242	-0.1733*	-0.2703**	-0.3457***
	(0.184)	(0.105)	(0.13)	(0.121)
Red River Delta	-0.2809**	-0.1414**	-0.2364***	-0.1728**
	(0.114)	(0.072)	(0.067)	(0.077)
North Central Coast	-0.2627	-0.19	-0.3167*	-0.1785
	(0.248)	(0.137)	(0.18)	(0.232)
South Central Coast	-0.0264	-0.1084	-0.0522	0.0041
	(0.175)	(0.143)	(0.141)	(0.128)
Central Highlands	-0.8721***	-0.0676	-0.3006	0.0607
	(0.311)	(0.18)	(0.233)	(0.354)
Southeast	0.1779	0.2132***	0.2899***	0.2128***
	(0.114)	(0.057)	(0.055)	(0.055)
Mekong River Delta	0.3278	-0.2067	-0.1641	-0.16
	(0.515)	(0.212)	(0.16)	(0.164)
Overall variability	0.1293	0.1487	0.2342	0.1623

Notes:

a) ***, **, and * denotes statistically significant at the 0.01, 0.05 and 0.1 levels respectively;
b) Standard errors reported in parentheses and the overall variability are calculated as per Haisken-DeNew and Schmidt (1997).

Instead of interpreting the regional effects relative to the base, the differentials reported in table 5.6 now represent the regional variations from the overall weighted-average level of workplace injuries of the whole manufacturing sector. Particularly, manufacturing firms located in the Northern Uplands and the Red River Delta experienced lower levels of injuries than the weighted average level of the manufacturing sector. In contrast, the Southeast experienced the largest positive differential, which implies that the Southeast is the region with the highest injury risk at workplace compared to the national average level. It is important to note that these differences are obtained after controlling for observed firm characteristics. Therefore, such differences are considered as '*ceteris paribus'* for those manufacturing firms that are located in the regions.[51]

Results reported in table 5.5 are obtained by estimating expression [5.2] and controlling for the industry effects by including a set of dummies for the manufacturing sub-sectors that are classified according to the two-digit ISIC classification. This inclusion of this set of industry controls is motivated by the fact that these dummies capture potential effects on injuries of affiliation to different manufacturing sub-sectors. In implementing the estimation procedure, one industry was arbitrarily omitted and the industry effects are then interpreted relative to this arbitrary base. In order to avoid this, the approach used by Haisken-DeNew and Schmidt (1997) is also adapted to estimate the industry workplace injury differentials. Results are reported in table 5.7 and should be interpreted as the workplace injury level that a firm in a specific sector achieved relative to the 'average' firm within the whole manufacturing sector.[52]

[51] In order to examine the separate locations of Hanoi and HCMC with respect to the weighted average injury level, these two cities are separated from the Red River Delta and Southeast, respectively. Results reveal that without HCMC, there is level of injuries is still highest in the Southeast. HCMC as a single category experienced the second highest level of workplace risk in the country. For the Red River Delta, the estimates for this region are statistically insignificant in most of the cases through the estimates remain negative as above.

[52] This is however should be considered as an explorative exercise given the small sample sizes experienced in this analysis.

Unfortunately, few estimated differentials are found to be statistically significant and drawing a consistent story from these estimates is thus not straightforward. One possible explanation is that the estimates were made from small sample sizes (see table 5.3), especially for 2001. However, some inferences could be offered from the estimated differentials that are statistically significant. First, firms in the agricultural resource-intensive category exhibit a lower level of injuries than the 'average' firm. Second, in the capital-intensive group, the metal product sub-sector exhibits a high workplace injuries (with the differential of the order of between 23 to 50 percent), while coke and refined petroleum products experience the lowest differential from the weighted average injury level. Regarding the machinery and technology-intensive sub-sectors, only the estimates on other transport equipment sub-sector is statistically significant in most of the years under consideration. This industry exhibits an injury differential that is between 32 to 39 percent higher than the weighted average of the whole manufacturing sector. The last row of table 5.7 reveals the overall variability. The figures suggests that there is limited variability in the workplace injuries across the manufacturing sector in the period 2001-2005 and that the incidence of injuries appears fairly homogeneous across the manufacturing sector.

Table 5.7: Workplace Injuries Effects for the Manufacturing Sub-Sectors

	2001	**2002**	**2004**	**2005**
Agricultural resource-intensive				
15. Food and beverages	-0.0733	-0.0745	-0.3007***	-0.2215**
	(0.138)	(0.1)	(0.104)	(0.11)
Labour-intensive production				
17. Textiles	0.1034	0.0639	0.2415	0.2301
	(0.202)	(0.151)	(0.167)	(0.171)
18. Wearing apparel	0.2548	-0.1867	0.0027	0.1868
	(0.308)	(0.249)	(0.194)	(0.198)
19. Leather tanning and processing	0.4526	-0.2918	-0.1026	0.3143
	(0.499)	(0.238)	(0.235)	(0.222)
20. Wood and wood products	0.3526	0.277*	0.2345	0.0055
	(0.351)	(0.16)	(0.166)	(0.22)
36. Furniture	0.2294	-0.0963	0.219	0.2158
	(0.22)	(0.156)	(0.138)	(0.14)
Capital-intensive production				

16. Tobacco products	-1.1008	-1.0932***	-0.7407	-1.6035
	(0.854)	(0.261)	(0.461)	(0.43)
21. Paper and paper products	-0.6248***	-0.2786	-0.2743**	0.0831
	(0.168)	(0.14)	(0.129)	(0.124)
22. Publishing and printing	0.4403**	0.1373	-0.1212	-0.1528
	(0.212)	(0.197)	(0.275)	(0.216)
23. Coke, refined petroleum products	-0.6352**	-0.2998*	-0.1958	-0.6027***
	(0.259)	(0.157)	(0.142)	(0.21)
24. Chemicals and chemical products	-0.0069	-0.1524	-0.0457	-0.2966**
	(0.237)	(0.133)	(0.123)	(0.124)
25. Rubber and plastic products	-0.3287	-0.0561	-0.0799	-0.0876
	(0.203)	(0.116)	(0.139)	(0.135)
26. Non-metallic mineral products	0.2089	0.2662*	0.0949	-0.0077
	(0.236)	(0.154)	(0.183)	(0.207)
27. Basic metal products	0.1551	0.4992***	0.2249*	0.2362**
	(0.202)	(0.141)	(0.135)	(0.115)
28. Fabricated metal products	-0.6248***	-0.2786	-0.2743**	0.0831
	(0.168)	(0.14)	(0.129)	(0.124)
Machinery & technology-intensive goods				
29. Machinery and equipment	-0.0071	0.1759	0.3051	0.4795
	(0.239)	(0.167)	(0.191)	(0.504)
30. Office, accounting and computing machinery	-0.8997	-1.0052	0.408	0.543***
	(0.204)	(0.15)	(0.675)	(0.142)
31. Electrical machinery and apparatus	-0.153	-0.0145	0.0095	0.0057
	(0.301)	(0.179)	(0.209)	(0.209)
32. Television and communication equipment	0.1093	-0.1908	0.305	-0.5998***
	(0.225)	(0.319)	(0.511)	(0.207)
33. Medical and optical instruments, watches	0.3134	0.0876	*f*	-0.5252*
	(0.223)	(0.219)		(0.301)
34. Motor vehicles	0.0771	0.0316	0.0435	0.1434
	(0.339)	(0.205)	(0.206)	(0.194)
35. Other transport equipment	0.2465	0.3161**	0.3844**	0.3191*
	(0.201)	(0.152)	(0.193)	(0.186)
Overall variability	0.1712	0.1656	0.1366	0.186

Notes:

a) See notes in table 5.6
b) Two-digit numbers before the name of sub-sectors are according to the classification of the two-digit ISIC.
c) This classification of these sub-sectors according to different groups according to factor intensity is in line with those in the previous chapters.

A note on workplace injuries and trade reforms

This sub-section explores the potential link between the trade reforms and workplace injuries in the manufacturing sector of Vietnam. Given the country's trade regime has become more liberalized (see section 4.1 of chapter 4), the hypothesis under test is whether greater openness exerts a negative effect on workplace injuries. This negative effect could be diminishing over time as domestic firms grow under competition and learn from their foreign counterparts. But given the data timeframe available for this study, only the potential short-term effect of trade reforms on workplace injuries is subject to investigation. Before undertaking some empirical analysis, data on injuries and tariff as a proxy for trade reforms are plotted to provide some visual insights. The plots, given in figure A5.1 in the Appendix, do not suggest a clear association between these two factors.

The potential link is then captured by including a dummy for whether or not the enterprise is an exporter to investigate possible effects of a firm's export orientation on workplace injuries. The estimated coefficient on this variable is given in table 5.5. The estimates for the different years provide an inconclusive answer regarding the relationship between export orientation and workplace injuries. In three out of the four years under consideration in which data on export orientation is available, only the estimate for 2004 is found to be statistically significant. In this year, the result exhibits a significant effect of exporting on the estimated level of workplace injuries. On average and *ceteris paribus*, exporting firms experience about a 22 percent lower level of injuries compared to other non-exporting firms. Although the evidence from this year suggests that export orientation might enhance workplace safety, this is just one single year over the period under consideration. Thus the nature of the relationship is not conclusively determined and should not be interpreted as a robust finding.

In another attempt to explore the potential relationship between trade reforms and workplace injuries, a tariff variable (expressed in fractional points) is added to the set of injury explaining variables. To allow for meaningful variations in the tariff variable, the weighted average tariff rates constructed for the manufacturing sub-sectors that are defined according to the three-digit ISIC classification (as used in chapter 4) are employed.[53] As there is only one tariff rate for each sub-sector, the set of industry dummies used in the above analysis is dropped from this model.[54] The findings reported in table 5.8 is however inconclusive.[55] With respect to the tariff variable, the estimated effects are not statistically significant in three out of the four years under consideration. In 2002, where the estimate is statistically significant, the result suggests that, on average and *ceteris paribus*, a ten percent reduction in the average tariff rate would increase the reported injuries by nearly four percent. However, as this effect is only observed in 2002, the relationship between the tariff variable and injury remains ambiguous for the manufacturing sector of Vietnam.[56] In other words, a robust or convincing empirical link between trade reforms and workplace injuries is not detected in this study.

Table 5.8: Trade Openness and Firm-Level Workplace Injuries

	2001	**2002**	**2004**	**2005**
<u>*Types of ownership*</u>				
SOEs	-0.5624***	-0.4524***	-0.6811***	-0.6921***
	(0.182)	(0.127)	(0.123)	(0.13)
Domestic private enterprises	-0.2927	-0.0909	-0.3523***	-0.2572**
	(0.227)	(0.125)	(0.12)	(0.13)
<u>*Firm characteristics*</u>				
Firm size	0.4959***	0.5062***	0.5317***	0.5122***
	(0.057)	(0.042)	(0.037)	(0.039)
Proportion of female employees	-0.5832	-0.1931	-0.2919	-0.6925***
	(0.365)	(0.208)	(0.21)	(0.18)

[53] Similar to the discussion provided in chapter 4, it is important to note that the tariff could be used as a proxy for trade reform but this does not capture other reform measures in terms of non-tariff barriers – which were reported to be strong and important in the context of Vietnam.

[54] This is because for one industry, there is only one average tariff level. For instance, sector 152 (which is the manufacturing of footware in the UN's ISIC) was subject to the average tariff of 17.01% (using the UNCTAD-TRAINS database – as explained in chapter 2 of the submitted thesis) in 2005. Therefore, there is a perfect collinearity problem here if both the tariff and the industry dummies are included in the regression models. In such circumstances, the industry dummies are excluded from this estimation.

[55] In the interest of brevity, this sub-section will only focus on the trade variables (i.e. export orientation and the tariff rates). It is however important to emphasize that the estimated coefficients for other variables are essentially the same as those reported in table 5.5.

[56] One could argue that exporter dummy or tariff could be poor measure of trade openness and thus other trade openness variables should be experimented. In this direction, this chapter also replaced the tariff variable by the other trade measures as constructed in chapter 4, including lagged tariff, export ratio, and import penetration. However, this exercise does not improve the results compared to what reported in table 5.5 and table 5.7 above.

Proportion of employees with contract	*f*	-0.0019	0.1339	0.1345
		(0.177)	(0.17)	(0.195)
PC per employees	-2.0956	-0.6335	-0.5056	-1.3712**
	(1.395)	(0.682)	(0.769)	(0.602)
Age of establishment	0.0049	-0.0044	*f*	-0.0058
	(0.006)	(0.004)		(0.004)
Regional effects				
Red River Delta	-0.1567	0.0319	0.0339	0.1838
	(0.196)	(0.122)	(0.15)	(0.151)
North Central Coast	-0.1385	-0.0167	-0.0463	0.1712
	(0.294)	(0.166)	(0.222)	(0.266)
South Central Coast	0.0978	0.0649	0.2181	0.3656**
	(0.232)	(0.175)	(0.192)	(0.177)
Central Highlands	-0.7479**	0.1057	-0.0303	0.4193
	(0.352)	(0.204)	(0.266)	(0.375)
Southeast	0.3021	0.3865***	0.5603***	0.5743***
	(0.201)	(0.128)	(0.152)	(0.146)
Mekong River Delta	0.452	-0.0333	0.1063	0.1948
	(0.612)	(0.254)	(0.213)	(0.213)
Export orientation, trade protection				
Exporter	*f*	0.1602*	-0.1921**	-0.0375
		(0.095)	(0.097)	(0.104)
Tariff	0.0338	-0.4129*	-0.1427	-0.0025
	(0.476)	(0.247)	(0.285)	(0.341)
Constant term	-0.9822***	-1.4207***	-1.5240***	-1.2500***
	(0.363)	(0.297)	(0.28)	(0.29)
R^2	0.3685	0.3636	0.3635	0.3668
No. of observations	281	614	617	595

Notes:

a) *f* denotes not applicable;
b) ***, **, and * refers to the variables of which the estimated coefficients are statistically significant at level of 0.01; 0.05; and 0.1 respectively;
c) Breusch-Pagan/Cook-Weisberg test for heteroscedasticity is adopted in this specification. The test results decisively reject the null hypothesis of homoskedascity in all cases. Therefore, Huber (1967) corrected standard errors are used and reported in parentheses;

5.5 Conclusions

The rapid manufacturing growth recorded during the *Doi moi* era has been central for the recent achievements in economic growth in Vietnam. There has, however, been concerns on whether bad working conditions and a low awareness of occupational health and workplace safety are also consequences of the country's industrial growth and increasing trade openness. Like other developing countries, the issues of labour standards, in general, and occupational health and workplace safety, in particular, have not been considered as key priorities on the development agenda in Vietnam. Although a legal background for workplace safety has gradually evolved, the lack of clear guidelines on reporting work-related injuries, as well as compliance supervision is noteworthy. Consequently, the compliance by enterprises to these limited legal guidelines placed on workplace safety is relatively poor.

In this context, data on workplace injuries is very limited and this chapter represents arguably the first empirical study on the determinants of workplace injuries in the manufacturing sector of Vietnam. Using data available on workplace injuries, the paper shows an increasing tendency, albeit unstable across time, of work accidents during the 1990s. Hanoi, Quangninh, Haiphong (in the North), Danang (in the Central), Dongnai and HCMC (in the South) are reported as the places of highest level of workplace injuries. These six provinces accounted for nearly a half of the total industrial output and around one-third of reported workplace accidents in the period 1996-2007. FIEs account for an increasing share of the total injury cases reported to the authorities.

In attempts to explain the determinants of workplace injuries in the manufacturing sector, this chapter experimented with a number of different econometric approaches, including a simple OLS procedure, the Heckman (1979) two-stage procedure, the count data models (particularly, Zero-Inflated Poisson, and the Zero-Inflated Negative Binomial). However, after performing several experiments in estimating these alternative models, the three latter approaches were not employed mainly due to data constraints and the absence of good instruments. Therefore, this chapter adopted a probit model to inform the determinants of the probability of reported injuries, and uncorrected OLS to inform the determinants of the level of injury as the empirical strategy for its analysis. In this regard, this chapter should best be considered as an exploratory exercise and the results treated as suggestive rather than compelling. Further and more satisfactory investigation of workplace injuries is best considered in future research agenda, when data permitting.

However, the empirical results do provide some evidence on the determinants of workplace injuries. Interestingly, FIEs are reported to perform worse in terms of ensuring work safety. Combined with the results from a previous chapter and other studies, this chapter documents a challenge in our understanding of the impacts of FDI as the FIEs are shown to be the poorest performers in terms of technical efficiency, compliance with environmental standards (as Dao *et al.*, 2006) and workplace safety. The study also finds, not surprisingly, a strong and positive relationship between firm size and workplace injuries. In addition, being in the Southeast, especially in HCMC, exerts a negative *ceteris paribus* impact on workplace injuries in the manufacturing sector.

This chapter also explored the potential linkage between trade openness and workplace safety using different measures for trade exposure. Unfortunately, these experiments did not provide any conclusive evidence as the estimated effects of these trade variables were found to be poorly determined. In generally, there is little evidence suggesting a negative relationship between increasing trade openness, export orientation and workplace injuries. In this context, one implication that could be drawn from the findings is that data collection on workplace injury needs to be improved urgently in order to provide a better background and framework for understanding the determinants of workplace injury. The experience of Vietnam in moving from a centrally planned economy to a market one has probably had important impacts on workplace safety practices and applications. For the rights and benefits of workers, especially given the ongoing debate on the ‘race to the bottom’ or ‘social dumping’, further research on the determinants of workplace injuries and the potential impacts of trade reforms on workplace safety is clearly required.

Conclusions

This thesis investigated Vietnam's manufacturing sector during the period 2000-2006. The main focuses were on technical efficiency, determinants of technical efficiency, and determinants of workplace injuries. This represents arguably the most comprehensive and in-depth empirical analysis on the manufacturing sector of Vietnam in the post *Doi moi* era. The key conclusions of the thesis are as follow:

(a) The manufacturing sector has become an increasingly important sector in the recent economic growth of Vietnam. By the end of the period under consideration, the sector accounted for nearly 42 percent of GDP and a half of total exports. The sector is however relatively technically inefficient. On average, Vietnamese manufacturing firms are operating at 62 percent of their technical efficiency frontier. There is also a large deviation of about 16 percentage points around the average technical efficiency.

(b) There has been vigorous transformation of the manufacturing sector, which was marked by a diminishing role of SOEs, and increasing importance of the private sector as well as the foreign-invested sector. During the period 2000-2006, the share of SOEs in total manufacturing output decreased from nearly 40 percent to around 26 percent. This is partly attributed to the SOE reform agenda, which has been accelerated since the late 1990s. However, SOEs tend to outperform DPEs and FIEs in technical performance. Differences in technical efficiency favour the SOEs but, using quantile regression techniques, are found to be decreasing with movement from the least technically efficient to the most technical efficient firms. Interestingly, the thesis reported the FIE sector is the worst performer in terms of technical efficiency and workplace safety, the DPE sector ranked second, and the SOE sector is found to be the 'champion' in these two important respects.

(c) Trade reforms towards more liberalized trade regime in Vietnam have exerted a positive, albeit modest, effect on technical performance in the manufacturing sector. It is also found that the trade effect of technical performance tends to decrease with the movement up the conditional distribution of technical efficiency. It could be taken to suggest that trade liberalization could be most beneficial for the least technically efficient firms. The finding represents additional evidence to support a positive linkage between trade liberalization and firm performance in the current literature on the impact of trade liberalization on firm performance in a developing country context.

(d) With the recent growth of the manufacturing sector, workplace injuries are becoming a concern and there is generally an increasing tendency towards the occurrence of workplace injuries. However, Vietnam lacks effective legal regulations on workplace safety and statistics on work accidents are very poor. Using the data available to the current research, the thesis highlights some firm-level characteristics that exert influence on the probability and level of workplace injuries reported. Among a number of factors, types of ownership, firm size are important determinants of workplace injuries. Unfortunately, data constraints represent the main obstacles to providing further inferences on the determination process governing workplace injuries.

Based on these findings, the thesis suggests the following recommendations:

(i) Given the current technical performance of the manufacturing sector, there is room for improvements, which will enhance substantially the contribution of the sector to the country's economic growth. Supporting the youthful establishment is clearly an area of priority. Continuing the current SOE reform agenda might enhance the average level of technical efficiency in the manufacturing sector. However, given the SOE sector now accounts for less than one-fourth of the total output, enhancing technical performance of the FIE sector appears even more important for enhancing the overall technical efficiency of the manufacturing sector.

(ii) The recent WTO accession and Vietnam's continued commitment to trade liberalization could provide further incentives for Vietnamese manufacturing firms to improve their efficiency, especially for the least technically efficient firms. This provides further support for the trade liberalization process. One consequence of a more liberalized trade regime is of its inherent attractiveness to and a magnet for FDI. However, the experience of the manufacturing sector suggests that foreign-invested firms, through having a number of advantages over their domestic counterparts, perform technically worst. This implies that policies designed to attract FDI flows could consider taking into account their relatively poor performance to date and be more selective in the type of FDI activity encouraged to locate in Vietnam.

(iii) While workplace injuries have become an increasing policy concern, enforcement of legal regulations and guidelines on workplace injuries seems to be very poor. Consequently, the current understanding on workplace injuries in the manufacturing sector is limited, which prevents effective policy interventions to ensure better and safer work environment for workers in manufacturing firms. Reporting system on workplace injuries should firstly be enhanced to provide better statistics on workplace injuries. More importantly, awareness of workplace safety should be in place in order to ensure that work accidents will be properly reported and handled for the benefits of workers.

Finally, there are also some areas that are not examined in this thesis and should be considered as part of a future research agenda. These include the following directions:

(1) Given the importance of the manufacturing sector in Vietnam, analyzing technical efficiency using other estimation methods could be useful in informing a better picture of the technical performance of manufacturing firms. This thesis adopts the

stochastic frontier approach to estimate technical efficiency. It might also be useful to experiment with DEA or deterministic (i.e. full frontier) approaches to calculate/estimate technical efficiency of the manufacturing sector and see how robust are the results obtained in this thesis. In addition, other measures of efficiency, such as allocative efficiency, economic efficiency, productivity could also be investigated in the future research agenda.

(2) One potential area of interest is to investigate the ‘learning from exporting’ effect. The thesis reported a positive association between export orientation and technical performance but further attempts to determine causal effect is not possible due to data constraints. As export promotion has been an important part of the country’s economic growth, investigating whether potential ‘learning from exporting’ effects are present or not will be useful for a better understanding of the impacts of export promotion in Vietnam.

(3) This thesis represents arguably the first study to examine empirically the determinants of workplace injuries reported in the manufacturing sector. Through results from these attempts are not as satisfactory as expected due to data and other constraints, the current research could be considered as a benchmark for further studies on workplace safety in Vietnam. If data collection on workplace injuries is improved, there is certainly room for sound research on this important issue.

(4) In addition, there are a number of issues that could be better informed if there are improvements in data availability and data quality. For instance, examining the dynamics of technical efficiency over time should be better informed if an adequate panel could be constructed across time. If data on cost structures of manufacturing firms are available, the issue of allocative efficiency could then be explored to better inform the efficiency of the manufacturing sector (both technical efficiency and allocative efficiency). Exploring

the determinants of technical efficiency across sectors is also another potential research area.

Despite these limitations, the thesis represents an important step towards a better understanding of the manufacturing sector in Vietnam. The thesis substantially augments previous studies on the country's manufacturing sector during an important period of the *Doi moi*. In terms of methodologies, the thesis is among a few studies that perform an extensive set of statistical tests to provide as reliable estimates of technical efficiency as possible. This is one of the first applications of quantile regression approach in the literature on technical efficiency. Notably, the thesis highlights that manufacturing firms are operating at relatively low technical efficiency, especially the foreign-invested sector. This is also among the few studies that produce evidence for a positive impact of trade liberalization on the technical performance of manufacturing firms. Moreover, the thesis provides the very first empirical evidence on the determinants of workplace injuries in the manufacturing sector and emphasizes the need for further research on this important policy area.

References

ADB (2004), 'The Factor Markets in Vietnam', *Discussion Paper No. 5,* Making Markets Work Better for the Poor, Asia Development Bank, Vietnam Resident Mission.

Aghion, P., R. Burgess, S. Redding, and F. Zilibotti (2008), 'The unequal effects of liberalization: Evidence from Dismantling the License Rai in India', *American Economic Review,* 98(4), 1397-1412.

Aigner, D. J., and S.F Chu (1968), 'On estimating the industry production function', *American Economic Review,* 58, 826-839.

Aigner, D. J., C.A.K. Lovell, and P. Schmidt (1977), 'Formulation and estimation of stochastic frontier production function models', *Journal of Econometrics,* 6, 21-37.

Anh, L. (2004), 'Tai nạn lao động chết người tăng ngày càng nhanh', *Vietnamnet News,* 16 June [Vietnamese]

Akaike, H. (1974). 'A New Look at the Statistical Model Identification', *IEEE Transactions on Automatic Control AC,*19, 716-723.

Askenazy, P. (2006), 'Some determinants of reporting workplace accidents in France: The role of labour contract', *CEPREMAP Working Paper No. 0210,* CEPREMAP.

Athukorala, P. (2006), 'Trade Policy Reforms and the Structure of Protection in Vietnam', *The World Economy*, Blackwell Publishing, 29(2), 161-187.

Auffret, P. (2003), '*Trade Reform in Vietnam: Opportunities with Emerging Challenges*', Policy Research Working Paper No. 3076, Development Research Group, World Bank, Washington, D.C.

Bailer, A.J., L.D. Reed, and L.T. Stayner (1997), 'Modeling Fatal Injury Rates Using Poisson Regression: A Case Study of Workers in Agriculture, Forestry, and Fishing', *Journal of Safety Research*, 28(3), pp. 177-186.

Basu, S. and Fernald, J. G. (1995), 'Are Apparent Productive Spillovers a Figment of Specification Efforts', *Journal of Monetary Economics,* 36, 165-188.

Bauer, T.K. (2004), 'High Performance Workplace Practices and Job Satisfaction: Evidence from Europe', IZA DP No. 1265.

Bennett, J.D., and D.L. Passmore (1986), 'Multinomial logit analysis of injury severity in U.S. underground bituminous coal mines', *Accident Analysis and Prevention,* 17(5), pp. 399–408.

Bernard, A. and B. Jensen (1999), 'Exceptional Exporter Performance: Cause, Effects or Both?,' *Journal of International Economics,* 47(1), 1-25.

Bickel, P. J. and K. A. Doksum (1977), *Mathematical Statistics*, Holden-Day, Inc. Oakland: California.

Blomström, M. and A. Kokko (2003), '*From Natural Resources to High-tech Production: The Evolution of Industrial Competitiveness in Sweden and Finland*', CEPR Discussion Papers No. 3804.

Bollini, P. and H. Siem (1995), 'No Real Progress towards Equity: Health of Migrants and Ethnic Minorities on the Eve of the Year 2000', *Social Science and Medicine*. 41(6), pp. 819-828.

Brada, J. C., A. E. Kinh, and C. Y. Ma (1997), 'Industrial Economics of the Transition: Determinants of Enterprise Efficiency in Czechoslovakia and Hungary', *Oxford Economics Papers,* New Series, 49 (1), 104-127.

Brassard, C. (2004), 'Wage and Labour Regulation in Vietnam within the Poverty Reduction Agenda'. *mimeo*. Public Policy Programme, National University of Singapore.

Brock G. J. (1999), ‘Exploring a Regional Technical Efficiency Frontier in the Former USSR’, *Economics of Planning*, 32, 23-44.

Brown, A.K. (1996), ‘Workplace safety: A call for research’, *Journal of Operations Management,* 14, pp. 157-171.

Brown, D.K (2000), ‘International Trade and Core Labor Standards: A Survey of the Recent Literature’. *mimeo.* Department of Economics, Tufts University, US.

Brown, D.K., A.V. Deardorff, and R.M. Stern (1996), ‘International Labor Standards and Trade: A Theoretical Analysis’, in J.N. Bhagwati and R.E. Hudec eds. *Harmonization and Fair Trade: Prerequisites for Free Trade?.* Cambridge: MIT Press.

Brown, D.K., A.V. Deardorff, and R.M. Stern (2002), ‘The Effects of Multinational Production on Wages and Working Conditions in Developing Countries’ in R.E. Baldwin and L.A. Winters eds. *Challenges to Globalization.* Chicago: University of Chicago Press.

Buchinsky, M. (1998), ‘The Dynamics of Changes on the Female Wage Distribution in the USA: A Quantile Regression Approach’, *Journal of Applied Econometrics*, 13(1), 1-30.

Cameron, A.C. and P.K. Trivedi (1990), ‘Regression-based tests for overdispersion in the Poisson models’, *Journal of Econometrics,* 46, pp. 347-364.

Cameron, A.C. and P.K. Trivedi (1999), ‘Essentials of Count Data Regression’, *mimeo,* Department of Economics, the University of California – Davis.

Carrivick, P.J.W., A. H. Lee, K.W. Yau (2003), ‘Zero-inflated Poisson modeling to evaluate occupational safety interventions’, *Safety Science*, 41, 53–63.

Caudill S. B., and J. M. Ford (1993), ‘Biases in frontier estimation due to heteroscedasticity’, *Economics Letters*, 41, 17-20.

Caudill, S. B., J. M. Ford and D. M. Gropper (1995), ‘Frontier Estimation and Firm-Specific Inefficiency Measures in the Presence of Heteroscedasticity’, *Journal of Business & Economic Statistics*, 13(1), 105-11.

Chamberlain, G. (1994), ‘Quantile Regression, Censoring and the Structure of Wages’, in Christopher Sims (eds), *Advances in Econometrics*, New York: Elsevier, 171–209.

Chand, S. and K. Sen (2002), ‘Trade Liberalization and Productivity Growth: Evidence from Indian Manufacturing’, *Review of Development Economics* 6(1), pp.120-132.

Charnes, A., W. W. Cooper and E. Rhodes (1978), ‘Measuring the Efficiency of Decision-Making Units’, *European Journal of Operational Research*, 2, 429–444.

CIEM (2001), ‘An Overview of Vietnam’s Trade Policy in the 1990s’, *mimeo,* Central Institute for Economic Management, Hanoi.

CIEM (2002), ‘Explaining Growth in Vietnam’, *Global Research Project Report*, East Asian Development Network, Global Development Network.

CIEM and NIAS (2004), *A New Vietnam Social Accounting Matrix for the Year 2000*, Science and Technics Publishing House, Hanoi.

CIEM-UNDP (2005), *Enterprises Law (2005 revised),* translated version of the Vietnam Enterprise Law, revised version in 2005, [available at http://www.ccife.org/vietnam/Fichiers/investissement_eng1.pdf]

Clerides, S., Lach, S. and J. Tybout (1998), ‘Is Learning by Exporting Important? Microdynamic Evidence from Colombia, Mexico, and Morocco’, *Quarterly Journal of Economics*, 113(3), 903-947.

Coelli, T., D. S. P. Rao, C. J. O’Donnell, G. E. Battese (2005), *An Introduction to Efficiency and Productivy Analysis,* Springer Science+Busisness Media: New York.

Cousineau, J. M, R. Laxcroix, and A.M. Girard (1992), ‘Occupational Hazard and Wage Compensting Differentials’, *Review of Economics and Statistics*, 74(1), 166-169.

CPV (2001), *Toàn văn Văn kiện Đại hội Đảng* (Collection of Offical Documents by the National Party Congresses), Political Publishing House, Hanoi (*Vietnamese*).

Dahlback, O. (1991), 'Accident-proneness and risk-taking', *Personal and Individual Differences,* 12, pp. 79–85.

Danilin, V. I., I. S. Materov, S. Rosefielde and C. A. K. Lovell (1985), 'Measuring Enterprise Efficiency in the Soviet Union: A Stochastic Frontier Analysis', *Economica*, New Series, 52(206), 225-233.

Dao, L.T., H.C. Pham and T.H. Pham (2006), 'Đầu tư trực tiếp nước ngoài vào Việt Nam: Định hướng xuất khẩu và thay thế nhập khẩu' (*Foreign direct investment in Vietnam: Export Orientation or Import Substitution*), Tạp chí Kinh tế Châu Á- Thái Bình Dương (*Journal of Asia-Pacific Economics*), 14(105), 18-25.

Dao, L.T., T.H. Pham, and B. Reilly (2010), 'Technical Efficiency in the Vietnamese Manufacturing Sector', *Journal of International Development*, 22(4), 503-520.

Deaton, A. (1997), *The Analysis of Household Surveys: A Microeconomic Approach to Development Policy*, World Bank, Washington, D.C.

Dollar, D and A. Kraay (2002), 'Institutions, trade, and growth', *Journal of Monetary Economics*, 50, 133-62.

Dollar, D and A. Kraay (2004), 'Trade, Growth, and Poverty', *Economic Journal*, 114(493), 22-49.

Dollar, D and S.J. Wei (2007), DAS (wasted) kapital: Firm ownership and investment efficiency in China, NBER Working Paper 13103, National Bureau of Economic Research.

Dorman, P. (2000), 'The Economics of Safety, Health, and Well-Being at Work: An Overview', report, InFocus Program on SafeWork, International Labour Organisation.

Dutta, P.V. (2007), 'Trade Protection and Industry Wages in India', *Industrial and Labour Relations Review*, 60(2), pp. 268-286.

Edwards, S. (1993), 'Openness, Trade Liberalization, and Growth in Developing Countries', *Journal of Economic Literature* 31(3), 1358-1393.

Edwards, S. (1997), 'Openness, Productivity, and Growth: What Do We Really Know?', *NBER Working Paper No. 5978*, National Bureau of Economic Research.

Epifani, P. (2003), 'Trade liberalization, Firm Performance, and Labour Market Outcomes in the Developing World: What can we learn from micro-level data?' *Policy Research Working Paper No. 3063*, Development Research Group, World Bank, Washington, D.C.

Farrell, M. J. (1957), 'The Measurement of productive efficiency', *Journal of the Royal Statistical Society*, Series A, 120, 253-281.

Fenn, P. and S. Ashby (2004), 'Workplace Risk, Establishment Size and Union Density', *British Journal of Industrial Relations*, 42(3), pp. 461–480

Fernandes, A. M. (2003), 'Trade Policy, Trade Volumes, and Plant-Level Productivity in Comumbian Manufacturing Industries', *Policy Research Working Paper No. 3064*, Development Research Group, World Bank, Washington, D.C.

Ffrode, A. and N.D. Huan (2001), 'Vietnamese Rural Society and its Institutions: Results of a Study of Cooperative Groups and Cooperatives in three Provinces', final research report to Ministry of Agriculture and Rural Development of Vietnam.

Frankel, A.J. and D. Romer (1999), 'Does Trade Cause Growth', *American Economic Review*, 89(3), 379-399.

Forastieri, V. (1999), 'Improvement of working conditions and environment in the informal sector through safety and health measures', *report*, International Labour Office.

Forastieri, V. (2001), 'Information Note on Women Workers and Gender Issues on Occupational Safety and Health', a report to SafeWork, International Office.

IMF (2002), 'Vietnam: Selected Issues and Statistical Appendix', *IMF Country Report No. 02/5,* International Monetary Fund.

IMF (2006), 'Vietnam: Statistical Appendix', *IMF Country Report No. 06/423*, International Monetary Fund.

IMF (2007), 'Vietnam: Statistical Appendix', *IMF Country Report No. 07/386*, International Monetary Fund.

Greene, W. H. (1993) 'The Econometric Approach to Efficiency Analysis', in H. O. Fried, C. A. K. Lovell, and S. S. S Schmidt (eds), *The Measurement of Productive Efficiency: Techniques and Applications*. New York: Oxford University Press.

Golub, S.S. (1997), 'International Labor Standards and International Trade', IMF Working Paper no. WP/97/37.

GSO (various years), *Vietnam Statistical Year Book 1995, 1996, 2000, 2004, 2006, 2007 and 2008*, Statistical Publishing House, Hanoi.

GSO (2004), *Ket qua Dieu tra Cong nghiep Vietnam,* Statistical Publishing House, Hanoi.

GSO (2005), *Ket qua Dieu tra Cong nghiep Vietnam (Dieu chinh, Bo sung),* Statistical Publishing House, Hanoi.

GSO (2006), *Vietnam Enterprises Survey Plan 2006,* General Statistical Office, Statistical Publishing House, Hanoi.

GSO (2008). *The situation of Enterprises through the results of survey in 2005, 2006, 2007*. Statistical Publishing House, Hanoi.

Glewwe, P., N. Agrawal, and D. Dollar (eds) (2004), *Economic Growth, Poverty, and Household Welfare in Vietnam*, World Bank Regional and Sectoral Studies, World Bank, Washington D.C.

Gunderson, M. and D. Hyatt (2001), 'Workplace Risks and Wages: Canadian Evidence from Alternative Models', *The Canadian Journal of Economics'*, 34(2), pp. 377-395.

Hahn, C. H (2004), '*Exporting and Performance of Plants: Evidence from Korean Manufacturing*', National Bureau of Economic Research Working Paper 10208.

Haisken-DeNew, J.P. and C.M. Schmidt (1997), 'Inter-Industry and Inter-Region Differentials: Mechanics and Interpretation' *Review of Economics and Statistics*, 79(3), 516-521.

Harrell, W. A. (1990), 'Perceived risk of occupational injury: Control over pace of work and blue-collar versus white-collar work', *Perceptual and Motor Skills,* 70, pp. 1351–1359.

Harrison, A. (1994) 'Productivity, Imperfect Competition and Trade Reform: Theory and Evidence,' *Journal of International Economics* 36(1-2), 53-73.

Hausman, J.A., B.H. Hall and Z. Griliches (1984), 'Econometric Models for Count Data With an Application to the Patents-R and D Relationship', *Econometrica*, 52, pp. 909-938.

Haussman, R. and D. Rodrik (2002), '*Economic Development as Self Discovery*', CEPR Discussion Papers No. 3356.

Hallward-Driemeier, M, G. Iarossi and K. L. Sokoloff (2002), '*Exports and Manufacturing Productivity in East Asia: A Comparative Analysis with Firm-level Data.*' National Bureau of Economic Research Working Paper 8894.

Heckman, J. (1979), 'Sample Selection Bias as a Specification Error', *Econometrica,* 47(1), 153-161.

Hersch, J. (1998), ‘Compensting Differentials for Gender-Specific Job Injury Risks’, *American Economic Review*, 88(3), 598-627.

Hoang, H. V., T. Carlin, L. T. Pham. (2008), ‘Determinants of Technical Efficiency in Vietnamese Enterprises during transition: 2001-2005’, *mimeo*, Macquarie Graduate School of Management, Australia.

Hogg, R. V. and E.A. Tanis (1983), *Probability and Statistical Inference*, 2nd edition. Macmillan Publishing Co., Inc: New York.

Hossain, M. A. and N. D. Karunaratne (2004), ‘Trade Liberalisation and Technical Efficiency: Evidence from Bangladesh Manufacturing Industries’, *The Journal of Development Studies*, 40 (3), 87-114.

Huber, P.J. (1967), The behaviour of maximum likelihood estimates under non-standard conditions in *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability. Berkeley, CA: University of California Press*, 1, 221 – 223.

ILO (1998), ‘Declaration on Fundamental Principles and Rights at Work’, International Labour Organisation.

JICA (Japanese International Cooperation Agency) (2002), ‘*Vietnam’s Trade and Industrial Policy in the Integration Era’*, Symposium on Vietnam’s Trade and Industrial Policy organized by JICA, Ministry of Planning and Investment, August, 2002: Hanoi

Jones, D., M. Klinedinst, and C. Rock (1998), ‘Productive Efficiency during Transition: Evidence from Bulgarian Panel Data’, *Journal of Comparative Economic*, 26, 446–464.

Jondrow, J., C. A. K. Lovell, I. S. Materov, and P. Schmidt (1982), ‘On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model’, *Journal of Econometrics*, 19(2/3), 233-238.

Kalirajan, K. P. and R. T. Shand (1999), ‘Frontier production functions and technical efficiency measures’, *Journal of Economic Surveys*, 13 (2), 149-172.

Kaminski, M. (2001), ‘Unintended Consequences: Organizational Practices and Their Impact on Workplace Safety and Productivity’, *Journal of Occupational Health Psychology*, 6(2), 127-138.

Krueger, A.O and L.H. Summers (1988), ‘Efficiency Wages and the Inter-Industry Wage Structure’, *Econometrica*, Vol. 56, 259-293;

Krueger, A.O and B. Tuncer (1982), ‘An Empirical Test of the Infant Industry Argument’, *American Economic Review*, 72(5), 1142-1152.

Koenker, R. (2005), *Quantile Regression*, Cambridge Books, Cambridge University Press.

Koenker, R. and G. Bassett (1978), ‘Regression Quantiles’, *Econometrica*, 46(1), 33-50.

Kumbhakar, S. C., C. A. K. Lovell (2003), *Stochastic Frontier Analysis*, Cambridge University Press, Cambridge.

Lambert, D. (1992), ‘Zero-inflated Poisson regression, with an application to defects in manufacturing’, *Technometrics*, 34, 1-14.

Lan, P. (2006), ‘Đẩy mạnh xã hội hoá công tác an toàn - vệ sinh lao động’, *Vietnam Economics Times*, 26 Sept [Vietnamese]

Larsen, A. F., J. Rand, and N. Torn (2011), Do recruitment ties affect wages? An analysis using matched employer-employee data from Vietnam, FOI Working Paper 2011/4, University of Copenhagen.

Le, C. L. V (2010), Technical efficiency performance of Vietnamese manufacturing small and medium enterprises, University of Wollongong, Australia.

Lord, D., S.P. Washington, J.N. Ivan (2005), 'Poisson, Poisson-gamma and zero-inflated regression models of motor vehicle crashes: balancing statistical fit and theory', *Accident Analysis and Prevention,* 37*,* 35–46.

Litchfield, J., H. Pham and P. Justino (2008), 'Poverty Dynamics during Trade Reform: Evidence from Rural Vietnam', Review of Income and Wealth, 54(2), 166-192.

Liu, Z., G. S. Liu (1996), 'The Efficiency Impact of the Chinese Industrial Reforms in the 1980s', *Journal of Comparative Economics*, 23, 237-255.

Lundrall, K. and G. Battese (2000), 'Firm Size, Age and Efficiency: Evidence from Kenyan Manufacturing Firms', *The Journal of Development Studies*, 36(3), 146-163.

Maddala, G.S. (1983), *Limited-Dependent and Qualitative Variables in Econometrics*, Cambridge University Press.

Maiti, J. and A. Bhattacherjee (1999), 'Evaluation of Risk of Occupational Injuries Among Underground Coal Mine Workers through Multinomial Logit Analysis', *Journal of Safety Research,* 30(2)*,* 93-101.

McCutcheon, D.M. and J.R. Meredith (1993), 'Conducting case study research in operations management', *Journal of Operations Management,* 11(3)*,* 239-356.

Meeusen, W. and J. van den Broeck (1977), 'Efficiency estimation from Cobb Douglas production functions with composed error', *International Economic Review*, 18, 435-444.

Melitz, M. J. (2003), 'The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity', *Econometrica*, 71(6), 1695-1725.

Meng, R. and D. Smith (1999), 'The impacts of workers' compensation on wage premiums for hazardous jobs', *Applied Economics*, 31, pp. 1101-1108.

MOLISA (2003), 'Báo cáo tình hình tai nạn lao động năm 2002', MOLISA Report No. 628/ LĐTBXH-TTAT, Ministry of Labour, War Invalids, and Social Affairs [Online, Vietnamese], [http://www.dosmolisa.gov.vn (cited 20 Nov 2006)]

MOLISA (2004a), 'Phân tích tình hình tai nạn lao động từ năm 1995 đến 2003', MOLISA Report, Ministry of Labour, War Invalids, and Social Affairs [Online, Vietnamese]. [http://www.dosmolisa.gov.vn (cited 20 Nov 2006)]

MOLISA (2004b), 'Thông báo Tình hình tai nạn lao động năm 2003', MOLISA Report No. 422/ LĐTBXH-TTr, Ministry of Labour, War Invalids, and Social Affairs [Online, Vietnamese], [http://www.dosmolisa.gov.vn (cited 20 Nov 2006)]

MOLISA (2005a), 'Thông báo Tình hình tai nạn lao động năm 2004', MOLISA Report, Ministry of Labour, War Invalids, and Social Affairs [Online, Vietnamese]. [http://www.dosmolisa.gov.vn (cited 27 Nov 2006)]

MOLISA (2006), 'Đánh giá về công tác thống kê tai nạn lao động', MOLISA Report, Ministry of Labour, War Invalids, and Social Affairs.

Mood, A. M. , F. A. Graybill, and D.C. Boes (1974), *Introduction to the Theory of Statistics*, 3rd edition, McGraw-Hill: New York.

Moore, M.J and W.K. Viscusi (1990), 'Discounting environmental health risks: New Evidence and Policy Implications', *Journal of Environmental Economics and Management*, 18(2), S51-S62.

Movshuk, O. (2004), 'Restructuring, productivity and technical efficiency in China's iron and steel industry, 1988–2000', *Journal of Asian Economics*, 15, 135–151.

MPI (2003), *Five Year Plans for Socio-Economic Development 2001-2005,* Ministry of Planning and Investment, Hanoi.

Mullahy, J. (1996), 'Specification and Testing of Some Modified Count Data Models', *Journal of Econometrics*, 33, 341-365.

Murillo-Zamarano, L. R. (2004), Economic efficiency and frontier techniques, *Journal of Economic Surveys*, 18(1), 33-77.

MUTRAP (2002), *Vietnam's integration into the world economy, accession to the World Trade Organization and the development of industry*, a report by the Multilateral Trade Policy Assistance Programme (funded by The European Community for Ministry of Trade, Vietnam according to Agreement No. VNM/B7-3010/IB/97/0294).

MUTRAP (2008), *Comprehensive evaluation of the impact of increased key imports-exports and regulatory changes resulting from Vietnam's WTO membership,* a report by the Multilateral Trade Policy Assistance Project Vietnam II (funded by The European Community for Ministry of Industry and Trade, Vietnam according to Agreement No. ASIE/2003/005711).

Nguyen, T. and T. T. To, and H. D. Vu (2002), 'Productivity Analysis for Vietnam's Textile and garment industry', research project by Institute for market and price research-IDRC/CIDA Project, Hanoi.

Nguyen, K. M. and T. L. Giang (eds.) (2007), Technical Efficiency and Productivity Growth in Vietnam, Publishing House of Social Labour, Hanoi.

Nguyen, K. M. and T. L. Giang (2008), Factor Productivity and Efficiency of Vietnamese Economy in Transition, *Asia-Pacific Development Journal*, 15(1), p.93-117.

Nguyen, V. D. (2006), 'TNLĐ chết người năm 2006 tăng hơn so với năm 2005', *mimeo*,Vietnam General Confederation of Labour, Hanoi [Vietnamese]

OECD (1996), 'Trade, Employment and Labor Standards', Organization for Economic Cooperation and Development.

Pavcnik, N. (2002), 'Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants', *Review of Economic Studies*, 69, p. 245-276.

Pham, T.H. and B. Reilly (2007), 'The Gender Pay Gap in Vietnam, 1993-2002: A Quantile Regression Approach', *Journal of Asian Economics*, 185(5), 775-806.

Pham, T.H., A.T. Bui and T.C. Nguyen (2009), 'The Impact of Trade Liberalization and Industrial Pollution: Empirical Evidence from Vietnam', Research Report n. 2008-RR5 for The Economy and Environment Program for Southeast Asia (EEPSEA).

Pham T. H., L. T. Dao, and H. C. Pham (2006), 'Export Performance by the FDI Sector in Vietnam'. *Journal of Southeast Asian Studies* (Vietnamese).

Pham. T. H. (2007), An Analysis of the Rural Nonfarm Sector in Vietnam during a period of trade reform 1993-2002, *thesis*, University of Sussex, UK.

Quintana, R., I. Pawlowitz, (1999), 'A Poisson model for work-related musculoskeletal disorder cost estimation', *Safety Science,* 32, pp. 19–31.

Raftery, A. E. (1986), 'Choosing models for cross-classification', *American Sociological Review*, 51, 145-146.

Ravallion, M. and D. Van de Walle (2002), 'Land Reallocation in Vietnam's Agrarian Transition', *Economic Journal*, 116, 924-942.

Reilly, B., P. Paci, and P. Holl (1995), 'Unions, Safety Committees and Workplace Injuries', *British Journal of Industrial Relations*, 33(3), pp. 275–288.

Robinson, J.C. 1989, 'Exposure to Occupational Hazards among Hispanics, Blacks, and Non-Hispanic Whites in California', *American Journal of Public Health*, 79(5), pp. 629-630.

Rodriguez, F. and D. Rodrik (2001), 'Trade Policy and Economic Growth: A Skeptic's Guide to the Cross-National Evidence', *NBER Macroeconomics Annual 2000*, MIT Press, pp.261-324.

Rodrik, D. (1995), 'Trade Policy and Industrial Policy Reform', in J. Behrman and T.N. Srinivasan (eds.), *Handbook of Development Economics,* North Holland, Amsterdam.

Sachs, J. and A. Warner (1995), 'Economic Reform and the Process of Global Integration', *Brookings Papers on Economic Activity No.1,* pp.1-118.

Schmidt, P. (1986), 'Frontier production functions', *Econometric Reviews,* 4, 289-328.

Schwarz, Gideon (1978), 'Estimating the Dimension of a Model', *Annals of Statistics,* 6, 461-464.

Seshan, G. (2005), 'The impact of trade liberalization on household welfare in Vietnam', *Policy Research Working Paper No. 3541,* Social and Economic Development Group, World Bank, Washington, D.C.

Shankar, V.N., G.F. Ulfarsson, R.M. Pendyala, and M.B. Nebergall (2003), 'Modeling crashes involving pedestrians and motorized traffic', *Safety Science*, 41(7), 627-640.

Shannon, H.S., J. Mayr and T. Haines (1997), 'Overview of the relationship between organisational and workplace factors and injury rates', *Safety Science,* 26(3), pp. 201-217.

Sherry, P. (1991), 'Person-Environment Fit and Accident Prediction', *Journal of Business and Psychology,* 5, pp. 411–416.

Silvestre, J. (2006), 'Wage Compensation for Workplace Disamenities during Industrialization: The Case of Spain, 1909–20', *Labour History*, 47(01), pp. 43-72.

Singer, H. W. (1988), 'The World Development Report 1987 on the Blessing of "Outward Orientation": a Necessary Correction', *Journal of Development Studies*, 24(2), pp. 232-236.

SRV (2007), *Labour Code of Socialist Republic of Vietnam*, National Assembly, Hanoi.

SRV (2003), *Comprehensive Poverty Reduction and Growth Strategy,* Socialist Republic of Vietnam.

StataCorp (2005*), Stata statistical software: Release 9.0*, Stata Corporation.

Stern, R.M. (2003), 'Labor Standards and Trade Agreements', Discussion Paper No. 496, University of Michigan.

Stevenson, R. E. (1980), 'Likelihood Functions for Generalized Stochastic Frontier Estimation', *Journal of Econometrics*, 13(1), 57-66.

Stiglitz, J. (2002), *Globalization and Its Discontents*, WW Norton and Co.

Sutherland, V.L., and C.L. Cooper, (1991), 'Personality, stress and accident involvement in the offshore oil and gas industry', *Personality and Industrial Differences,* 12, 195–204.

Tarp, F., D. Ronald-Holst, and J. Rand (2003), 'Economic structure and development in an emergent Asian country: Evidence from a social accounting matrix for Vietnam', *Journal of Asian Economics*, 13, 847-871.

Tenev, S., A. Carlier, O. Chaudry, and Q.T. Nguyen (2003), 'Informality and the Playing Field in Vietnam's Business Sector', *Research Report No. 26976,* International Finance Corporation and World Bank.

Thoburn, J., T.T.H. Nguyen, and T.H. Nguyen (2003), 'Globalization and Textiles Industry in Vietnam', *Discussion Paper No. 10,* DFID research programme on 'Globalization and Poverty'.

Thomason, T. and S. Pozzebon (2002), 'Determinants of Firm Workplace Health and Safety and Claims Management Practices', *Industrial and Labor Relations Review,* 55(2), pp. 286-307

Topalova, P. (2004). 'Factor Immobility and Regional Effects of Trade Liberalization: Evidence from India', unpublished paper, Massachusetts Institute of Technology.

Tran, T. B., Q. Q. Grafton and T. Kompas (2008), 'Firm Efficiency in a Transitional Economy: Evidence from Vietnam', *Asian Economic Journal*, 22(1), 47-66.

Tybout, J., J. de Melo, and V. Corbo (1991), 'The effects of trade reforms on scale and technical efficiency: New evidence from Chile', *Journal of International Economics*, 31(3,4), 231-250.

Tybout, J. and M. Westbrook (1995), 'Trade Liberalization and the Dimensions of Efficiency Change in Mexican Manufacturing Industries', *Journal of International Economics* 39(1-2), 53-78.

Yasar, M., C.H. Nelson and R. Rejesus (2006), 'Productivity and Exporting Status of Manufacturing Firms: Evidence from Quantile Regressions', *Review of World Economics*, 142(4), 675-694.

Young, A. (1991), 'Learning by Doing and the Dynamic Effects of International Trade', *Quarterly Journal of Economics*, 106, 369-406.

UNDP (2001), *Human Development Report*, United Nations Development Programme, New York.

VASS (Vietnam Academy of Social Sciences) (2007), *Vietnam Poverty Update Report: Poverty and Poverty Reduction in Vietnam, 1993-2006*, National Political Publishing House: Hanoi.

Vijverberg, W. (2006), 'Non-Farm Household Enterprises: Comparison of VHLSS and AHBS Concepts', research report, The World Bank Hanoi Office.

Vu, Q. N. (2003), 'Technical efficiency of industrial state-owned enterprises in Vietnam', *Asian Economic Journa*l, 17(1), 87-101.

Wadud, I. K. M. M.(2004), Technical Efficiency in Australian textile and clothing firms: Evidence from the business longitudinal survey, Australian Economic Papers, 43(3), 357-378.

Wagner, J. (2002), 'The causal effects of exports on firm size and labor productivity: first evidence from a matching approach', Economics Letters, 77(2), 287-292.

Wagner, J. (2007), 'Exports and Productivity: A Survey of the Evidence from Firm Level Data', *The World* Economy, 30(1), 60-82.

Westphal, L.E. (2002), 'Technology strategies for economic development in a fast changing global economy', *Economics of Innovation and New Technology*, 11(4,5), 275-320.

Winters, A. (2004), 'Trade Liberalization and Economic Performance: An Overview', *The Economic Journal*, 114, 4-21.

Winters, A., N. McCulloch, and A. McKay (2004), 'Trade Liberalization and Poverty: The Evidence So Far', *Journal of Economic Literature*, 42(1), pp. 72-115.

World Bank (1998), *Vietnam Development Report 1999: Preparing for Take-offs?*, World Bank Vietnam Office, Hanoi.

World Bank (1999), *Vietnam Development Report 2000: Attacking Poverty*, World Bank Vietnam Office, Hanoi.

World Bank (2001), *Vietnam Development Report 2002: Implementing Reforms for Faster Growth and Poverty Reduction*, World Bank Vietnam Office, Hanoi.

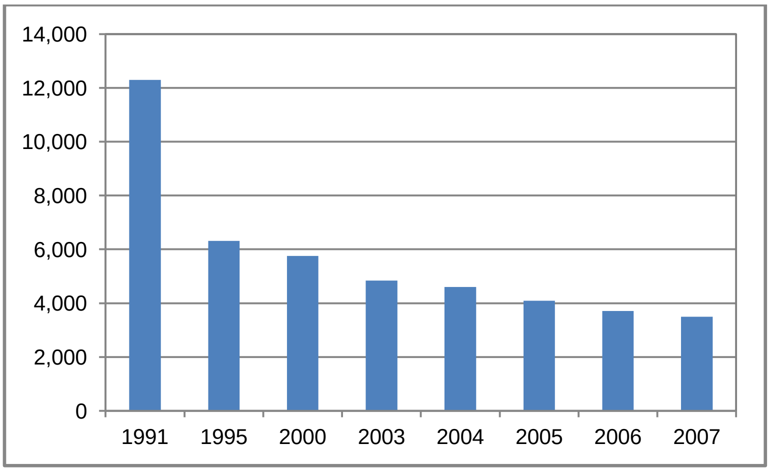
World Bank (2005), *Vietnam Development Report 2006: Business*, World Bank Vietnam Office, Hanoi.

World Bank (2006), *Vietnam Development Report 2007: Aiming High*, World Bank Vietnam Office, Hanoi.

World Bank (2007), *Vietnam Development Report 2008: Social Protection*, World Bank Vietnam Office, Hanoi.

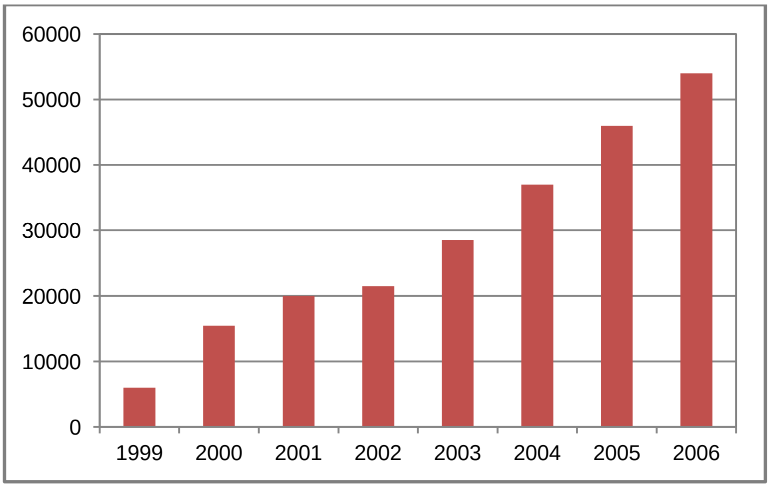
Appendix A1

Table A1.1 Number of State-Owned Enterprises during the *Doi moi*



Source: GSO Statistical Yearbook 2008 for data from 2000-2007; World Bank (2005) for data in 1991 and 1995

Table A1.2 Number of New Establishments after the Enterprise Law



Source: World Bank (2005) for data between 1999-2005; World Bank (2006) for data on 2006

Figure A1.3a Structure of Export Markets, 1990-2006

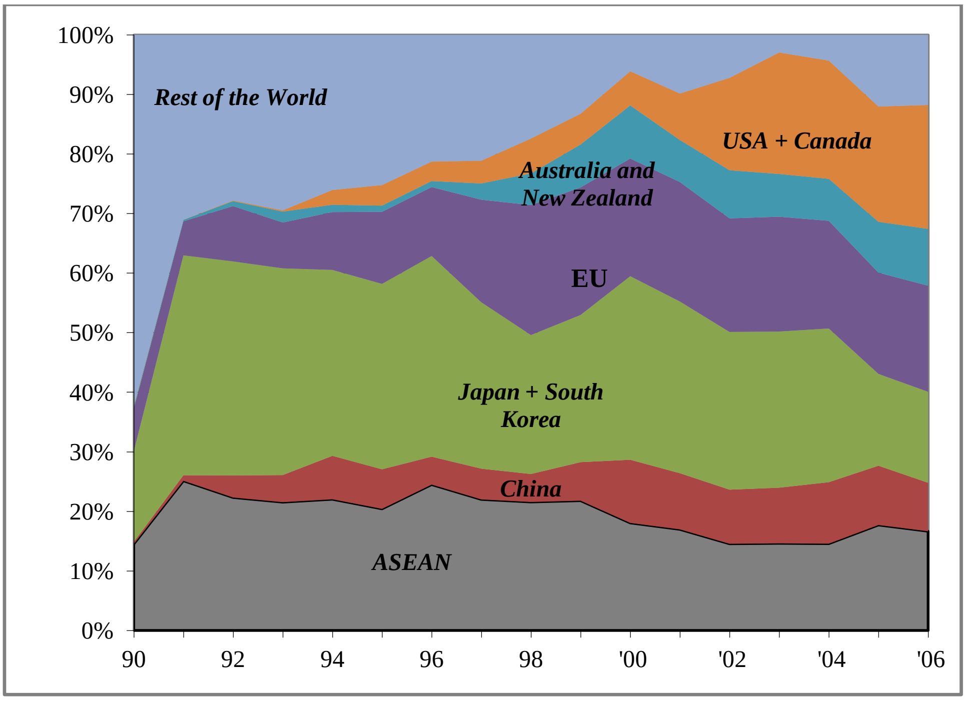
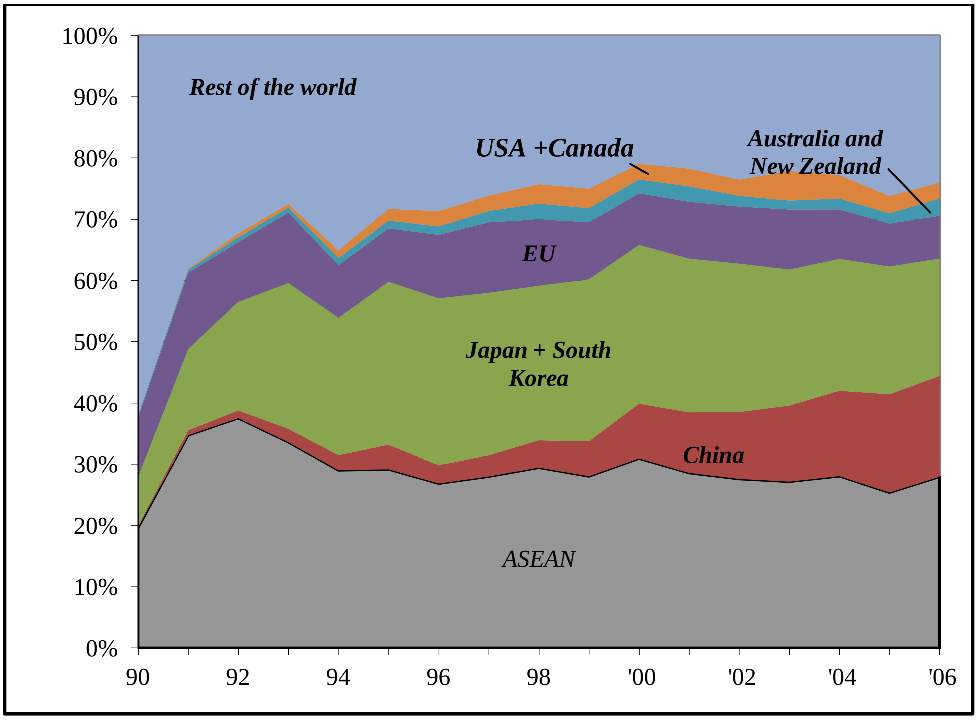


Figure A1.3b Structure of Import Destinations, 1990-2006



Source: GSO Statistical Yearbook 1996, 2000, and 2008

Table A1.1 Vietnam's FDI Distribution by Activities, 1988-2006

	Number of projects		Total capital commitment	
	Number	**%**	**US$ mil.**	**%**
Agriculture, forestry, fishery	638	8.76	3,685	5.56
Mining and quarrying	95	1.31	3,336	5.04
Manufacturing	4,699	64.56	33,192	50.11
Construction	141	1.94	5,173	7.81
Hotels and restaurants	233	3.20	5,154	7.78
Transport; storage and communications	218	2.99	4,664	7.04
Real estate, renting business activities	872	11.98	6,258	9.45
Others activities	383	5.26	4,783	7.22
Total	7,279	100	66,244	100

Source: compiled from MPI data in Document No. 2338/BKH-DTNN in 2006.

Table A1.2 Vietnam's FDI Distribution by Location, 1988-2006

	Number of projects		Total capital commitment	
	Number	**%**	**US$ mil.**	**%**
By regions				
North Mountain and Midland	353	4.85	2,245	3.39
Red river delta	1,474	20.25	16,969	25.61
North Central Coast	112	1.54	1,428	2.16
South Central Coast	318	4.37	3,762	5.68
Central Highlands	106	1.46	1,025	1.55
South East	4,571	62.80	35,941	54.26
Mekong Delta	296	4.07	1,978	2.99
Petroleum and Gas	49	0.67	2,898	4.37
Total	7,279	100	66,244	100
By selected provinces				
Hà Nội	816	11.21	11,470	17.31
Vĩnh Phúc	111	1.52	854	1.29
Hải Phòng	232	3.19	2,479	3.74
Quảng Ninh	125	1.72	1,322	2.00
Đà Nẵng	110	1.51	1,122	1.69
Lâm Đồng	88	1.21	958	1.45
Bình Dương	1,142	15.69	5,357	8.09
Đồng Nai	788	10.83	9,403	14.19
Bà Rịa - Vũng Tàu	181	2.49	4,512	6.81
TP. Hồ Chí Minh	2,265	31.12	15,870	23.96
Others	1,421	19.52	12,898	19.47
Total	7,279	100	66,244	100

Source: see above.
Notes: 'Petroleum and gas' was not categorized in any of the seven regions as projects are mainly in the South China Sea.

Appendix A2

Enterprise Survey Questionnaire 2005

Quest. 1A-§ TDN

The General Statistics Office

========= o O o =========

ID No: ☐

Coded by Statistics Office

Questionnaire

Collecting Information of the Enterprise *in 2005*

(issued by the statistical law)

(For all types of enterprise)

1- Name of the enterprise: . . . .

*(By capital letters, **not** in brief)*

- Name of enterprise in brief: ....

Tax code of the enterprise ☐☐☐☐☐☐☐☐☐☐ ☐

2- Address of the enterprise *(Notes the full address of the enterprise's head office):*

- Hamlet (house number, road, street): ....
- Commune/ward/town: .... ☐☐☐☐☐
- District: .... ☐☐☐
- Province: .... ☐☐
- Telephone number: *Provincial code* ☐☐☐☐ *Number* ☐☐☐☐☐☐☐
- Fax number: *Provincial code* ☐☐☐☐ *Number* ☐☐☐☐☐☐☐
- Email: . . . .

3- Type of the enterprise *(please circle in the suitable number)* **:** ☐☐

- Central State:	01	- **Collective name**:	08	% of state capital
- Local State:	02	- **Private Ltd Co,** Ltd. Co. having state capital ? 50%	09 → ☐	
- Central State Ltd. Co	03	- **Joint stock Co.** not having state capital: . .	10	% of state capital
- Local State **Ltd. Co**:	**04**	- **Joint stock Co.** having **state capital** ? 50%. .	11 → ☐	
- Joint stock **Co, Ltd. Co. having state capital** > 50% **in which: % of central state capital** ☐ **% of local state capital** ☐	**05**	**↳ Does state control the enterprise? 1: Yes 2: No**	→ ☐	
- Collective:	06	- **100% foreign capital**:	12	
- Private enterprise:	07	- Joint venture between **State & foreign**:	13	
		- Joint venture between **others & foreign**:	14	

4- Economic activities in the year of 2005:

Economic activity code

4.1 Main activity: . . . . ☐☐☐☐☐☐

4.2 Other activities:

- Activity : . . . . ☐☐☐☐☐☐
- Activity : . . . . ☐☐☐☐☐☐
- Activity : . . . . ☐☐☐☐☐☐

4.3 Does the enterprise have direct service im-export in **the year** of 2006? ☐ 1 : **Yes** 2 : No

***If yes**, please fill in **details in** question 22*

5- Labour of year 2005

Unit: Person

	Code	At the beginning of the year		At the end of the year	
		Total	*Of which*: Female	Total	*Of which*: Female
A	B	1	2	3	4
5.1 Total labour	01				
Of which: - Number of employee is contributed social security					
Total labour by economic activities: - Main economic activities:	Economic activity code				
- *Other economic activities:* + Activity :	↓				
+ Activity :					
+ Activity :					
5.2 Number of new employees employed during the year	03				
5.3 Number of employees reduced during the year	04				

6- Compensation of employees and enterprise employer's contribution to social security, health and Trade-Union in the year 2005

Unit: Mill.dongs

	Code	Year 2005
A	B	1
6.1 Compensation of employees *(01= 02+03+04)*	01	
- Wages, salaries, bonus, gratuities and the like considered as salaries	02	
- Social security contributed to employees	03	
- Other compensation out of production costs	04	
6.2 Contributions to insurance and pension, health, trade-union	05	

7- Assets and liabilities of year 2005

Unit: Mill.dongs

	Code	At the beginning of year	At the end of year
A	B	1	2
Total assets *(01=02+08)*	**01**		
A. Short term assets	02		
Of which: - Short term receivable accounts	03		
- Inventories (total)	04		
Of which: + Works in process	05		
+ Finished product	06		
+ Consigned goods for sale	07		
B. Long term assets	08		
Of which:			
I. Long term receivable accounts	09		
II. Fixed assets	10		
1. Tangible fixed assets	11		
+ Original value	12		
+ Accumulated depreciation	13		
2. Financial rented out fixed assets	14		
+ Original value	15		
+ Accumulated depreciation	16		
3. Intangible fixed assets	17		
+ Original value	18		
+ Accumulated depreciation	19		

8- Business results in 2005

Unit: Mill.dongs

	Code	Year 2005
A	B	1
8.1 Turnover		
1. Turnover of goods, services activities	01	
1.1 Reductions	02	
*Of which: Tax (*excise tax, Export duties or fees, VAT paid directly)	03	
1.2 Net turnover of goods, services *(04 = 01 - 02)*	04	
Of which: - Retail turnover	05	
By economic activities:	Economic activity code ↓	
+ Activity:		
+ Activity:		
+ Activity:		
+ Activity:		
2. Turnover of financial activities	06	
3. Other revenue	07	
8.2 Total profit before taxes *(08= 09+10+11)*	08	
Of which: - Profit from business	09	
- Profit from financial activities	10	
- Profit from other activities	11	

9- Performance of obligations to the State in 2005

Unit: Mill.dongs

	Code	Payables during the year (not include previous year)	Paid during the year
A	B	1	2
Total taxes, fees and charges tranfered to the State	01		
Of which: - VAT tax of domestic goods	02		
- Excise tax	03		
- Export, import tax	04		
Of which: Export tax	05		

10. Implementation of charter capital share *(For joint venture enterprises)*

Unit: 1000 USD

	Code	Charter capital up to 31/12/2005	Cumulative capital invested up to 31/12/2005		Code	Charter capital up to 31/12/2005	Cumulative capital invested up to 31/12/2005
A	B	1	2	A	B	1	2
Total *(01=02+06)*	01			***12.2 Foreign partner***	06		
12.1 Viet Nam partner *(02=03+04+05)*	02			*Of which:*	Country code ↓		
Of which:				- Country			
+ State own enterprises	03			- Country			
+ Non-State own enterprises	04			- Country			
+ Other partners	05			- Country			

11- Investment capital of year 2005

Unit: Mill.dongs

	Code	**Year 2005**
A	**B**	**1**
Total *(01=03+06+09+10 = 11+14+16+17+18)*	01	
Of which: Capital for leasing and purchasing the land using right	02	
A. By investment sources		
1. State budget	03	
- Central state budget	04	
- Local state budget	05	
2. Loans for construction and purchasing equipments	06	
- Developing investment preferential credit of the State	07	
- Other sources	08	
3. Own outlays	09	
4. Others	10	
B. By investment types		
1. Investment capital for construction	11	
Of which: - Construction assembly works	12	
- Machinery and equipment	13	
2. Purchasing fixed assets not included in construction	14	
Of which: New fixed assets	15	
3. Investment for capital repairing of fixed assets	16	
4. Investment for current capital supplement	17	
5. Other development investment capital	18	

12. Some indicators about environmental protection of the enterprise

12.1 Investment of the enterprise for environmental treatment

- Total value of current waste treatment equipment of the enterprise up to 31/12/2005: [ ] *Mill*
- Total costs of the enterprise for environmental protection in the year of 2005: [ ] *Mill*

Of which: Costs for construction assembly works and equipment in the year of 2005: [ ] *Mill*

12.2 Waste treatment of the enterprise in the year of 2005

Type of waste	Volume of waste in the year			Type of treatment (Please tick 'X' in the suitable cell)				
	Unit	Volume of untreated waste of the enterprise	Volume of treated waste of the enterprise	Use filter equipment	Use deposition pool	Use chemical	Others	Not treated
A	B	1	2	3	4	5	6	7
- Liquid waste	m^3							
- Atmospheric waste	m^3							
- Solid waste	ton							

13. Products of industry sector in the year of 2005

(For enterprises having industrial activity which is not the main activity. For others, please fill in the questionnaire 1C-§ TDN)

Name of products	Code	Unit	Volume of products produced in the the year of 2005
A	B	C	1

14. Construction activity in 2005

(For enterprises having construction activity)

14.1 Construction gross output

Unit: Mill.dongs

	Code	Implemented
A	B	1
Construction gross output *(at current price) (01=02+08)*	**01**	
- Gross output of contstruction and assembly works (02=03+...+0	***02***	
Of which: - Value of housing construction works	03	
- Value of storehouse and factory const. works	04	
- Value of other housing construction works	05	
- Value of infrastructure construction works	06	
- Value of other construction and assembly works	07	
(2) Value of construction investigation, design and planning counted in construction activities	***08***	

14.2 Housing Areas completed in 2005

Unit: m^2

	Code	Implemented
A	B	1
Total housing areas completed in the year of 2005 *(01=02+...+07)*	**01**	
Of which - Ferro-concrete	02	
Of which: + Flat, unit or apartment attached to a house	03	
+ Separate house	04	
- Semi-concrete	05	
- Wood frame	06	
- Other	07	

15. On-the-job accident in 2005

	Code	Unit	Total
A	B	C	1
9.1 Number of accidents happened in the year	01	Case	
Of which: Number of cases leading to dead	02	Case	
9.2 Number of person with injury or dead from the accidents in the year	03	Person	
Of which: Number of dead	04	Person	
9.3 Total direct expenses for the accidents	05	Mill. Dongs	

16. Commerce activity in 2005 *(for enterprises having activities of commerce, agency, repair of motor vehicles, motorcycles, motorbikes, personnel and household tools)*

	Code	Unit	Total	*By type of commerce*		
				Wholesale	Retail	
					Total	*Of which:* supermarket
A	B	C	1	2	3	4
1. Net turnover	01	Mill. dongs				
2. Cost of sale goods	02	"				
3. Tax (VAT, export duty)	03	"				

4. Commerce turnover by commodity groups *Unit: Mill. dongs*

	Code	Total net turnover	*Of which*	
			Wholesale	Retail
A	B	1	2	3
Total	01			
- Food, foodstuff	02			
- Textile and garment products	03			
- Household equipments and appliances	04			
- Cultural and educational products	05			
- Timber and construction material	06			
- Fertilizer, insecticide	07			
- Means of transport (include parts)	08			
- Petrol, petroleum	09			
- Other fuel *(exclude petrol, petroleum)*	10			
- Others	11			
- Repairing motor cycles, motorbikes, personnel and household tools	12			

17. Hotel activity in 2005

(For enterprises having activities of hotel, camping, and other related services)

	Code	Unit	Year 2005
A	B	C	1
1. Guests			
-- Guest night	01	Guest times	
Of which: International guest	02	"	
-- Guest day	03	"	
Of which: International guest	04	"	
2. Guest night			
(For only guest having all day and night)	05	Guest night	
Of which: International guest	06	"	
3. Net turnover	07	Mill. dongs	
Of which: Net turnover from rooms and beds	08	"	
+ Of which: Net turnover from international	09	"	
4. Tax (VAT, export duty)	10	"	

5. Classification of establishments in detail

	Code	No. of room up to the end of 2005 (room)	No. of bed up to the end of 2005 (bed)	No. of guest night during 2005 (for only guests having all day and night) -(Guest night)		No. of using day during 2005 (day)	
				Total	*Of which* Inter. Guests	Day* Rooms	Day* Beds
A	B	2	3	4	5	6	7
Total	01						
Restaurant	02						
- Five stars	03						
- Four stars	04						
- Three stars	05						
- Two stars	06						
- One star	07						
- Under the star standard	08						
Guest-house	09						
Villa for tourism business	10						
Tourism village	11						
House for tourism business	12						
Others	13						

18. Transport activity in the year of 2005

(For enterprises having transport activities)

A. Business means as of 31/12/2005

		Code	Unit	Year 2006			Code	Unit	Year 2005
A		B	C	1	A		B	C	1
1 Road transport means					***2 Maritime transport means***				
1.1 Motor trucks:	- Quantity	01	Piece		2.1 Freight ships	- Quantity	04	Piece	
	- Tonnage	02	Ton			- Tonnage		Ton	
1.2 Passenger motor cars:	- Quantity	03	Piece		2.2 Oil ships	- Quantity	05	Piece	
(From 5 and more seats)	- Seat	04	Seat			- Tonnage		Ton	
1.3 Motor cars :	- Quantity	05	Piece		2.3 Passenger ships	- Quantity	06	Piece	
(under 5 seats)	- Seat	06	Seat			- Seat		Seat	
					3. Waterway transport mean				
					3.1 Freight ships	- Quantity	07	Piece	
						- Tonnage		Ton	
					3.2 Passenger ships	- Quantity	08	Piece	
						- Seat		Seat	

B. Products of transport activity in 2005

Name	Code	Unit	Total	*Of which:* Road	Waterway
A	B	C	1	2	3
1. Volume of passengers inside the country	01	Person			
2. Volume of passengers outside the country	02	Person			
3. Volume of passengers traffic inside the country	03	Person.Km			
4. Volume of passengers traffic outside the country	04	Person.Km			
5. Volume of freight inside the country	05	Ton			
6. Volume of freight outside the country	06	Ton			
7. Volume of freight traffic inside the country	07	Ton.Km			
8. Volume of freight traffic outside the country	08	Ton.Km			
9. Volume of freight loading through seaport	09	Ton			
Of which: - Loading export goods	10	Ton			
- Loading import goods	11	Ton			
- Loading domestic goods	12	Ton			
In which: Loading container items	13	Ton			
10. Volume of freight loading through river-port	14	Ton			

19. Restaurant activities in 2005

(For enterprises having activities of restaurant, bar and canteen)

	Code	Unit	Year 2005
A	B	C	1
1. Net turnover	01	Mill. dongs	
Of which: -- Net turnover from food	02	"	
Of which: Net turnover from transferred sale goods	03	"	
2. Cost of sale goods	04	"	
3. VAT tax	05		

20. Tourism by tour and activities supporting for tourist of year 2005

(For enterprises having tourism activities by tour and activities supporting for tourist)

	Code	Unit	Year 2005
A	B	1	2
1. Tour guests	01	Guest times	
Of which: - International guests	02	"	
- National guests	03	"	
- Vietnamese guests going to abroad	04	"	
2. Guest night of tour	05	Guest night	
Of which: - International guests	06	"	
- National guests	07	"	
- Vietnamese guests going to abroad	08	"	
3. Net turnover	09	Mill. dongs	
Of which: - From international guests	10	"	
- From National guests	11	"	
- From Vietnamese guests going to abroad	12	"	
Of which: terms of spending for guests	13	"	
4. Tax (VAT, export duty)	14	"	

21. Other service activities in 2005

	Code	Net turnover (Mill. dongs)	Tax (VAT, export duty) (Mill. dongs)
A	B	1	2
Total *(01=02+...+07)*	01		
- Scientific and technological services	02		
- Services related to property business and consultant services	03		
- Education and training services	04		
- Health services	05		
- Cultural and sport services	06		
- Personnel and commune services	07		

- Expenses of lottery award in the year of 2005 (for enterprise having lottery business activities) [ ] Mill dongs

22. Ex-import of services in the year of 2005

Unit: 1000 USD

	Code	Export (revenue)	Import (expenses)
A	B	1	2
Total *(01=02+06+09+13+14+17+18+19+26+29)*	**01**		
1. Maritime transport *(02=03+04+05)*	***02***		
1.1. Passenger transport	03		
1.2. Freight transport	04		
1.3. Other maritime services	05		
2. Road transport *(06=07+08)*	***06***		
2.1. Passenger transport	07		
2.2. Freight transport	08		
3. Post and telecommunications *(09=10+11+12)*	***09***		
3.1. Postal services	10		
3.2. Telecommunication	11		
3.3. Express mail and other services	12		
4. Construction	***13***		
5. Insurance (14=15+16)	***14***		
5.1. Import goods insurance	15		
5.2. Other insurances	16		
6. Finance	***17***		
7. Computer and information	***18***		
8. Business services *(19=20+...+25)*	***19***		
8.1. Goods in merchanting transactions and other business service	20		
8.2. Rent or lease service	21		
8.3. Legal, accounting, auditorial and consultative service	22		
8.4. Advertisement and market research service	23		
8.5. Architectural and technical service	24		
8.6. Other business services	25		
9. Individual, cultural and entertainment service *(26=27+28)*	***26***		
9.1. Educational service	27		
9.2. Others	28		
10. Others	***29***		

23. List of the enterprise's branches

Name of branches	Tax code	Address of the main office of the branch	Provincial code	Main business activity	Activity code	No. of employees up to 31/12/2005 (person)	Net turnover *(mill. dongs)*
A	B	C	D	E	G	1	2

Day month 2006

Interviewer	**Person who filled in this questionnaire**	**Director of the Enterprise**
(Signature, Full name)	*(Signature, Full name)*	*(Signature, Stamp)*

Appendix A3

Table A3.1 Number of Establishments by Manufacturing Sub-Sectors, 2000-2006

	2000		2001		2002		2003		2004		2005		2006	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Agricultural resource-intensive	**1,744**	**22.68**	**1,856**	**20.93**	**2,164**	**19.62**	**2,386**	**18.59**	**2,725**	**17.54**	**3,050**	**17.2**	**3,189**	**16.69**
− Food and beverages	1,744	22.68	1,856	20.93	2,164	19.62	2,386	18.59	2,725	17.54	3,050	17.2	3,189	16.69
Labor-intensive production	**2,183**	**28.38**	**2,566**	**28.94**	**3,297**	**29.89**	**3,973**	**30.96**	**4,912**	**31.61**	**5,561**	**31.37**	**6,183**	**32.36**
− Textiles	373	4.85	429	4.84	540	4.9	618	4.82	719	4.63	874	4.93	1,030	5.39
− Wearing apparel	546	7.1	643	7.25	876	7.94	1,073	8.36	1,377	8.86	1,446	8.16	1,762	9.22
− Leather tanning and processing	253	3.29	282	3.18	340	3.08	374	2.91	459	2.95	514	2.9	490	2.56
− Wood and wood products	551	7.16	626	7.06	795	7.21	917	7.15	1,133	7.29	1,280	7.22	1,404	7.35
− Furniture	460	5.98	586	6.61	746	6.76	991	7.72	1,224	7.88	1,447	8.16	1,497	7.84
Capital-intensive production	**2,938**	**38.19**	**3,457**	**38.99**	**4,342**	**39.37**	**5,069**	**39.5**	**6,222**	**40.06**	**7,273**	**41.03**	**7,868**	**41.19**
− Tobacco products	23	0.3	27	0.3	22	0.2	23	0.18	24	0.15	24	0.14	24	0.13
− Paper and paper products	361	4.69	414	4.67	494	4.48	601	4.68	713	4.59	845	4.77	891	4.66
− Chemical and chemical products	339	4.41	390	4.4	488	4.42	574	4.47	661	4.26	781	4.4	881	4.61
− Non-metallic mineral products	956	12.43	1,025	11.56	1,139	10.33	1,217	9.48	1,432	9.22	1,579	8.91	1,632	8.54
− Basic metal products	106	1.38	142	1.6	190	1.72	237	1.85	293	1.89	368	2.08	427	2.24
− Fabricated metal products	514	6.68	658	7.42	954	8.65	1,193	9.3	1,558	10.03	1,841	10.38	2,067	10.82
− Rubber and plastic products	411	5.34	513	5.79	669	6.07	772	6.02	955	6.15	1,146	6.46	1,221	6.39
− Coke, refined petroleum products	10	0.13	12	0.14	11	0.1	10	0.08	11	0.07	12	0.07	22	0.12
− Publishing and printing	218	2.83	276	3.11	375	3.4	442	3.44	575	3.7	677	3.82	703	3.68
Machinery & technology-intensive goods	**826**	**10.73**	**987**	**11.13**	**1,226**	**11.11**	**1,406**	**10.96**	**1,675**	**10.78**	**1,847**	**10.42**	**1,865**	**9.75**
− Machinery and equipment	198	2.57	262	2.96	326	2.96	401	3.12	479	3.08	516	2.91	534	2.8
− Office, accounting and computing machinery	3	0.04	5	0.06	8	0.07	14	0.11	17	0.11	20	0.11	20	0.1
− Electrical machinery and apparatus	143	1.86	165	1.86	210	1.9	242	1.89	309	1.99	323	1.82	350	1.83
− Television and communication equipment	77	1	81	0.91	102	0.92	120	0.94	155	1	165	0.93	178	0.93
− Medical and optical instruments, watches	40	0.52	42	0.47	51	0.46	54	0.42	61	0.39	69	0.39	75	0.39
− Motor vehicles	141	1.83	163	1.84	215	1.95	214	1.67	250	1.61	290	1.64	218	1.14
− Other transport equipment	224	2.91	269	3.03	314	2.85	361	2.81	404	2.6	464	2.62	490	2.56
Total manufacturing	**7,691**	**100**	**8,866**	**100**	**11,029**	**100**	**12,834**	**100**	**15,534**	**100**	**17,731**	**100**	**19,105**	**100**

Source: calculations from VES 2001-2007 (for the data on manufacturing firms in the period 2000-2006)

Table A3.2 Employment by Manufacturing Sub-sectors, 2000-2006 (*Unit: people and %)*

	2000		2001		2002		2003		2004		2005		2006	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Agricultural resource-intensive	**263,440**	**16.7**	**291,479**	**16.4**	**346,814**	**15.9**	**382,218**	**14.9**	**421,525**	**14.3**	**446,882**	**14.0**	**451,652**	**13.1**
− Food and beverages	263,440	16.7	291,479	16.4	346,814	15.9	382,218	14.9	421,525	14.3	446,882	14.0	451,652	13.1
Labor-intensive production	**790,151**	**50.1**	**890,619**	**50.1**	**1,112,466**	**51.1**	**1,359,118**	**52.9**	**1,567,638**	**53.2**	**1,699,521**	**53.1**	**1,854,582**	**53.6**
− Textiles	127,043	8.1	141,193	7.9	153,285	7.0	171,150	6.7	178,384	6.0	194,152	6.1	203,898	5.9
− Wearing apparel	218,832	13.9	246,826	13.9	349,366	16.1	442,430	17.2	510,639	17.3	533,982	16.7	606,229	17.5
− Leather tanning and processing	310,618	19.7	343,432	19.3	403,185	18.5	483,174	18.8	536,004	18.2	574,919	18.0	593,359	17.2
− Wood and wood products	63,230	4.0	67,019	3.8	83,858	3.9	91,595	3.6	112,025	3.8	121,729	3.8	118,717	3.4
− Furniture	70,428	4.5	92,149	5.2	122,772	5.6	170,769	6.6	230,586	7.8	274,739	8.6	332,379	9.6
Capital-intensive production	**378,356**	**24.0**	**426,336**	**24.0**	**511,725**	**23.5**	**587,964**	**22.9**	**684,883**	**23.2**	**741,719**	**23.2**	**789,483**	**22.8**
− Tobacco products	12,179	0.8	13,628	0.8	13,621	0.6	14,268	0.6	14,726	0.5	15,023	0.5	15,126	0.4
− Paper and paper products	37,535	2.4	40,145	2.3	48,502	2.2	55,109	2.1	63,407	2.1	76,303	2.4	72,488	2.1
− Chemical and chemical products	56,136	3.6	59,128	3.3	67,410	3.1	72,977	2.8	80,281	2.7	88,324	2.8	97,030	2.8
− Non-metallic mineral products	126,737	8.0	146,833	8.3	173,464	8.0	199,842	7.8	224,975	7.6	233,548	7.3	237,445	6.9
− Basic metal products	29,252	1.9	31,250	1.8	32,738	1.5	37,442	1.5	40,907	1.4	43,510	1.4	47,634	1.4
− Fabricated metal products	42,583	2.7	49,420	2.8	68,138	3.1	84,077	3.3	109,461	3.7	125,458	3.9	144,300	4.2
− Rubber and plastic products	51,431	3.3	60,729	3.4	78,315	3.6	92,684	3.6	113,513	3.8	117,687	3.7	130,372	3.8
− Coke, refined petroleum products	813	0.1	894	0.1	1,123	0.1	838	0.0	1,006	0.0	1,242	0.0	3,900	0.1
− Publishing and printing	21,690	1.4	24,309	1.4	28,414	1.3	30,727	1.2	36,607	1.2	40,624	1.3	41,188	1.2
Machinery & technology-intensive goods	**144,411**	**9.2**	**168,242**	**9.5**	**204,785**	**9.4**	**239,279**	**9.3**	**275,177**	**9.3**	**313,483**	**9.8**	**363,545**	**10.5**
− Machinery and equipment	31,587	2.0	37,515	2.1	36,997	1.7	44,881	1.7	50,258	1.7	51,106	1.6	54,063	1.6
− Office, accounting and computing machinery	3,083	0.2	2,899	0.2	3,672	0.2	4,691	0.2	5,991	0.2	11,165	0.3	16,291	0.5
− Electrical machinery and apparatus	39,625	2.5	44,184	2.5	54,389	2.5	63,709	2.5	68,230	2.3	80,027	2.5	99,257	2.9
− Television and communication equipment	14,557	0.9	15,735	0.9	18,675	0.9	23,899	0.9	29,038	1.0	35,791	1.1	41,866	1.2
− Medical and optical instruments, watches	6,785	0.4	8,272	0.5	9,401	0.4	10,344	0.4	11,965	0.4	11,186	0.3	13,210	0.4
− Motor vehicles	14,632	0.9	17,288	1.0	25,814	1.2	26,607	1.0	32,086	1.1	36,083	1.1	44,361	1.3
− Other transport equipment	34,142	2.2	42,349	2.4	55,837	2.6	65,148	2.5	77,609	2.6	88,125	2.8	94,497	2.7
Total manufacturing	**1,576,358**	**100**	**1,776,676**	**100**	**2,175,790**	**100**	**2,568,579**	**100**	**2,949,223**	**100**	**3,201,605**	**100**	**3,459,262**	**100**

Source: calculations from VES 2001-2007 (for the data on manufacturing firms in the period 2000-2006)

Table A3.3 The Manufacturing Sector by Types of Ownership, 2000-2006

Year	Total		SOEs		Non-SOEs		FDIs	
Number of firms	*No. of firms*	*%*	*No. of firms*	*%*	*No. of firms*	*%*	*No. of firms*	*%*
2000	7,691	100	1,597	20.76	5,076	66.00	1,018	13.24
2001	8,866	100	1,497	16.88	6,136	69.21	1,233	13.91
2002	11,029	100	1,536	13.93	7,906	71.68	1,587	14.39
2003	12,834	100	1,477	11.51	9,445	73.59	1,912	14.9
2004	15,534	100	1,451	9.34	11,833	76.17	2,250	14.48
2005	17,731	100	1,362	7.68	13,825	77.97	2,544	14.35
2006	19,105	100	1,312	6.87	14,861	77.79	2,932	15.35
Manufacturing output	*Billion VND*	*%*	*Billion VND*	*%*	*Billion VND*	*%*	*Billion VND*	*%*
2000	237,000	100	93,500	39.45	41,500	17.51	102,000	43.04
2001	291,200	100	104,000	35.71	70,200	24.11	117,000	40.18
2002	369,000	100	132,000	35.77	82,000	22.22	155,000	42.01
2003	466,000	100	154,000	33.05	111,000	23.82	201,000	43.13
2004	612,000	100	189,000	30.88	157,000	25.65	266,000	43.46
2005	728,000	100	205,000	28.16	200,000	27.47	323,000	44.37
2006	892,000	100	230,000	25.78	243,000	27.24	419,000	46.97
Manufacturing employment	*Workers*	*%*	*Workers*	*%*	*Workers*	*%*	*Workers*	*%*
2000	1,576,358	100	720,553	45.71	485,690	30.81	370,115	23.48
2001	1,776,676	100	726,239	40.88	606,070	34.11	444,367	25.01
2002	2,175,790	100	789,813	36.30	752,646	34.59	633,331	29.11
2003	2,568,579	100	837,419	32.60	909,707	35.42	821,453	31.98
2004	2,949,223	100	846,681	28.71	1,108,135	37.57	994,407	33.72
2005	3,201,605	100	786,839	24.58	1,248,802	39.01	1,165,964	36.42
2006	3,459,262	100	730,046	21.10	1,353,293	39.12	1,375,923	39.78
Manufacturing capital	*Billion VND*	*%*	*Billion VND*	*%*	*Billion VND*	*%*	*Billion VND*	*%*
2000	236,400	100	82,500	34.90	27,900	11.80	126,000	53.30
2001	276,500	100	94,100	34.03	41,400	14.97	141,000	50.99
2002	346,500	100	115,000	33.19	60,500	17.46	171,000	49.35
2003	425,400	100	136,000	31.97	83,400	19.61	206,000	48.43
2004	541,000	100	176,000	32.53	118,000	21.81	247,000	45.66
2005	655,000	100	206,000	31.45	157,000	23.97	292,000	44.58
2006	768,000	100	223,000	29.04	194,000	25.26	351,000	45.70

Source: calculations from VES 2001-2007 (for the data on manufacturing firms in the period 2000-2006)

Table A3.4: Description of Variables and Summary statistics

Variables	Brief description	2000	2001	2002	2003	2004	2005	2006
Output	Natural logarithm of output value (mil. VND)	8.1474	8.2088	8.2314	8.3048	8.3296	8.3785	8.519
		(2.13)	(2.102)	(2.082)	(2.062)	(2.084)	(2.058)	(2.018)
Capital	Natural logarithm of capital (mil. VND)	8.1598	8.2578	8.319	8.3926	8.4269	8.4851	8.6314
		(2.007)	(1.956)	(1.913)	(1.891)	(1.868)	(1.846)	(1.822)
Employment	Natural logarithm of employment size (persons)	4.1683	4.138	4.105	4.0892	4.0293	3.9707	3.9793
		(1.387)	(1.375)	(1.375)	(1.38)	(1.364)	(1.348)	(1.341)
Proportion of female employees	Proportion of female employees	0.3955	0.3902	0.3896	0.3915	0.3919	0.3908	0.4023
		(0.270)	(0.270)	(0.270)	(0.269)	(0.267)	(0.261)	(0.267)
Proportion of employees with contract	Proportion of employees with contract	*f*	*f*	0.7512	0.7794	0.7761	0.7979	*f*
				(0.351)	(0.330)	(0.327)	(0.305)	
PC per employees	Number of computers per employees	*f*	0.0470	0.0506	0.0507	0.0668	0.0723	*f*
			(0.083)	(0.085)	(0.084)	(0.098)	(0.099)	
Age of establishment	Age of firms (years)	7.7526	6.5684	5.8692	*f*	*f*	5.1372	*f*
		(9.997)	(8.673)	(8.442)			(7.340)	
SOEs	=1 if SOEs, =0 otherwise	0.2076	0.1688	0.1393	0.1151	0.0934	0.0768	0.0687
Domestic private enterprises	=1 if domestic private, =0 otherwise	0.6600	0.6921	0.7168	0.7359	0.7617	0.7797	0.7779
Foreign-invested enterprises	=1 if foreign-invested, =0 otherwise	0.1324	0.1391	0.1439	0.1490	0.1448	0.1435	0.1535
Exporter	=1 if firm exports, =0 otherwise	0.3771	*f*	0.3579	0.3317	0.3544	0.359	0.3507
Northern Uplands	=1 if located in Northern Uplands, =0 otherwise	0.0568	0.0539	0.0543	0.0570	0.0565	0.0565	0.0550
Red River Delta	=1 if located in Red River Delta, =0 otherwise	0.2654	0.2719	0.2809	0.2878	0.2923	0.2884	0.2863
North Central Coast	=1 if located in North Central Coast, =0 otherwise	0.0433	0.0424	0.0403	0.0391	0.0391	0.0386	0.0406
South Central Coast	=1 if located in South Central Coast, =0 otherwise	0.0750	0.0727	0.0714	0.0697	0.0677	0.0695	0.0719
Central Highlands	=1 if located in Central Highlands, =0 otherwise	0.0243	0.0215	0.0208	0.0197	0.0190	0.0198	0.0179
Southeast	=1 if located in Southeast, =0 otherwise	0.3856	0.4086	0.4191	0.4186	0.4233	0.4268	0.4299
Mekong River Delta	=1 if located in Mekong River Delta, =0 otherwise	0.1495	0.1288	0.1132	0.1081	0.1021	0.1004	0.0984
Weighted average tariff	Weighted average tariff given in fractional	0.2181	0.2195	0.2182	0.2087	0.2015	0.1927	0.1933
		(0.149)	(0.154)	(0.152)	(0.154)	(0.148)	(0.140)	(0.141)

Source: compiled from VES 2001-2007; tariff data is compiled from TRAINS database

Notes: Standard deviations for continuous variables are reported in parentheses, *f* denotes not available.

Table A3.5 The Estimates of the Cobb-Douglas vs. Translog Production Function

Variable	Cobb-Douglas	Translog
2000		
Log of capital	0.7547***	0.6311***
	(0.01)	(0.048)
Log of labour	0.2878***	0.4568***
	(0.015)	(0.063)
Log of capital squared	*f*	0.0155***
		(0.005)
Log of labour squared	*f*	0.0115
		(0.01)
Log of capital multiplied by log of labour	*f*	-0.0314***
		(0.012)
Constant term	1.2051***	1.3135***
	(0.085)	(0.184)
Adjusted R2	0.7226	0.7226
No. of observations	7691	7691
2001		
Log of capital	0.7684***	0.5982***
	(0.009)	(0.044)
Log of labour	0.3007***	0.6244***
	(0.014)	(0.057)
Log of capital squared	*f*	0.0201***
		(0.004)
Log of labour squared	*f*	0.0024
		(0.009)
Log of capital multiplied by log of labour	*f*	-0.0394***
		(0.011)
Constant term	1.1524***	1.1485***
	(0.062)	(0.169)
Adjusted R2	0.7322	0.7329
No. of observations	8866	8866
2002		
Log of capital	0.7603***	0.4124***
	(0.008)	(0.04)
Log of labour	0.2916***	0.7152***
	(0.012)	(0.049)
Log of capital squared	*f*	0.033***
		(0.004)
Log of labour squared	*f*	0.0012
		(0.008)
Log of capital multiplied by log of labour	*f*	-0.0498***
		(0.009)
Constant term	1.3449***	1.8732***
	(0.05)	(0.151)
Adjusted R2	0.726	0.7276
No. of observations	11029	11029
2003		
Log of capital	0.7505***	0.4219***

	(0.007)	(0.039)
Log of labour	0.2947***	0.7114***
	(0.011)	(0.046)
Log of capital squared	*f*	0.035***
		(0.004)
Log of labour squared	*f*	0.0152**
		(0.007)
Log of capital multiplied by log of labour	*f*	-0.0636***
		(0.009)
Constant term	1.5499***	2.0388***
	(0.051)	(0.152)
Adjusted R2	0.7332	0.7346
No. of observations	12834	12834
2004		
Log of capital	0.7615***	0.4024***
	(0.007)	(0.036)
Log of labour	0.2727***	0.5908***
	(0.009)	(0.042)
Log of capital squared	*f*	0.0361***
		(0.003)
Log of labour squared	*f*	0.0233***
		(0.007)
Log of capital multiplied by log of labour	*f*	-0.0612***
		(0.008)
Constant term	1.5436***	2.3742***
	0.7615***	(0.14)
Adjusted R2	0.7022	0.7028
No. of observations	15534	15534
2005		
Log of capital	0.7594***	0.4857***
	(0.006)	(0.033)
Log of labour	0.2672***	0.5725***
	(0.009)	(0.038)
Log of capital squared	*f*	0.0259***
		(0.003)
Log of labour squared	*f*	0.0066
		(0.006)
Log of capital multiplied by log of labour	*f*	-0.0415***
		(0.007)
Constant term	1.5096***	2.0383***
	(0.038)	(0.128)
Adjusted R2	0.7207	0.7217
No. of observations	17731	17731
2006		
Log of capital	0.76***	0.4356***
	(0.006)	(0.033)
Log of labour	0.3096***	0.6842***
	(0.008)	(0.037)
Log of capital squared	*f*	0.0302***
		(0.003)
Log of labour squared	*f*	0.0065
		(0.006)

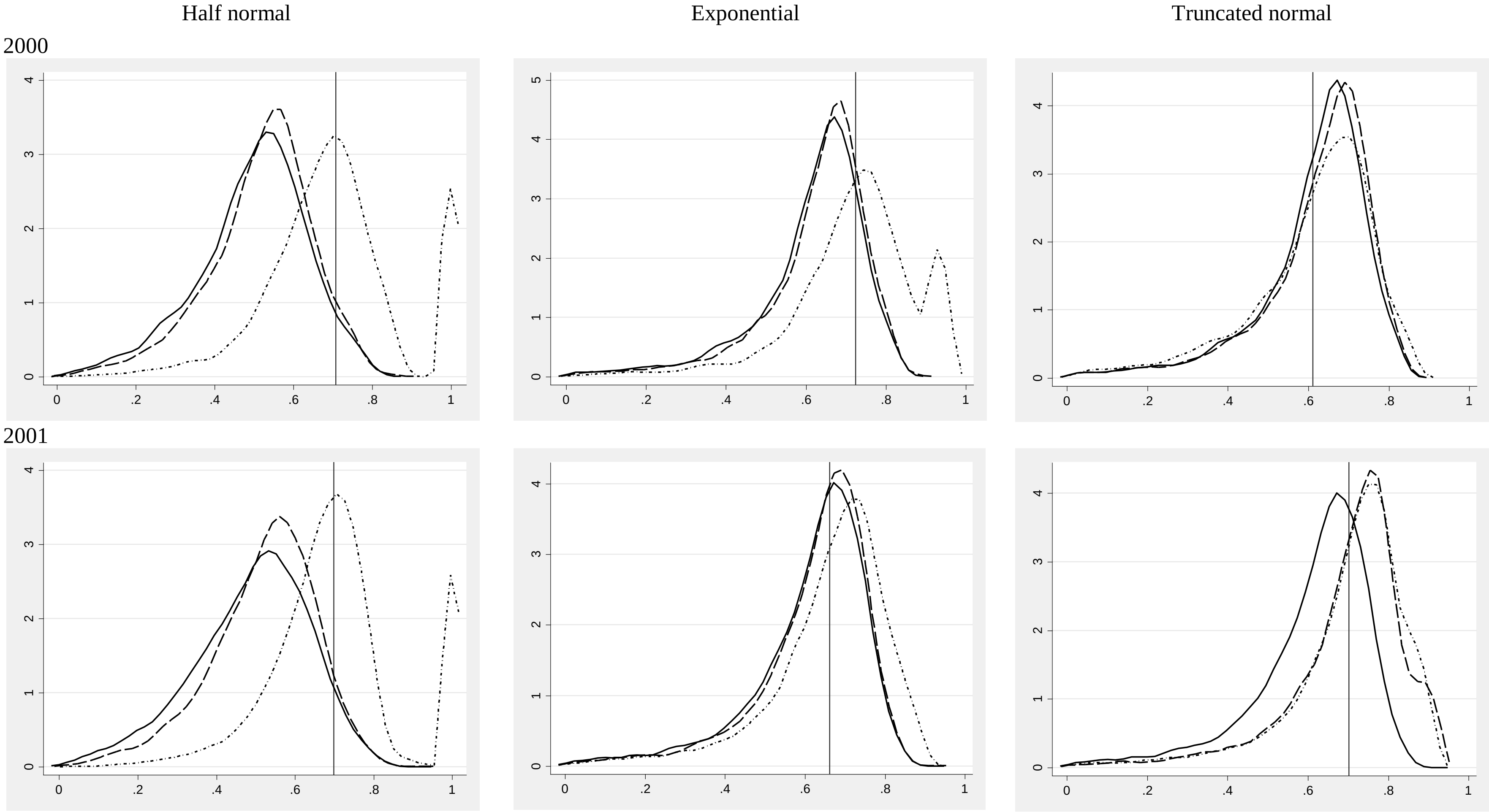
Log of capital multiplied by log of labour	*f*	-0.0489***
		(0.007)
Constant term	1.4197***	2.0401***
	(0.037)	(0.128)
Adjusted R2	0.7286	0.7298
No. of observations	19105	19105

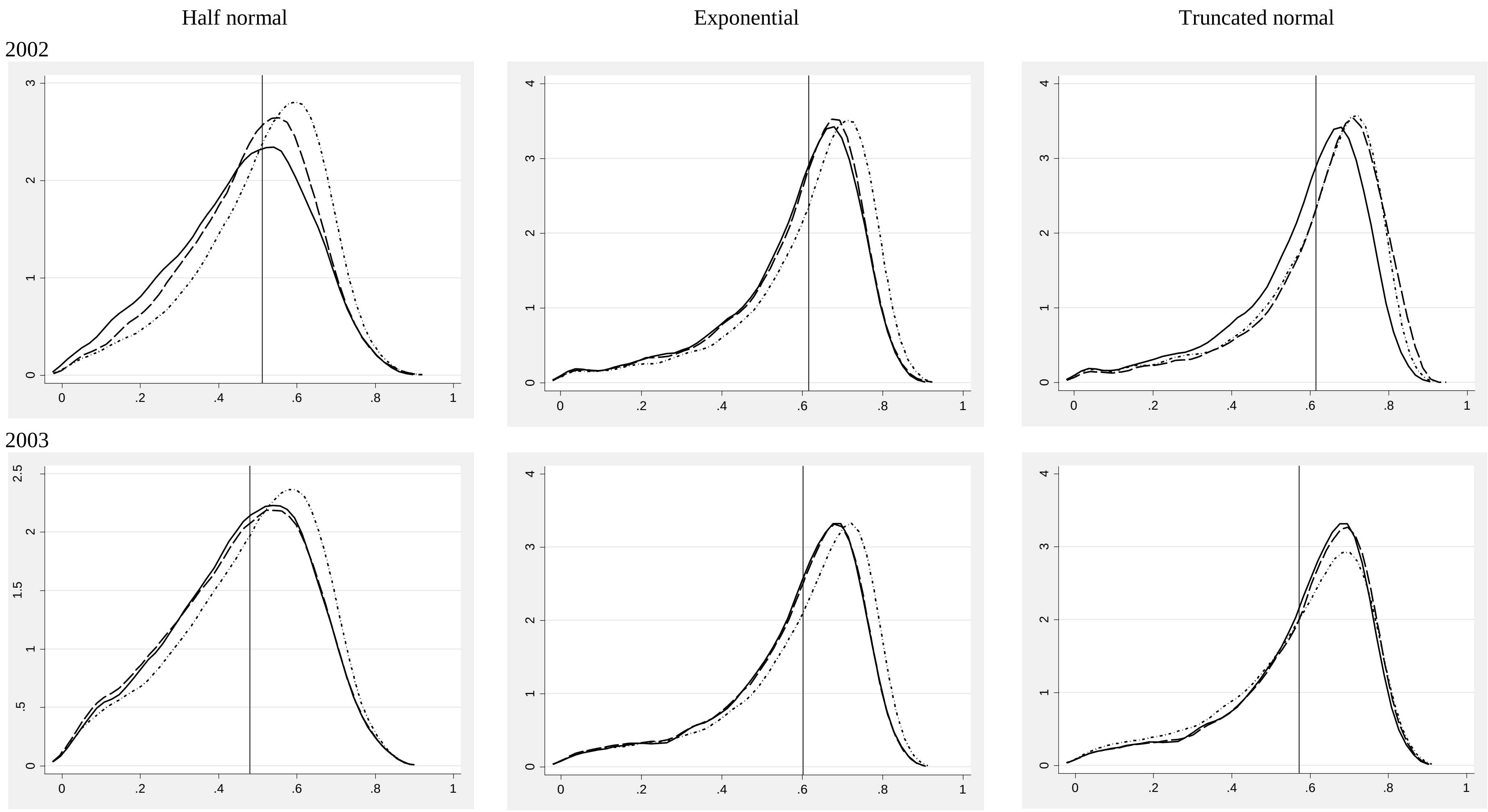
Notes:

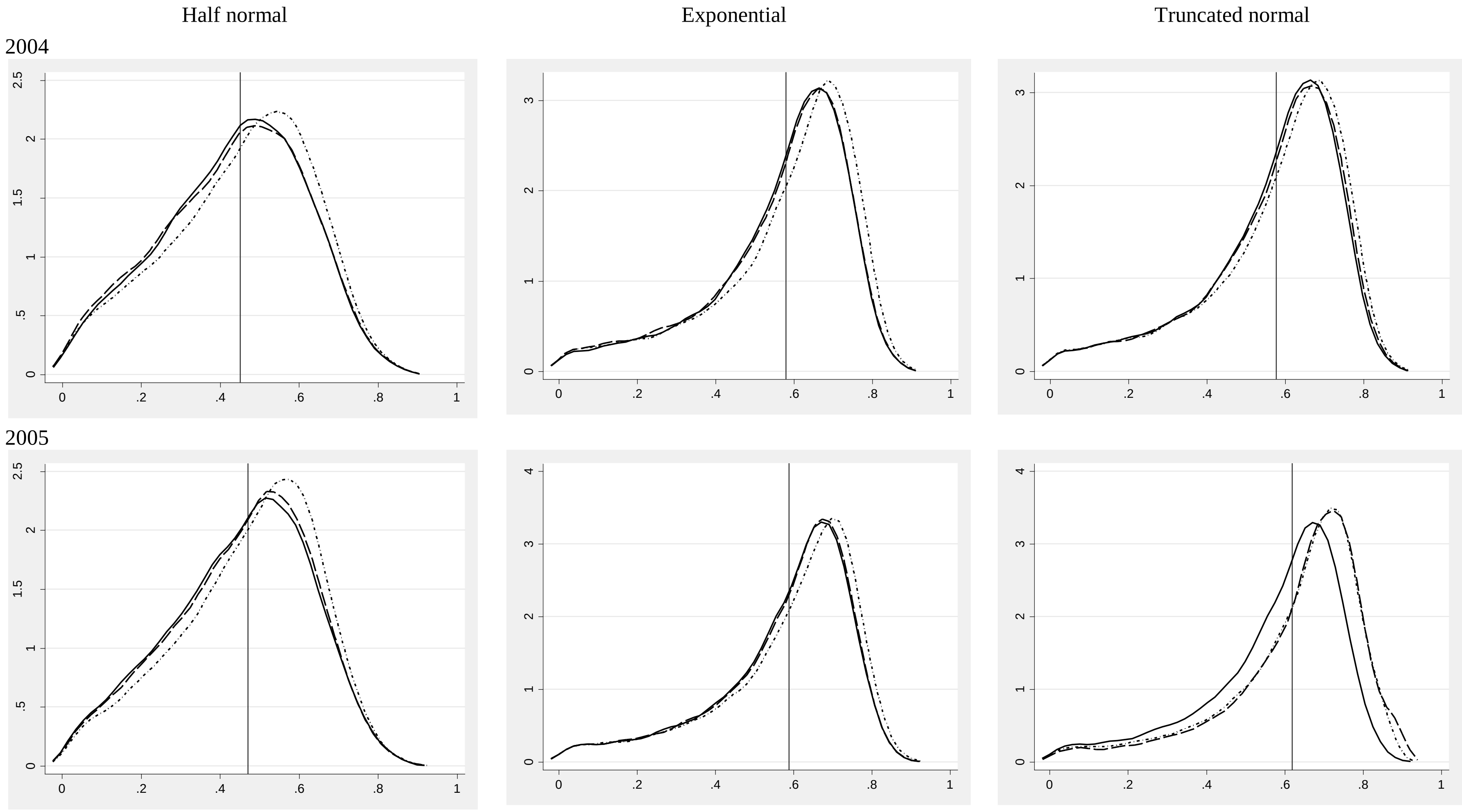
(a) ***, **, and * refers to the variables of which the estimated coefficients are statistically significant at level of 0.01; 0.05; and 0.1 respectively.

(b) *f* denotes not applicable in estimation.

Figure A3.1 Kernel Density Plots of Technical Efficiency Levels Under Different Assumptions

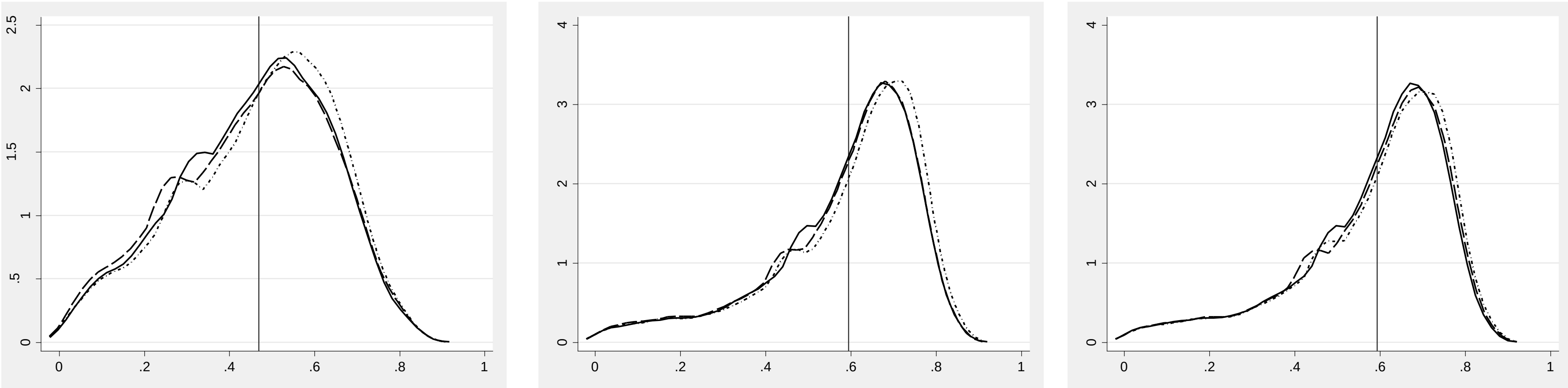



Half normal
Exponential
Truncated normal
2002
2003
0
.5
1
1.5
2
2.5
3
4
0
.2
.4
.6
.8
1


Half normal
Exponential
Truncated normal
2004
2005
0
.5
1
1.5
2
2.5
3
4
.2
.4
.6
.8

Half normal | Exponential | Truncated normal

2006



Notes:

The solid lines represent the estimated technical efficiency under the assumption of homoscedasticity; the long dashed lines are those estimated under the assumption that the error term v_i is heteroscedastic; the dotted line are efficiency estimates when both two error terms v_i and u_i are assumed heteroscedastic.

Figure A3.2 Kernel Density Plots of the Technical Efficiency, 2000-2006

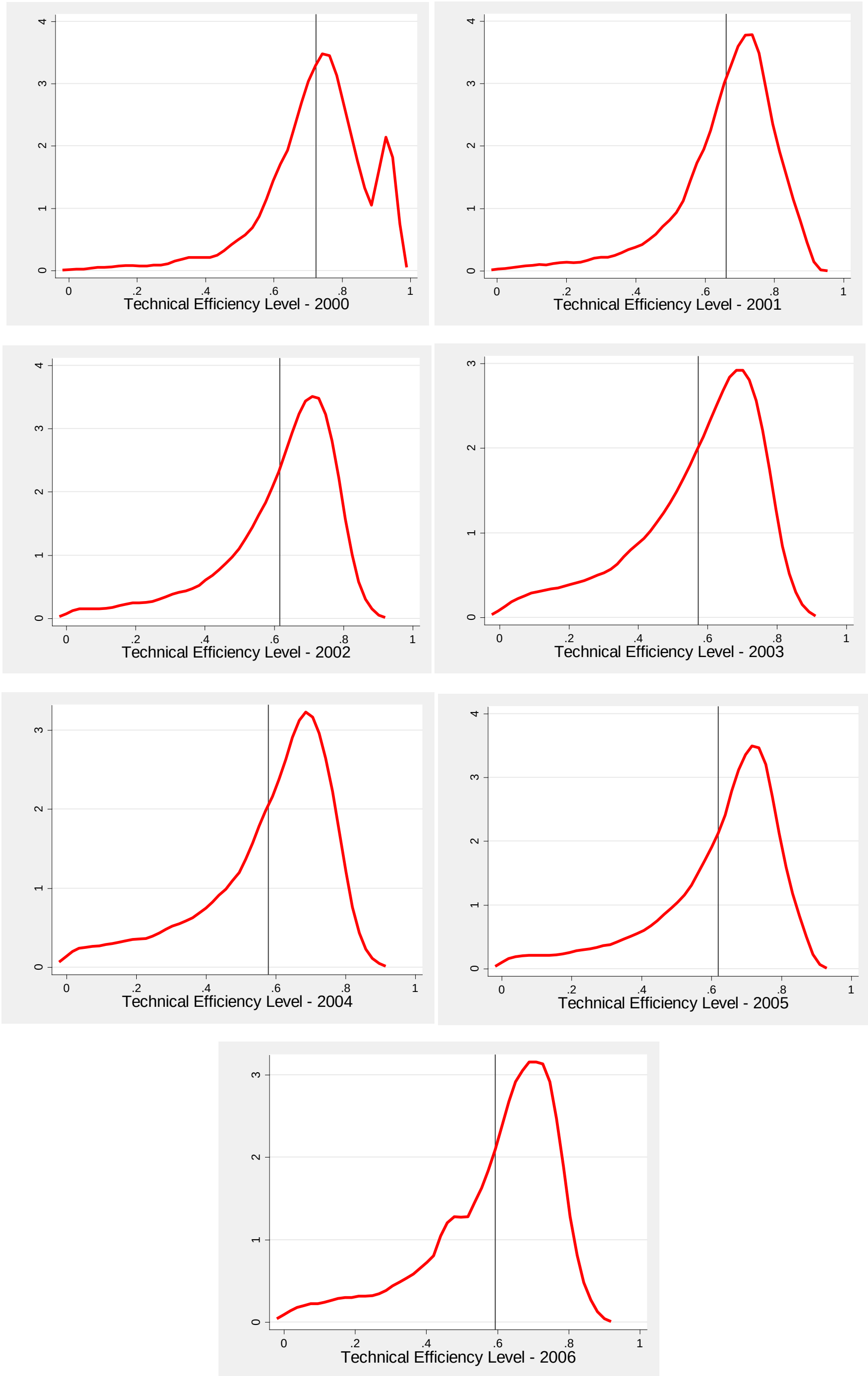
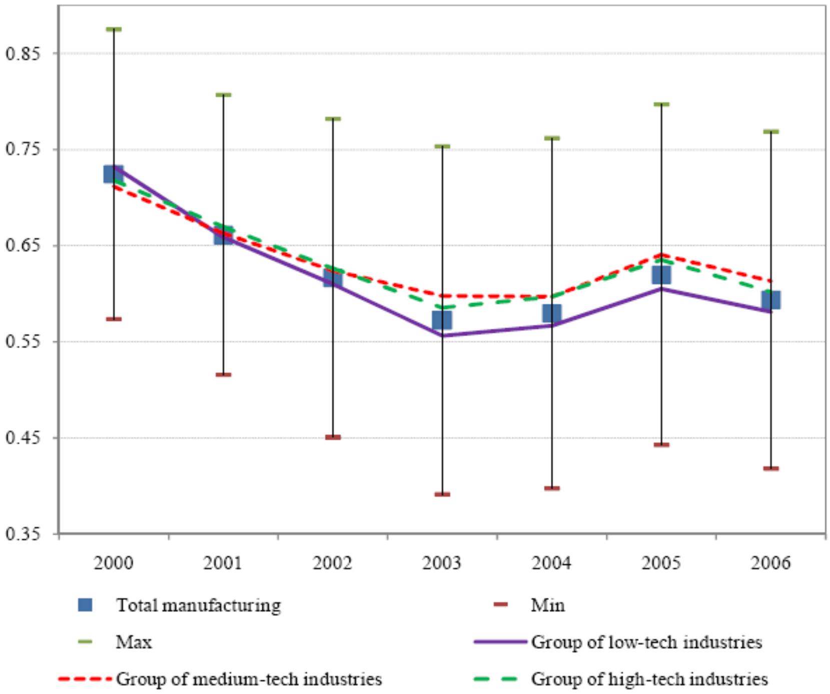


Figure A3.3. Technical Efficiency by Production Technology, 2000-2006



Notes: the classification of manufacturing activities in these three broadly defined sub-sectors is based on the UNIDO's definition of manufacturing activities by level of production technology (as noted in section 1 of this study).

Figure A3.4a Technical Efficiency of Red River Delta, 2000-2006

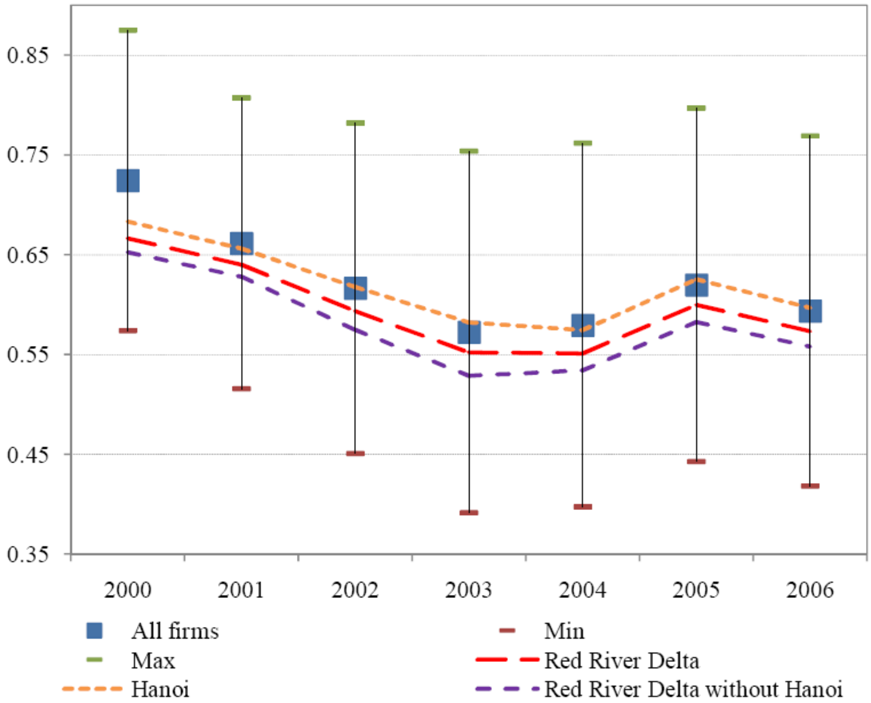


Figure A3.4b Technical Efficiency of Southeast, 2000-2006

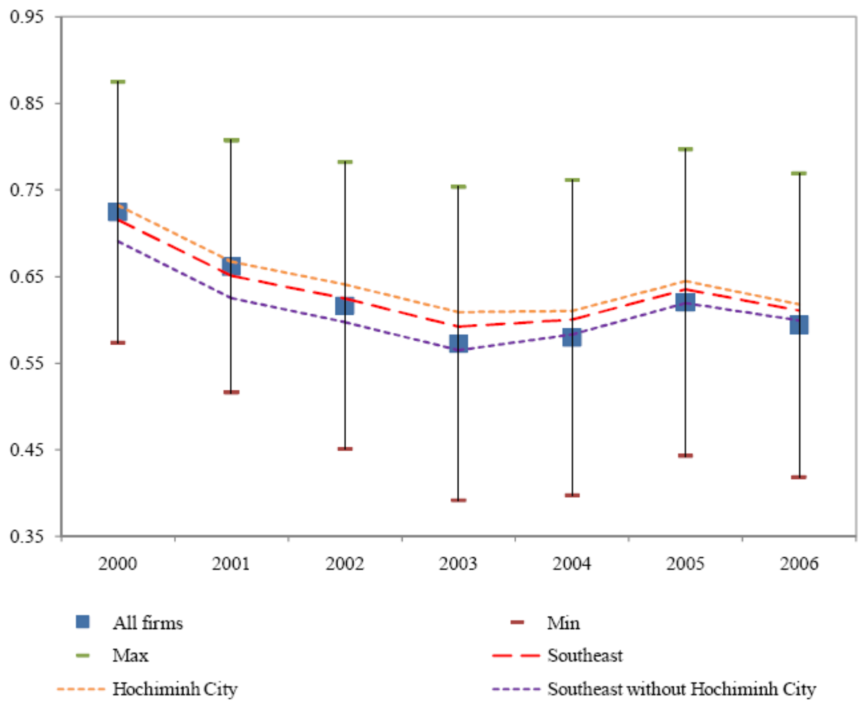


Table A3.6 Estimated technical efficiency vs. Dollar and Wei's (2007) ARPK

	2000	2001	2002	2003	2004	2005	2006
Observed average revenue product of capital (as per Dollar and Wei, 2007)							
SOEs	1.2477	1.2110	1.3534	1.3227	1.3185	1.2741	1.2367
DPEs	1.5234	1.4207	1.1986	1.2154	1.2333	1.2156	1.2460
FIEs	0.9528	0.9282	0.9473	0.9753	1.0437	1.0522	1.0869
Average	1.3881	1.3156	1.2721	1.2582	1.2698	1.2369	1.2143
Estimated TE as reported in table 3.6 and 3.11, chapter 3							
SOEs	0.7047	0.6636	0.6369	0.6027	0.6272	0.7268	0.6534
DPEs	0.7481	0.6806	0.6295	0.5818	0.5826	0.6159	0.5973
FDIs	0.6364	0.5622	0.5311	0.5027	0.5319	0.5834	0.5479
Average	0.7243	0.6612	0.6163	0.5724	0.5794	0.6198	0.5936

Notes:

a. Figures in the upper panel of this table are obtained from calculating the average revenue product of capital (ARPK) as per Dollar and Wei's (2007) for the manufacturing sector as a whole as well as sub-sectors by types of ownership.

b. Figures in the lower panel are extracted from table 3.6 (for average level of technical efficiency) and 3.11 (for the levels according to types of ownership).

Appendix A4

Table A4.1 Description of Variables and Selected Summary Statistics

Variables	Brief description	2000	2001	2002	2003	2004	2005	2006
Output	Natural logarithm of output value (mil. VND)	8.1474 (2.13)	8.2088 (2.102)	8.2314 (2.082)	8.3048 (2.062)	8.3296 (2.084)	8.3785 (2.058)	8.519 (2.018)
Capital	Natural logarithm of capital (mil. VND)	8.1598 (2.007)	8.2578 (1.956)	8.319 (1.913)	8.3926 (1.891)	8.4269 (1.868)	8.4851 (1.846)	8.6314 (1.822)
Employment	Natural logarithm of employment size (persons)	4.1683 (1.387)	4.138 (1.375)	4.105 (1.375)	4.0892 (1.38)	4.0293 (1.364)	3.9707 (1.348)	3.9793 (1.341)
Proportion of female employees	Proportion of female employees	0.3955 (0.270)	0.3902 (0.270)	0.3896 (0.270)	0.3915 (0.269)	0.3919 (0.267)	0.3908 (0.261)	0.4023 (0.267)
Proportion of employees with contract	Proportion of employees with contract	*f*	*f*	0.7512 (0.351)	0.7794 (0.330)	0.7761 (0.327)	0.7979 (0.305)	*f*
PC per employees	Number of computers per employees	*f*	0.0470 (0.083)	0.0506 (0.085)	0.0507 (0.084)	0.0668 (0.098)	0.0723 (0.099)	*f*
Age of establishment	Age of firms (years)	7.7526 (9.997)	6.5684 (8.673)	5.8692 (8.442)	*f*	*f*	5.1372 (7.340)	*f*
SOEs	=1 if SOEs, =0 otherwise	0.2076	0.1688	0.1393	0.1151	0.0934	0.0768	0.0687
Domestic private enterprises	=1 if domestic private, =0 otherwise	0.6600	0.6921	0.7168	0.7359	0.7617	0.7797	0.7779
Foreign-invested enterprises	=1 if foreign-invested, =0 otherwise	0.1324	0.1391	0.1439	0.1490	0.1448	0.1435	0.1535
Exporter	=1 if firm exports, =0 otherwise	0.3771	*f*	0.3579	0.3317	0.3544	0.359	0.3507
Northern Uplands	=1 if located in Northern Uplands, =0 otherwise	0.0568	0.0539	0.0543	0.0570	0.0565	0.0565	0.0550
Red River Delta	=1 if located in Red River Delta, =0 otherwise	0.2654	0.2719	0.2809	0.2878	0.2923	0.2884	0.2863
North Central Coast	=1 if located in North Central Coast, =0 otherwise	0.0433	0.0424	0.0403	0.0391	0.0391	0.0386	0.0406
South Central Coast	=1 if located in South Central Coast, =0 otherwise	0.0750	0.0727	0.0714	0.0697	0.0677	0.0695	0.0719
Central Highlands	=1 if located in Central Highlands, =0 otherwise	0.0243	0.0215	0.0208	0.0197	0.0190	0.0198	0.0179
Southeast	=1 if located in Southeast, =0 otherwise	0.3856	0.4086	0.4191	0.4186	0.4233	0.4268	0.4299
Mekong River Delta	=1 if located in Mekong River Delta, =0 otherwise	0.1495	0.1288	0.1132	0.1081	0.1021	0.1004	0.0984
Weighted average tariff	Weighted average tariff given in fractional	0.2181 (0.149)	0.2195 (0.154)	0.2182 (0.152)	0.2087 (0.154)	0.2015 (0.148)	0.1927 (0.140)	0.1933 (0.141)
Import penetration	Import value/output, obtained from SAM 2000	0.2440 (0.209)	0.2549 (0.211)	0.2627 (0.21)	*f*	*f*	*f*	*f*
Export ratio	Export value/output, obtained from SAM 2000	0.2397 (0.190)	0.2362 (0.189)	0.2355 (0.189)	*f*	*f*	*f*	*f*

Source: compiled from VES 2001-2007; tariff data is compiled from TRAINS database; Import penetration and Export ratio are calculated from the Vietnam SAM 2000;
Notes: Standard deviations for continuous variables are reported in parentheses, *f* denotes not available.

Table A4.2 Estimated level of technical efficiency when determinants of technical efficiency are also included in the production function

	Previous estimates	New estimates
2000	0.7243	0.7116
	(0.151)	(0.174)
2001	0.6612	0.6465
	(0.146)	(0.158)
2002	0.6163	0.6025
	(0.166)	(0.172)
2003	0.5724	0.5698
	(0.181)	(0.191)
2004	0.5794	0.5747
	(0.182)	(0.189)
2005	0.6198	0.6085
	(0.177)	(0.188)
2006	0.5936	0.5909
	(0.175)	(0.18)

Notes: ‘new estimates’ of technical efficiency are obtained using the same set of assumptions used to derive the ‘previous estimates’ of technical efficiency in chapter 3 (see 3.4.1 for more details).

Table A4.3 Determinants of Investment Efficiency as per Dollar and Wei's (2007), 2000-2006

	2000	2001	2002	2003	2004	2005	2006
Types of ownership							
SOEs	0.3488***	0.3237***	0.3231***	0.3746***	0.285***	0.2214***	0.2255***
	(0.036)	(0.032)	(0.031)	(0.029)	(0.026)	(0.028)	(0.024)
DPEs	0.4896***	0.3853***	0.4071***	0.3674***	0.2829***	0.2848***	0.1307***
	(0.031)	(0.026)	(0.025)	(0.023)	(0.021)	(0.019)	(0.016)
Firm characteristics							
Proportion of female employees	-0.0382	-0.0437	-0.0636*	-0.0606**	-0.0041	-0.0491**	-0.0429*
	(0.038)	(0.035)	(0.034)	(0.029)	(0.028)	(0.025)	(0.023)
Proportion of employees with contract	*f*	*f*	0.1255***	0.1057***	0.1318***	0.1715***	*f*
			(0.025)	(0.025)	(0.023)	(0.022)	
PC per employees	*f*	0.2954**	0.1768*	-0.0944	-0.0735	-0.1952***	*f*
		(0.105)	(0.101)	(0.09)	(0.07)	(0.067)	
Age of establishment	0.002*	0.0014	0.0025**	*f*	*f*	0.0051***	*f*
	(0.001)	(0.001)	(0.001)			(0.001)	
Regional effects							
Red River Delta	0.0484	0.066*	0.0427	0.1633***	0.0141	0.0554*	0.055**
	(0.045)	(0.041)	(0.036)	(0.034)	(0.031)	(0.029)	(0.027)
North Central Coast	0.0232	-0.012	-0.0948*	0.0327	-0.0634	0.0201	0.0104
	(0.062)	(0.055)	(0.05)	(0.047)	(0.044)	(0.04)	(0.038)
South Central Coast	0.2068***	0.125**	0.1127**	0.213***	0.1163***	0.1632***	0.1059***
	(0.054)	(0.05)	(0.044)	(0.042)	(0.039)	(0.036)	(0.034)
Central Highlands	-0.0154	-0.1647**	-0.1045*	0.005	-0.0905	-0.1193**	-0.0659
	(0.076)	(0.073)	(0.064)	(0.061)	(0.058)	(0.053)	(0.05)
Southeast	0.0897**	0.0927**	0.0972***	0.2457***	0.147***	0.1953***	0.1658***
	(0.045)	(0.041)	(0.036)	(0.034)	(0.031)	(0.029)	(0.027)
Mekong River Delta	0.209***	0.2135***	0.1604***	0.2334***	0.1927***	0.2631***	0.197***
	(0.051)	(0.047)	(0.042)	(0.04)	(0.037)	(0.033)	(0.032)
Export orientation							
Exporter	0.1812***	*f*	0.1016***	0.1195***	0.0971***	0.1583***	0.2153**
	(0.024)		(0.02)	(0.019)	(0.016)	(0.015)	(0.104)
Constant term	-0.5821***	-0.469***	-0.5878***	-0.6484***	-0.5118***	-0.6137***	-0.2814***
	(0.052)	(0.048)	(0.048)	(0.045)	(0.041)	(0.039)	(0.031)
R^2	0.4032	0.3151	0.3085	0.2864	0.2106	0.3107	0.1162
No. of observations	7,691	8,866	11,029	12,834	15,534	17,731	19,105

Notes:

f) *f* denotes not applicable.

g) ***, **, and * refers to the variables of which the estimated coefficients are statistically significant at level of 0.01; 0.05; and 0.1 respectively;

h) Based on the F test results, the null hypothesis of homoskedasticity is decisively rejected. Therefore, the Huber (1967) corrected standard errors are reported in parentheses.

Table A4.4 Determinants of technical efficiency under different distributional assumptions of the technical inefficiency error terms

	Using truncated normal (extracted from table 4.3)			Using exponential distribution (new estimates)		
	2003	**2005**	**2006**	**2003**	**2005**	**2006**
Types of ownership						
SOEs	0.1702***	0.0427***	0.1143***	0.1892***	0.052***	0.1185***
	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)
DPEs	0.1309***	0.0359***	0.0504***	0.1401***	0.0307***	0.0503***
	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)
Firm characteristics						
Proportion of female employees	-0.095***	-0.0211***	-0.0609***	-0.1677***	-0.0310***	-0.1437***
	(0.007)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Proportion of employees with contract	0.075***	0.0925***	*f*	0.0769***	0.1057***	*f*
	(0.005)	(0.004)		(0.005)	(0.005)	
PC per employees	-0.0169	-0.0674***	*f*	-0.0138***	-0.0732	*f*
	(0.021)	(0.014)		(0.019)	(0.014)	
Age of establishment	*f*	0.0091***	*f*	*f*	0.0013***	*f*
		(0.0001)			(0.000)	
Regional effects						
Red River Delta	0.0667***	0.0528***	0.054***	0.0674***	0.0503***	0.0577***
	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)
North Central Coast	0.0146	0.0437***	0.0365***	0.0189**	0.0401***	0.0329***
	(0.01)	(0.008)	(0.008)	(0.01)	(0.008)	(0.008)
South Central Coast	0.0844***	0.0687***	0.0548***	0.094***	0.0738***	0.0646***
	(0.008)	(0.007)	(0.007)	(0.008)	(0.008)	(0.007)
Central Highlands	0.0109	-0.0298***	0.0003	0.0154	-0.0382***	0.0066
	(0.012)	(0.011)	(0.011)	(0.013)	(0.012)	(0.011)
Southeast	0.1232***	0.1218***	0.1118***	0.1232***	0.1114***	0.1093***
	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)
Mekong River Delta	0.1561***	0.1508***	0.1063***	0.1676***	0.18***	0.1298***
	(0.008)	(0.006)	(0.007)	(0.008)	(0.007)	(0.007)
Export orientation						
Exporter	0.0814***	0.0355***	0.1192***	0.0814***	0.0376***	0.1385***
	(0.004)	(0.014)	(0.014)	(0.004)	(0.003)	(0.016)
Constant term	0.3148***	0.3925***	0.4913***	0.3565***	0.3836***	0.5231***
	(0.01)	(0.008)	(0.007)	(0.009)	(0.008)	(0.007)
R^2	0.1631	0.2217	0.0853	0.1952	0.1529	0.1098
No. of observations	12,834	17,731	19,105	12,834	17,731	19,105

Notes:

a) *f* denotes not applicable.
b) ***, **, and * refers to the variables of which the estimated coefficients are statistically significant at level of 0.01; 0.05; and 0.1 respectively;
c) The Breusch-Pagan/Cook-Weisberg test for heteroscedasticity was performed for the new estimation and the test results decisively reject the null hypothesis of homoskedascity in all cases. Therefore, the Huber (1967) corrected standard errors are used and reported in parentheses;
d) Industry dummies are included but not reported for brevity

Table A4.5 Determinants of the Technical Efficiency in the panel framework

	Model 1	Model 2
Age of establishment	0.0001*	0.0001**
	(0.000)	(0.000)
Ratio of female employees	-0.0109***	-0.0134***
	(0.002)	(0.002)
PCs per employees	0.0185***	0.0262***
	(0.004)	(0.005)
Ratio of employees with contract	0.010***	0.0108***
	(0.001)	(0.001)
exporter	0.0031***	0.0042***
	(0.001)	(0.001)
Capital intensity	*f*	-0.0018***
		(0.000)
Constant terms	0.8391***	0.8462***
	(0.001)	(0.002)
R2 (within)	0.0068	0.0079
Number of observations	23520	23520
Hausman test	260.84 (p=0.000)	263.33 (p=0.000)
F test	63.38 (p=0.000)	67.97 (p=0.000)

Notes:

a) *f* denotes not applicable.

b) ***, **, and * refers to the variables of which the estimated coefficients are statistically significant at level of 0.01; 0.05; and 0.1 respectively;

c) F test results decisively reject the null hypothesis that all the coefficients in the models are not different from zero

d) Hausman test results suggest the appropriateness of the fixed-effects estimators in all models;

e) Wald test results decisively reject the null hypothesis that all the coefficients of the industry dummies are not different from zero.

Table A4.6 Technical Efficiency Premia by Regions with Distinction to Hanoi and HCMC

	2000	2001	2002	2003	2004	2005	2006
Northern Uplands	-0.0726***	-0.0536***	-0.0693***	-0.0968***	-0.0737***	-0.0909***	-0.0842***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Red River Delta without Hanoi	-0.0601***	-0.0368***	-0.0452***	-0.0409***	-0.0433***	-0.0437***	-0.0364***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
North Central Coast	-0.109***	-0.0893***	-0.0971***	-0.0841***	-0.0679***	-0.0525***	-0.055***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
South Central Coast	0.0123***	-0.0258***	0.0174***	-0.0031	-0.0037	-0.017***	-0.0196***
	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
Central Highlands	-0.0944***	-0.1576***	-0.0983***	-0.0865***	-0.0774***	-0.1182***	-0.0775***
	(0.008)	(0.011)	(0.011)	(0.01)	(0.01)	(0.01)	(0.009)
Southeast without HCMC	-0.0239***	-0.0105***	0.0109***	0.0123***	0.0111***	0.0213***	0.0214***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Mekong River Delta	0.1915***	0.1323***	0.0804***	0.0669***	0.0707***	0.0706***	0.036***
	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
Hanoi	-0.0424***	-0.014***	-0.0211***	-0.0083**	-0.0222***	-0.0209***	-0.0074**
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
HCMC	-0.0037***	0.0158***	0.0281***	0.0357***	0.0361***	0.0378***	0.037***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Overall variability	0.0857	0.0602	0.0467	0.0454	0.0429	0.0469	0.0379

Notes:

(c) ***, **, and * denotes statistically significant at the 0.01, 0.05 and 0.1 levels respectively.

(d) The standard errors reported in parentheses and the overall variability measure are calculated as suggested in Haisken-DeNew and Schmidt (1997).

Table A4.7: Trade Reforms and Firm-Level Technical Efficiency: Using Lagged Tariff

	2001	2002	2003	2004	2005	2006
Types of ownership						
SOEs	0.1244***	0.1414***	0.1766***	0.1376***	0.045***	0.1174***
	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Domestic private enterprises	0.1111***	0.1345***	0.1331***	0.0981***	0.0368***	0.0503***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)
Firm characteristics						
Proportion of female employees	-0.1203***	-0.126***	-0.1118***	-0.1062***	-0.0304***	-0.0658***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Proportion of employees with contract	*f*	0.0903***	0.0777***	0.0827***	0.0941***	*f*
		(0.005)	(0.005)	(0.005)	(0.004)	
PC per employees	0.1512***	0.1538***	0.0295	-0.0402***	-0.0524***	*f*
	(0.016)	(0.018)	(0.019)	(0.015)	(0.013)	
Age of establishment	-0.00001	0.0003	*f*	*f*	0.009***	*f*
	(0.0002)	(0.0002)			(0.0001)	
Regional effects						
Red River Delta	0.0268***	0.0347***	0.0675***	0.0386***	0.0541***	0.0577***
	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
North Central Coast	-0.0355***	-0.0287***	0.0132	0.0056	0.0381***	0.0288***
	(0.009)	(0.01)	(0.01)	(0.009)	(0.008)	(0.008)
South Central Coast	0.0278***	0.0874***	0.0918***	0.0696***	0.0726***	0.0635***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)
Central Highlands	-0.1038***	-0.0269**	0.0076	-0.0037	-0.0272**	0.0068
	(0.013)	(0.013)	(0.012)	(0.012)	(0.011)	(0.011)
Southeast	0.0601***	0.0907***	0.1218***	0.1007***	0.1213***	0.1146***
	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
Mekong River Delta	0.1873***	0.1512***	0.1627***	0.1452***	0.1618***	0.1198***
	(0.006)	(0.007)	(0.008)	(0.007)	(0.006)	(0.007)
Export orientation, trade protection						
Exporter	*f*	0.0449***	0.0786***	0.0776***	0.0346***	0.1303***
		(0.004)	(0.004)	(0.003)	(0.013)	(0.015)
Lagged tariff	-0.0872***	-0.1271***	-0.2472***	-0.1705***	-0.2677***	-0.2649***
	(0.01)	(0.011)	(0.01)	(0.011)	(0.009)	(0.009)
Constant term	0.568***	0.4141***	0.3687***	0.4063***	0.4461***	0.5426***
	(0.008)	(0.009)	(0.01)	(0.009)	(0.008)	(0.007)
R^2	0.3445	0.2194	0.2115	0.1615	0.2761	0.1368
No. of observations	8,866	11,029	12,834	15,534	17,731	19,105

Notes:

a) *f* denotes not applicable due to data availability.

b) ***, **, and * refers to the variables of which the estimated coefficients are statistically significant at level of 0.01; 0.05; and 0.1 respectively;

c) Huber (1967) corrected standard errors are reported in parentheses.

Table A4.8: Trade Reforms and Firm-Level Technical Efficiency: Test for sensitivity

	Import penetration			Export ratio		
	2000	**2001**	**2002**	**2000**	**2001**	**2002**
Types of ownership						
SOEs	0.1536***	0.1257***	0.1415***	0.1534***	0.1242***	0.1411***
	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)
Domestic private enterprises	0.1647***	0.1126***	0.1358***	0.1666***	0.1119***	0.1369***
	(0.004)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)
Firm characteristics						
Proportion of female employees	-0.1952***	-0.1348***	-0.1484***	-0.1868***	-0.1283***	-0.1391***
	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)
Proportion of employees with contract	*f*	*f*	0.0896***	*f*	*f*	0.0884***
			(0.005)			(0.005)
PC per employees	*f*	0.1576***	0.1711***	*f*	0.1532***	0.1615***
		(0.016)	(0.018)		(0.016)	(0.018)
Age of establishment	-0.0001	0.00004	0.0005*	-0.0001	-0.00001	0.0004
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Regional effects						
Red River Delta	0.0192***	0.0247***	0.034***	0.0191***	0.025***	0.0333***
	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)
North Central Coast	-0.0349***	-0.034***	-0.0262***	-0.0355***	-0.0346***	-0.0267***
	(0.009)	(0.009)	(0.01)	(0.009)	(0.009)	(0.01)
South Central Coast	0.085***	0.0268***	0.0869***	0.0851***	0.0273***	0.0872***
	(0.006)	(0.008)	(0.008)	(0.006)	(0.008)	(0.008)
Central Highlands	-0.0183*	-0.1004***	-0.0228*	-0.0144	-0.0977***	-0.0191
	(0.01)	(0.013)	(0.013)	(0.01)	(0.013)	(0.013)
Southeast	0.0608***	0.0586***	0.09***	0.0593***	0.0587***	0.0892***
	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)
Mekong River Delta	0.2649***	0.1869***	0.151***	0.2689***	0.1891***	0.155***
	(0.006)	(0.006)	(0.008)	(0.006)	(0.006)	(0.007)
Export orientation, trade protection						
Exporter	0.1406***	*f*	0.0437***	0.1446***	*f*	0.0474***
	(0.003)		(0.004)	(0.003)		(0.004)
Trade Exposure variable	0.0091	0.0093	0.0112*	0.0486***	0.0312***	0.0467***
	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
Constant term	0.5337***	0.5516***	0.3937***	0.542***	0.5596***	0.4009***
	(0.007)	(0.008)	(0.01)	(0.007)	(0.008)	(0.009)
R^2	0.5982	0.3377	0.2072	0.6012	0.3389	0.2095
No. of observations	7,691	8,866	11,029	7,691	8,866	11,029

Notes:

a) f denotes not applicable due to data availability.

b) ***, **, and * refers to the variables of which the estimated coefficients are statistically significant at level of 0.01; 0.05; and 0.1 respectively;

c) Huber (1967) corrected standard errors are reported in parentheses.

Appendix A5

Table A5.1 Reported Workplace Injuries by Provinces, 1995-2007

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
HCMC													
Number of injury cases	na	na	na	339	360	780	601	1,195	668	791	543	782	666
Of which: Number of fatal cases	20	37	27	31	41	46	29	55	60	60	64	101	na
Number of injured person	na	na	na	347	383	814	608	1,228	679	816	572	798	na
Of which: Number of dead	23	41	28	32	49	51	30	69	62	61	66	103	117
Hanoi													
Number of injury cases	na	na	na	224	196	177	364	343	355	357	98	152	183
Of which: Number of fatal cases	17	9	25	21	22	37	36	33	43	63	23	16	na
Number of injured person	na	na	na	224	202	177	368	343	357	379	105	158	na
Of which: Number of dead	17	9	31	21	23	37	39	33	44	64	24	16	17
Quang Ninh													
Number of injury cases	na	na	na	314	264	306	296	306	268	264	256	253	400
Of which: Number of fatal cases	16	24	26	16	20	28	25	28	22	22	34	41	na
Number of injured person	na	na	na	342	110	311	302	333	274	271	265	306	na
Of which: Number of dead	22	37	39	21	44	44	25	44	23	27	42	59	42
Dong Nai													
Number of injury cases	na	na	na	163	259	400	676	652	808	1,480	1,207	872	1,117
Of which: Number of fatal cases	na	11	20	17	6	4	8	13	16	30	29	30	na
Number of injured person	na	na	na	na	286	405	695	662	819	1,496	1,219	882	na
Of which: Number of dead	na	12	20	18	6	4	8	14	17	30	29	31	23
Hai Phong													
Number of injury cases	na	na	na	193	298	204	165	303	286	na	284	277	89
Of which: Number of fatal cases	15	na	na	8	10	11	13	10	15	na	14	10	na

Number of injured person	na	na	na	2 14	304	206	166	311	311	na	288	286	na
Of which: Number of dead	17	na	na	8	10	11	13	11	22	na	15	10	19
Total of 5 provinces													
Number of injury cases	na	na	na	1,233	1,377	1,867	2,102	2,799	2,385	na	2,388	2,336	2,455
Of which: Number of fatal cases	na	na	na	93	99	126	111	139	156	na	164	198	na
Number of injured person	na	na	na	na	1,285	1,913	2,139	2,877	2,440	na	2,449	2,430	na
Of which: Number of dead	na	na	na	100	132	147	115	171	168	na	176	219	218
Total of all provinces													
Number of injury cases	1,104	1,545	1,725	2,737	2,611	3,405	3,601	4,298	3,896	6,026	4,050	5,881	5,951
Of which: Number of fatal cases	230	249	202	312	335	368	362	449	469	561	443	505	505
Number of injured person	2,127	1,665	2,072	2,228	2,813	3,530	3,748	4,521	4,089	6,186	4,164	6,088	6,337
Of which: Number of dead	264	285	320	362	399	403	395	514	513	575	473	536	621

Source: Data are quoted from the Annual Workplace Accident Reports of the Labour Inspectorate of MOLISA (various years).

Table A5.2 Description of Variables and Summary statistics

Variables	Brief description	2001	2002	2004	2005
Number of injured workers	Number of injured workers (ln)	1.4433	1.4093	1.4568	1.6161
		(1.161)	(1.162)	(1.237)	(1.207)
SOEs	= 1 if state-owned enterprises, 0 otherwise	0.4911	0.399	0.3525	0.2538
		(0.501)	(0.49)	(0.478)	(0.436)
Domestic private enterprises	= 1 if private sector enterprises, 0 otherwise	0.1886	0.2264	0.2194	0.2571
		(0.392)	(0.419)	(0.414)	(0.437)
Foreign-invested enterprises	= 1 if foreign-invested enterprises, 0 otherwise	0.3203	0.3746	0.4281	0.4891
		(0.467)	(0.484)	(0.495)	(0.5)
Employment	Number of employees (ln)	5.9279	5.9026	5.9751	5.9472
		(1.31)	(1.234)	(1.304)	(1.359)
Proportion of female employees	Proportion of female employees	0.3953	0.3964	0.4187	0.4181
		(0.248)	(0.241)	(0.253)	(0.264)
Proportion of employees with contract	Proportion of employees with contract	*f*	0.8747	0.8586	0.8678
			(0.237)	(0.24)	(0.228)
PC per employees	Number of computers per employees	0.0437	0.0515	0.0615	0.0718
		(0.054)	(0.065)	(0.068)	(0.073)
Age of establishment	Age of firms (years)	12.7651	11.285	*f*	9.4101
		(12.406)	(12.124)		(10.88)
Weighted average tariff	Weighted average tariff given in fractional	0.2126	0.214	0.2075	0.2063
		(0.16)	(0.155)	(0.154)	(0.144)
Northern Uplands	=1 if located in Northern Uplands, =0 otherwise	0.0996	0.1026	0.062	0.0689
Red River Delta	=1 if located in Red River Delta, =0 otherwise	0.2918	0.241	0.2148	0.1597
North Central Coast	=1 if located in North Central Coast, =0 otherwise	0.0534	0.0505	0.0363	0.037
South Central Coast	=1 if located in South Central Coast, =0 otherwise	0.1388	0.0798	0.0832	0.1025
Central Highlands	=1 if located in Central Highlands, =0 otherwise	0.0178	0.0179	0.0106	0.0151
Southeast	=1 if located in Southeast, =0 otherwise	0.3843	0.4674	0.5386	0.563
Mekong River Delta	=1 if located in Mekong River Delta, =0 otherwise	0.0142	0.0407	0.0545	0.0538
Exporter	=1 if firm exports, =0 otherwise	*f*	0.6156	0.7383	0.0084
Food and beverages	=1 if firm is in this sector, =0 otherwise	0.1423	0.1042	0.1029	0.1059
Tobacco products	=1 if firm is in this sector, =0 otherwise	0.0071	0.0049	0.0076	0.005
Textiles	=1 if firm is in this sector, =0 otherwise	0.0819	0.0603	0.0635	0.0571
Wearing apparel	=1 if firm is in this sector, =0 otherwise	0.0427	0.0423	0.0605	0.0588
Leather tanning and processing	=1 if firm in this sector, =0 otherwise	0.0391	0.0456	0.059	0.0555

Wood and wood products	=1 if firm in this sector, =0 otherwise	0.0391	0.0554	0.053	0.0336
Paper and paper products	=1 if firm in this sector, =0 otherwise	0.032	0.0391	0.053	0.0555
Publishing and printing	=1 if firm in this sector, =0 otherwise	0.0071	0.0098	0.0045	0.0134
Coke, refined petroleum products	=1 if firm in this sector, =0 otherwise	0	0	0	0
Chemicals and chemical products	=1 if firm in this sector, =0 otherwise	0.0356	0.0489	0.0499	0.0252
Rubber and plastic products	=1 if firm in this sector, =0 otherwise	0.0676	0.0603	0.0666	0.0706
Non-metallic mineral products	=1 if firm in this sector, =0 otherwise	0.0961	0.1352	0.0908	0.1042
Basic metal products	=1 if firm in this sector, =0 otherwise	0.0498	0.044	0.0348	0.0353
Fabricated metal products	=1 if firm in this sector, =0 otherwise	0.0747	0.0782	0.0923	0.1059
Machinery and equipment	=1 if firm in this sector, =0 otherwise	0.0605	0.044	0.0439	0.0118
Office, accounting and computing machinery	=1 if firm in this sector, =0 otherwise	0.0036	0.0016	0.003	0.0017
Electrical machinery and apparatus	=1 if firm in this sector, =0 otherwise	0.032	0.0391	0.0348	0.0319
Television and communication equipment	=1 if firm in this sector, =0 otherwise	0.0036	0.0065	0.0045	0.0118
Medical and optical instruments, watches	=1 if firm in this sector, =0 otherwise	0.0036	0.0049	*f*	0.0034
Motor vehicles	=1 if firm in this sector, =0 otherwise	0.032	0.0261	0.0287	0.037
Other transport equipment	=1 if firm in this sector, =0 otherwise	0.0498	0.0603	0.0469	0.0588
Furniture	=1 if firm in this sector, =0 otherwise	0.0996	0.0896	0.0998	0.1176
Number of observations	Number of observations	281	614	661	595

Source: compiled from VES 2002-2006; tariff data is compiled from TRAINS database
Notes: Standard deviations for continuous variables are reported in parentheses, *f* denotes not applicable

Table A5.3: Determinants of Injuries: Corrected OLS

	2001	2002	2004	2005
Types of ownership				
SOEs	-0.7962***	-0.4744***	-0.5858***	-0.568***
	(0.271)	(0.14)	(0.122)	(0.158)
Domestic private enterprises	-1.2914***	-0.1534	-0.3387*	-0.2028
	(0.47)	(0.168)	(0.182)	(0.19)
Firm characteristics				
Firm size	1.1671***	0.6174***	0.539***	0.4795***
	(0.291)	(0.1)	(0.096)	(0.1)
Proportion of female employees	-2.1515***	-0.0552	-0.1376	-0.6448**
	(0.721)	(0.275)	(0.289)	(0.277)
Proportion of employees with contract	*f*	0.0574	0.1337	0.228
		(0.167)	(0.169)	(0.181)
PC per employees	-1.2971	-0.171	-0.2505	-0.7683
	(1.429)	(0.686)	(0.698)	(0.665)
Age of establishment	0.0204**	-0.0027	*f*	-0.0039
	(0.01)	(0.005)		(0.005)
Regional effects				
Red River Delta	-0.122	-0.0675	0.0621	0.0459
	(0.301)	(0.162)	(0.19)	(0.189)
North Central Coast	-0.1781	-0.0131	0.0007	0.1285
	(0.401)	(0.207)	(0.256)	(0.257)
South Central Coast	0.2581	0.0168	0.1647	0.2859
	(0.35)	(0.186)	(0.217)	(0.207)
Central Highlands	-1.2281**	-0.0916	-0.2133	0.3475
	(0.574)	(0.324)	(0.411)	(0.353)
Southeast	0.0743	0.2962*	0.4903***	0.5686***
	(0.321)	(0.161)	(0.192)	(0.181)
Mekong River Delta	-0.5691	-0.079	0.0981	0.2524
	(0.739)	(0.236)	(0.23)	(0.226)
Hanoi	-1.2482**	-0.2407	-0.2169	0.1236
	(0.519)	(0.2)	(0.211)	(0.354)
HCMC	-0.5342	0.3895**	0.5537***	0.4316**
	(0.46)	(0.187)	(0.191)	(0.181)
Export orientation				
Exporter		0.1421	-0.2226**	0.2727
		(0.099)	(0.112)	(0.46)
Selection bias correction term	1.8997**	0.2485	0.0122	-0.0193
	(0.778)	(0.231)	(0.25)	(0.265)
Constant term	-7.4193***	-2.7032***	-2.0065**	-1.4582
	(2.726)	(0.871)	(0.963)	(0.985)
Adjusted-R^2	0.4213	0.3982	0.3944	0.4127
No. of observations	281	614	661	595

Notes:

f) *f* denotes not applicable;
g) ***, **, and * refers to the variables of which the estimated coefficients are statistically significant at level of 0.01; 0.05; and 0.1 respectively;
h) robust standard errors are reported in parentheses.

Table A5.4a: Determinants of Injuries: ZINB

	2001	2002	2004	2005
Types of ownership				
SOEs	-0.2396	-0.4294**	-0.8351***	-0.9609***
	(0.298)	(0.173)	(0.201)	(0.19)
Domestic private enterprises	-0.1371	0.0563	-0.5647***	-0.2659
	(0.398)	(0.191)	(0.213)	(0.215)
Firm characteristics				
Firm size	0.6926***	0.8449***	0.8274***	0.7458***
	(0.091)	(0.065)	(0.068)	(0.062)
Proportion of female employees	-0.0613	-0.1631	-0.4913	-0.8686**
	(0.577)	(0.343)	(0.387)	(0.385)
Proportion of employees with contract	*f*	-0.2526	0.1197	0.3294
		(0.265)	(0.249)	(0.288)
PC per employees	-0.5178	-0.539	0.1225	-1.6497
	(3.216)	(1.18)	(1.136)	(1.526)
Age of establishment	-0.0075	-0.017**	*f*	-0.0034
	(0.009)	(0.007)		(0.007)
Regional effects				
Red River Delta	-0.3854	0.2116	0.3514	0.3347
	(0.299)	(0.227)	(0.301)	(0.273)
North Central Coast	-0.0364	-0.28	0.5717	0.6618
	(0.476)	(0.412)	(0.673)	(0.554)
South Central Coast	-0.0158	0.3274	0.5769*	0.6684**
	(0.342)	(0.267)	(0.333)	(0.297)
Central Highlands	-2.1643***	-0.3314	-0.5823	0.5666
	(0.496)	(0.401)	(0.465)	(0.437)
Southeast	0.3301	0.6303***	0.7678***	1.1999***
	(0.308)	(0.212)	(0.262)	(0.265)
Mekong River Delta	0.2439	0.4117	0.2732	0.8542**
	(0.577)	(0.391)	(0.321)	(0.387)
Hanoi	-0.6348	0.16	-0.2021	0.4203
	(0.436)	(0.282)	(0.296)	(0.335)
HCMC	0.3714	0.9232***	0.9196***	1.1397***
	(0.282)	(0.217)	(0.275)	(0.294)
Export orientation, trade protection				
Exporter	*f*	0.278*	-0.1335	-0.1632
		(0.153)	(0.201)	(0.494)
Constant	-2.3779***	-3.6209***	-3.743***	-3.2813***
	(0.868)	(0.563)	(0.585)	(0.593)
α (overdispersion parameter)	1.0716	1.3394	1.7673	1.4129
	(0.196)	(0.161)	(0.193)	(0.14)
No. of observations	8,866	11,029	15,534	17,731

Notes:
d) *f* denotes not applicable;
e) ***, **, and * refers to the variables of which the estimated coefficients are statistically significant at level of 0.01; 0.05; and 0.1 respectively;
f) robust standard errors are reported in parentheses.

Table A5.4b: Determinants of Injuries: ZIP

	2001	2002	2004	2005
Types of ownership				
SOEs	-0.4656**	-0.545***	-0.6448***	-0.5819***
	(0.202)	(0.197)	(0.18)	(0.207)
Domestic private enterprises	-0.3277	-0.0261	-0.383	-0.1175
	(0.278)	(0.184)	(0.24)	(0.288)
Firm characteristics				
Firm size	0.6325***	0.7494***	0.6382***	0.7562***
	(0.073)	(0.076)	(0.057)	(0.102)
Proportion of female employees	-0.6742	-0.7202**	-0.7464**	-0.764**
	(0.544)	(0.31)	(0.363)	(0.39)
Proportion of employees with contract	*f*	0.0822	0.2952	0.2419
		(0.294)	(0.278)	(0.389)
PC per employees	-1.6418	-1.1572	-1.7825	-0.3023
	(2.398)	(1.225)	(1.637)	(1.43)
Age of establishment	-0.0034	-0.0127*	*f*	-0.0247**
	(0.007)	(0.007)		(0.01)
Regional effects				
Red River Delta	-0.3496	0.2006	0.2453	0.2543
	(0.278)	(0.196)	(0.254)	(0.241)
North Central Coast	-0.0131	-0.0599	-0.2386	-0.3176
	(0.371)	(0.282)	(0.42)	(0.553)
South Central Coast	-0.1589	0.3874*	0.2377	0.5752**
	(0.311)	(0.236)	(0.279)	(0.267)
Central Highlands	-1.4659***	0.182	-0.417	0.5288
	(0.479)	(0.351)	(0.326)	(0.384)
Southeast	0.1982	0.7314***	0.9279***	1.2336***
	(0.267)	(0.215)	(0.217)	(0.236)
Mekong River Delta	0.5091	0.8694**	0.3809	0.1238
	(0.449)	(0.365)	(0.293)	(0.479)
Hanoi	-0.6265*	0.2653	-0.39*	0.1988
	(0.367)	(0.266)	(0.23)	(0.325)
HCMC	0.2398	1.0539***	0.8871***	0.9383***
	(0.251)	(0.212)	(0.253)	(0.32)
Export orientation, trade protection				
Exporter	*f*	0.1298	0.086	-0.6914
		(0.178)	(0.217)	(0.604)
Constant	-1.3286**	-2.7771***	-2.517***	-3.0448***
	(0.571)	(0.555)	(0.52)	(0.934)
α (overdispersion parameter)	*f*	*f*	*f*	*f*
No. of observations	8,866	11,029	15,534	17,731

Notes: as in Table A5.4a

Table A5.5: Determinants of injuries (adjusted by firm size)

	2001	2002	2004	2005
Types of ownership				
SOEs	-0.0021	-0.0064*	-0.0110***	-0.0131***
	(0.008)	(0.003)	(0.003)	(0.004)
DPEs	-0.0149	0-.0044	-0.0009**	0.0027**
	(0.012)	(0.005)	(0.000)	(0.000)
Firm characteristics				
Proportion of female employees	-0.0055**	-0.0049	-0.0098	-0.0207**
	(0.001)	(0.007)	(0.008)	(0.007)
Proportion of employees with contract		0.0018	0.0001	0.008
		(0.006)	(0.006)	(0.007)
PC per employees	-0.0771	-0.0213	-0.0288	-0.0429
	(0.097)	(0.023)	(0.062)	(0.038)
Age of establishment	0.0001	-0.0001		-0.0001
	(0.000)	(0.000)		(0.000)
Regional effects				
Red River Delta	-0.0173*	-0.0044	-0.0056	-0.0072
	(0.007)	(0.003)	(0.004)	(0.007)
North Central Coast	-0.0117	0.0063	-0.0255	0.0548
	(0.008)	(0.004)	(0.027)	(0.038)
South Central Coast	-0.0108	0.0008	0.002	0.004**
	(0.012)	(0.004)	(0.004)	(0.001)
Central Highlands	-0.0389**	-0.0135	-0.0096	0.0057
	(0.012)	(0.007)	(0.005)	(0.012)
Southeast	0.0008	0.0066**	0.0085**	0.0136**
	(0.007)	(0.003)	(0.003)	(0.006)
Mekong River Delta	-0.0009	-0.0111	0.0004	0.0076
	(0.014)	(0.010)	(0.005)	(0.007)
Export orientation				
Exporter	*f*	0.0049	-0.0027**	-0.0078
		(0.004)	(0.001)	(0.010)
Constant term	-0.1044***	-0.0729***	-0.0691***	-0.0968***
	(0.018)	(0.013)	(0.015)	(0.023)
R^2	0.234	0.197	0.146	0.156
Number of observation	281	614	661	595

Notes:

e) *f* denotes not applicable;

f) ***, **, and * refers to the variables of which the estimated coefficients are statistically significant at level of 0.01; 0.05; and 0.1 respectively; standard errors are reported in parentheses;

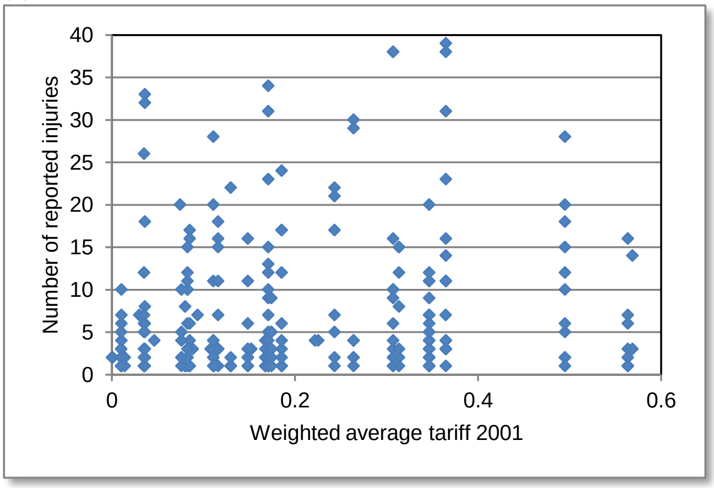
g) Industry dummies are also included in the regression but not reported here for brevity.

h) Breusch-Pagan/Cook-Weisberg test decisively reject the null hypothesis of constant variance and thus suggest the presence of heteroscedasticity in all case. Therefore, the Huber's (1976) standard errors are reported.

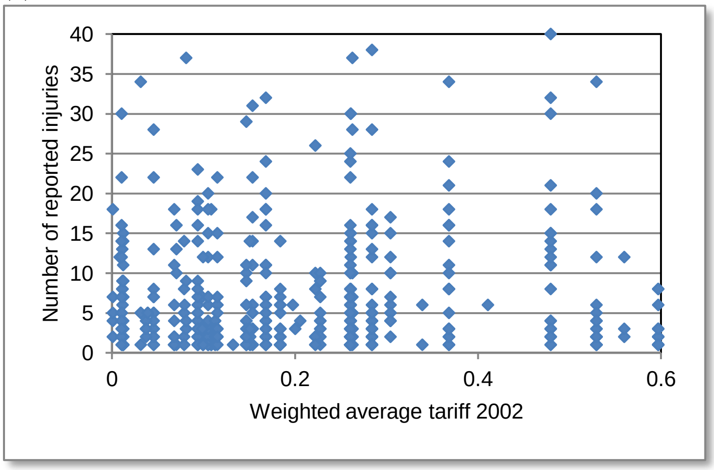
i) The Ramset RESET test rejects the null hypothesis of no omitted variables in two, out of four cases. And the functional form test results are therefore inconclusive.

Figure A5.1: Reported injuries and weighted average tariff

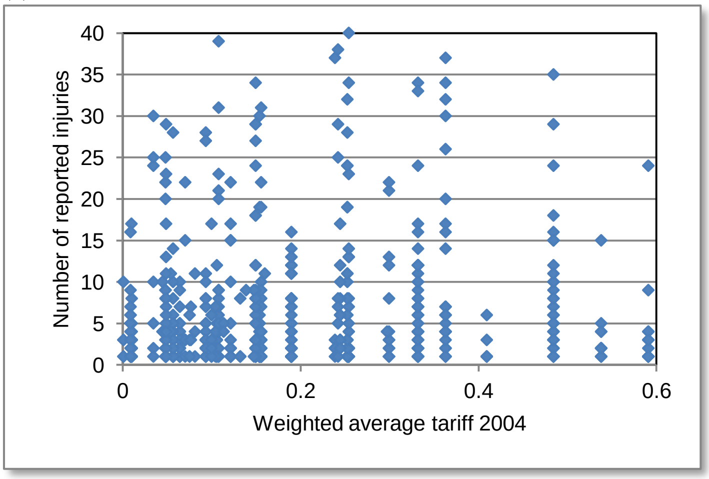
(a) 2001



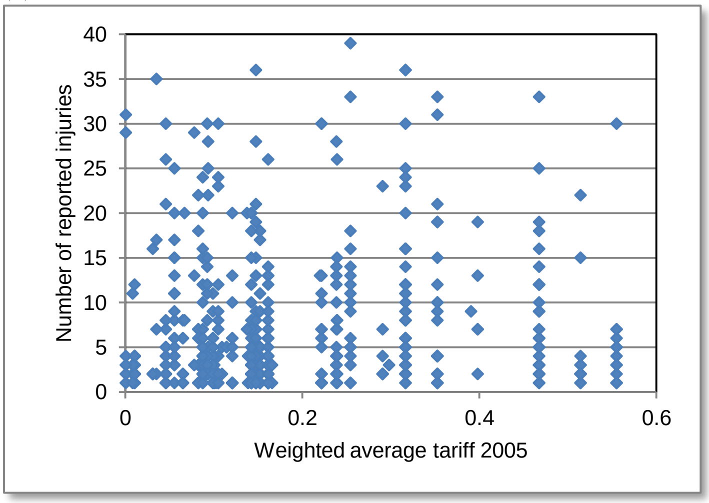
(b) 2002



(c) 2004



(d) 2005


40
35
30
25
20
15
10
5
0
Number of reported injuries
0
0.2
0.4
0.6
Weighted average tariff 2005