Impact of Trade Liberalization on Technical Efficiency of Vietnamese Manufacturing Firms*

Son Ngoc Chu
and
Kaliappa Kalirajan
Crawford School of Economics and Government
The Australian National University

---

* Paper for presentation at the Conference on "Frontier Issues in Technology, Development and Environment" organised by the Madras School of Economics and the Forum for Global Knowledge Sharing at the Madras School of Economics, March 19 -21, 2010.

Impact of Trade Liberalization on Technical Efficiency of Vietnamese Manufacturing Firms

Abstract

Using a balanced firm-specific panel data on manufacturing firms and a comprehensive set of trade data from 2000 to 2003, when substantial trade liberalization took place, this paper examines the impact of trade liberalization on technical efficiency of Vietnamese manufacturing firms. The study reveals that while more trade liberalization is conducive to better firm performance, increasing the share of skilled labour is the key for firms to achieve higher potential output in the long-run rather than using more unskilled labour, which is relatively more abundant in Vietnam. The policy implication is that more attention should be paid by policymakers to provide incentives and support for firms to facilitate upgrading the skills of their workers through different means such as on-the-job training. The results also indicate that trade liberalization has exerted further efficiency-enhancing effects through the promotion of various domestic institutional reforms and competition.

Keywords: Trade policy reforms, technical efficiency, manufacturing firms, and Vietnam.
JEL classifications: C13, D24, F13, F14, O53.

1. Introduction

Substantial trade liberalization in the last decade has been one of the driving forces of Vietnam's economic reform process. Following the introduction of the *Doi Moi* (Renovation) policy in the mid 1980s, the trade policy regime was transformed by dismantling the state monopoly in trading activities and developing a set of instruments of the market-based economy's trade regime such as tariffs, quotas and licenses (Aufret 2003). In the 1990s, in line with initial steps of integrating into the world economy by signing various bilateral trade agreements and joining multilateral organisations such as ASEAN with the ASEAN Free Trade Area framework (AFTA) and APEC, Vietnam made further important changes, which included introducing a new tariff system, giving more trading rights to the private sector, reducing import and export license requirements, step-by-step relaxing foreign exchange control. However, an increasing trend of protection emerged, particularly in the manufacturing sector, in terms of increasing average nominal tariff level and maintaining

quantitative restrictions (World Bank 2003), due to the transformation process of the trade regime and the influence of the import-substitution view in the industrial policy. Since 2000, trade liberalization has expanded substantially through the implementation of Vietnam's commitments within various bilateral and multilateral frameworks, which included the AFTA agreement (the CEPT scheme), the Vietnam-US Bilateral Trade Agreement (USBTA) and ASEAN – China Free Trade Area (ACFTA). Due to its continuous and intensive efforts, Vietnam became the 150th member of WTO on 11th January 2007. As a result, there has been a substantial reduction in tariffs and removal of many non-tariff barriers. The trade policy regime and Vietnam's economy have become much more open. As a result, domestic firms are now exposed to international competition.

Due to the high correlation between trade and manufacturing, relevant questions here are whether trade liberalization has facilitated Vietnam's manufacturing sector to achieve their production potentials or technical efficiency fully. If not, what are the factors that constrain the sector from achieving its potential?

It is observed that there are only a few empirical studies solely on the effects of trade liberalization on manufacturing growth in transitional economies such as China, Vietnam and Eastern Europe. In the case of Vietnam, studies such as Thang *et al.* (2002), Ngu (2003), Minh (2005) and Tien (2007) have concentrated on the impacts of ownership transformation, foreign-invested capital and other firm characteristics on firm performance while almost no study has explicitly examined the potential impact of trade liberalization on manufacturing firm performance. Therefore, the motivation of this study is to fill in the existing gap in the literature by exploring the relationship between trade liberalization and manufacturing performance at the firm level in Vietnam during the period 2000-03, when substantial trade liberalization was implemented. To the best of our knowledge, this is the first study focusing on this potential relationship, using a panel dataset of manufacturing firms and a systematic trade and tariff dataset to estimate various measures of trade liberalization.

This paper is organized as follows. The next section provides a context for the empirical analysis by reviewing the trade policy reforms and presenting the estimated possible effects of such trade reforms on the reduction of the manufacturing protection. Section 3 gives a brief review about the possible impacts of trade liberalization on firm performance. Section 4 presents empirical methodology, including the theoretical framework, main hypothesis,

data, and empirical model. Section 5 provides estimation results and firm performance analysis. Finally, the conclusion is presented in section 6.

2. Trade liberalization and protection of manufacturing sector in Vietnam.

2.1. Import control liberalization

To some extent, the import control reforms in Vietnam appear to follow the standard process of trade liberalization in transitional economies as described by McKinnon (1993). The changes in the import control regime were started by gradually replacing central planning instruments of import control combined with strict control of foreign exchange to keep the current account balanced, followed by the wide-scale application of both tariff and non-tariff instruments, accompanied by the tarification process with removing non-tariff barriers and then the reduction of general tariff levels. To see how the import controls have been relaxed, we look at various reforms taken with respect to two main groups of instruments used to protect domestic production: tariff and non-tariff instruments.

(i) Reduction of import tariffs

The introduction of a trade tax system in the late 1980s started fundamental reforms of Vietnam's hitherto trade regime, which is based on targets and quotas to manage trade flows (Auffret 2003). Initially, the tariff system was simple with its coverage of 130 commodity categories and rates ranging from 0 to 60 percent (Thanh 2005). Since then, there have been many significant changes in the import duty system to meet the standards of the international trade system and Vietnam's rapid expanding trade relationships with other countries. In 1992, the harmonized system (HS) of tariff nomenclature was adopted as a benchmark for the new tariff system. Substantial changes in the tariff system took place in 1999 with the introduction of the HS 1996 (eight-digit commodity code) and in 2003 with the application of the HS 2002 (ten-digit commodity code). As a result of the changes, there has been a large increase in the number of tariff lines.

In terms of tariff structure, little progress toward simplification and uniformity has been seen over the ten year period 1997 - 2007. The tariff range reduced from 200 percent in 1997 to 100 percent in 2000 and then went up again to 150 percent in 2003 and remained the same until 2007. Consequently, the dispersion of tariff rates (measured by the coefficient of variation) reduced from 1.28 in 1997 to 1.17 in 2000, then increased to 1.21 in 2003 and 1.33

in 2007. With a nearly similar trend, the number of tariff bands initially reduced from 35 in 1997 to only 15 in 2003, but then went up to 26 in 2007. The main cause of this trend is the remaining (albeit decreasing) selective protection by the government of some consumer and import-competing products such as beverages and alcohol (HS22), tobacco and cigarette (HS24), apparel (HS62-63) and motor vehicles and motorcycles (HS87). Despite a small change in the complex structure of tariff rates as a whole, there was still a real reduction in the protection level in the manufacturing sector due to changes in the tariff structure of goods classified by their main end use.

Other important dimension of change in the tariff system structure is the application of different types of tariffs on imports from different trading partners depending on whether Vietnam has signed or negotiated preferential trade agreements. Vietnam has applied four different tariff schedules: (i) The preferential most favoured nation (MFN) tariffs, having been introduced since 1992, applied on imports from countries having the MFN agreement with Vietnam and currently from WTO members; (ii) The Common Effective Preferential Tariff (CEPT/AFTA) tariff rates applicable to imports from ASEAN countries having been in effect since 1996; (iii) The ASEAN-China (ACPTA) tariff rates mainly applicable to imports from China, having become effective since 2006; and (iv) The normal tariff rates (equal 150 percent of the MFN rates) having been applied to imports from other countries. Of these four tariff schedules, the MFN and CEPT/AFTA schedules account for the overwhelming share of the tariff system in terms of import volume (98.8 percent in 2004 and 82 percent in 2006)[1]. Therefore, the changes in the MFN and CEPT/AFTA rates determine the level of Vietnam's import protection. In addition, the MFN schedule is the basis of the tariff system in term of its tariff rate structure because the CEPT/AFTA tariff schedule basically has a similar structure despite its lower average rate compared with the MFN schedule.

(ii) Removal of non-tariff barriers

Non-tariff barriers were extensively used before 2000 when import substitution was still dominantly used to protect SOEs and import-competing industries. After 2000, with the implementation of the AFTA, USBTA and reform efforts toward accession to the WTO, the non-tariff instruments that are not allowed in bilateral and multi-lateral trade agreements were quickly phased out. Important non-tariff instruments which had significant effects on

[1] These data are extracted from the previous chapter of thesis.

import flows in Vietnam include import-licensing, quantitative restrictions, foreign exchange controls and customs procedures.

Vietnam's import licensing system consists of issuing trading rights and special authority regulation. Before 1998, trading licenses (import/export) were almost limited to SOEs under the view of maintaining the role of the SOEs in foreign trade and effectively controlling consumer goods imports. The entry to foreign trade activity was restricted by a list of demanding conditions requiring a firm to have a foreign trade contract, shipment license, sufficient working capital, business license and trade experience, which are a difficult set of criteria to be met by non-state enterprises (Thanh 2005). Import licenses were also issued to a number of production enterprises, mostly SOEs and joint-ventures between SOEs and foreign partners, to import only capital and intermediate goods for their own business (CIE 1998). Decree 57/1998/ND-CP promulgated in July 1998 made a significant relaxation of the entry to international trading activities for businesses, particularly private firms by abolishing the requirement of import-export licenses (Thai 2005). Provided that enterprises have a business license and a reference trading code in the customs offices, they were allowed and encouraged to trade their goods registered in their business licences, except the goods in the groups of specialized regulation[2]. More liberal changes were made in 2001 by Decision 46/2001/QD-TTg when all enterprises were allowed to trade freely the goods not under special regulations (Thanh 2005). As a result, the number of enterprises registered in foreign trading activities has been seen to increase rapidly from 30 in 1988, to 1,200 in 1994, to 2,400 in 1998, to 10,000 in 2000, 16,200 in 2001 and to about 18,000 in early 2004 (CIE 1998, Thang 2004, Thanh 2005). This shows that entry conditions of importation as well as exportation have been greatly relieved.

Another part of the import licensing system is a specialized authority regulation. A significant number of the imported goods such as pharmaceuticals, some chemicals, fertilizers and broadcasting and recording equipment were subject to specialized management of respective government agencies (line ministries). This tool of import control has usually been used with quantitative restrictions. The specialized regulation may have acted as a measure of protection for SOEs under the management of the responsible specialized

[2] These groups, which will be discussed below, include prohibited goods and quota-restricted goods and goods under specialized management.

agencies (CIE 1998). Therefore, the import regulation based on the specialized agencies could be a potential technical barrier to trade as trading agents need to have import licenses from the specialized agencies before importation of the goods under regulation.

After being introduced in 1994, quantitative restrictions (QRs) were used on a considerable scale in the late 1990s. Except for petroleum[3], the number of goods subject to import quotas increased from four in 1996, to eight in 1998 and sixteen in 1999 (Table 1 of the Appendix). These goods are import-competing products mostly produced by SOEs or foreign invested enterprises, the majority are joint-ventures between SOEs and foreign partners. Therefore, together with official tariffs, the control of import quantity created a significantly high level of protection for the manufacturing industries[4]. From 2000 to 2003, the use of import quotas was quickly reduced from eight products to one product (sugar). Consequently, the protection of the QRs for several manufacturing industries had been nearly eliminated. It should be noted that tariff quotas, a legitimate instrument under the WTO, were introduced in 2003 to replace the QRs. However, the tariff quotas are only applied to agricultural products.

Vietnam has also used foreign exchange management as another significant instrument to regulate import flows in line with the Government's priorities: supporting certain import-competing industries, big infrastructure projects, controlling the current account balance, regulating imported consumer goods. Under this regulation, all firms were required to sell to local banks 80 percent of their foreign exchange earnings within 15 days after the fund in foreign currency was transferred to their account. Subsequently, this requirement was reduced to 50 percent in 1999, to 40 percent in 2001, 30 percent in 2002 and finally 0 percent in 2003 (Thanh 2005).

2.2. Export Promotion

Recognizing that high protection by tariff and non-tariff barriers would make potential costs to export production, Vietnam has applied the import duty exemption for exporters as a central measure in the policy regime to promote exports. In addition to refunding import

[3] This is considered as a strategic imported product of an economy-wide scale effect, for which there is no domestic production. Therefore, it is under strict control of the Government.

[4] It is desirable to take into account the QRs to obtain the true levels of nominal and effective protection. However, the limited data availability constrains the estimation. Two studies of CIE(1998) and Institute of Economics (2000) attempted to convert the quotas to equivalent tariff levels for two products and estimate the nominal and effective rates of protection (NRPs and ERPs) in 1997. Their estimation results show the NRPs and ERPs significantly higher.

duties, other domestic tax incentives have been applied. Often, export producers are exempted from the value added tax (VAT)[5] and special sales tax[6] for their imported inputs used for export production (VAT) and exported products. Moreover, exporters are also given concessionary rates of tax compared with the standard rates[7] on their profit from exports (corporate income tax), depending on the export level of production. A profit tax rate of 20 percent is applied to firms exporting between 50 and 80 percent of production for the first twelve years of operation while a more preferential tax rate of 15 percent is applied to firms having more than 80 percent of production exported for 15 years. The corporate income tax incentive is also applied to non-exporting firms if they have investment in rural or remote areas, significant contribution to employment creation and use advanced technology (Athukorala 2005).

Another important measure of export promotion is export subsidies. While no significant direct export subsidies have been observed (CIEM-USAID 2003), Vietnam has used some forms of subsidy facilities to exporters. The export credit facilities had been provided in the Development Assistance Fund (DAF)[8] and the Export Supporting Fund (ESF)[9], which were established in 1999. Since 2005, the export support in the DAF has been changed into short-term lending to finance exporter's working capital needs[10]. With regard to the Export Supporting Fund, financial support in terms of subsidized interest for export production is concentrated on agricultural and handicraft products and loss making export activities. Another form of subsidizing exports has been the Export Reward Programme, which was set up in 1998 and then included in the Export Supporting Fund to provide exporters in various exporting industries, particularly wearing apparel and footwear with financial rewards on their outstanding export performance in terms of volume or finding new markets or exporting new products. This programme was implemented at a significant scale in the period 2000-05 and then removed in 2007[11] due to Vietnam's accession to WTO. Subsequently, due to

[5] The value added tax replaced the turn-over tax in 1999 (Athukorala 2005).
[6] The special sales tax was introduced in 1990, amended in 1993 and 1995 and has 10 rates, ranging between 15 and 100 percent (Wold Bank 2003).
[7] The standard rates were 25 percent for industries and 32 percent for services between 1999 and 2003. The unified standard rate of 28 percent was applied since 2004.
[8] The Development Assistance Fund is aimed at providing policy lending for subsidized credit in term of policy lending from the government to prioritized investment projects in all sectors of the economy (IMF 2006).
[9] This Fund was established by Decision 195/1999/QD-TTg dated 27 September 1999.
[10] This is set fourth in Decision 59/2005/QD-TTg of the Prime Minister dated 23 March 2005.
[11] Decision 1042/QD-BTM of the Ministry of Trade dated 29 June 2007.

Vietnam's commitments under WTO framework, the Export Supporting Fund was also cancelled in 2008[12].

Vietnam has also developed export processing zones (EPZs) as a policy tool for promoting exports and attracting FDI. Firms in EPZs are provided with a number of tax incentives including duty-free access to imported inputs, domestic tax exemption and concessions, and non-tax incentives including secure and easier access to land, access to better utilities with favourable prices[13], and fast administrative procedures (UNTAD 2009). Since 1991, while six EPZs have been approved, only two are still in operation and other four were transformed into industrial zones soon after establishment. These two EPZs are located in Ho Chi Minh City in the South[14]. In contrast, there has been a proliferation of industrial zones, with the number increasing from 32 by mid 1997 (CIE 1998) to about 130 by the end of 2005[15].

2.3. Reduction of manufacturing protection

A key question is how trade liberalization has affected the protection level of the manufacturing sector? The above mentioned measures of simple average and dispersion of the whole tariff schedules tell us little about the actual reduction of manufacturing protection under various reforms in trade policy regime. A better way is to look at the structure of tariff protection by economic sectors and their sub-sectors. In addition, literature on trade protection has suggested a more useful and comprehensive measure of effective protection, which gives us the net impact of imposing tariffs and other taxes on a particular industry in terms of how much the value added of the industry would change under protection. Therefore, both measures of nominal and effective protection are used based on estimation obtained by methodology adopted by Greenaway and Milner (2003) with available data on tariffs, imports and input-output coefficient tables. A significant difference in both nominal and effective rates of protection, used in this study, is their estimation based on the weighted average of all different tariff schedules applied on imports[16].

---

[12] Decision 124/2008/QD-TTg of the Prime Minister dated 8 September 2008.

[13] Provision of power, water and telecommunications is more efficient and reliable, particularly the power supply is stable and continuous.

[14] They are Tan Thuan and Linh Trung export processing zones, established in 1991.

[15] See http://www.mofa.gov.vn/vi/tt_baochi/nr041126171753/ns060721160306/view (23/4/2009)

[16] The estimation of the NRPs and ERPs was done by the author in the previous chapter.

By the measure of the NRPs, which are shown in Table 2 of the Appendix, the manufacturing sector has received less and less protection in line with the progress of trade liberalization. The overall nominal rate of protection of the manufacturing sector shows a consistent and considerable decline over time. This rate dropped from 26.5 percent in 1997, to 23 percent in 2000, to 16.9 percent in 2006 and to 14.7 percent in 2007. At a more disaggregate level of 2-digit VSIC manufacturing industry, a similar declining trend is observed on all industries, except tobacco and cigarette. Despite this trend, the profound lack of uniformity in the protection structure appears to be pronounced among manufacturing industries. At the one end, one group of industries appear to have enjoyed significantly higher levels of protection. In this group of highly-protected industries, it is surprising that domestic market protection is not only given to import-competing oriented industries such as food and beverages (some products), tobacco and cigarette, paper and paper products, rubber and plastics products, non-metallic mineral products, motor vehicles and transport equipment, but also to export-oriented products such as textiles, apparel, leather and footwear, furniture. These industries are those mainly producing consumption goods. At the other end, low nominal protection seems to be for those industries, which mainly produce capital goods and intermediate inputs such as chemicals, basic metals, fabricated metal products, machinery and equipment, computing machinery, electrical machinery. This implies the considerable cascading structure of tariff protection, which manifests unequal gains and losses to these two opposite groups of manufacturing industries. It should be noted, however, that export-oriented industries do not get the benefits of high domestic protection because a dominant share of their output is sold in the foreign markets. Nevertheless, as discussed above, the government has taken several measures to address the disincentives created by the import protection barriers to promote export-oriented activities.

The ERPs, presented in Table 3 of the Appendix, show clearly the stronger impacts of trade liberalization on reducing the level of protection for manufacturing industries. The overall ERP of the manufacturing sector dropped from 91.1 percent in 1997 to 36.8 percent in 2007, or by about 2.5 times while the average NRP fell by about 2 times. A main reason is that the average tariffs on the final goods reduced more quickly than the tariffs on the intermediate goods. However, while the cascading structure of nominal tariffs make the ERPs significantly higher or lower from the NRPs in most cases, the structure of protection remain

unchanged between 1997 and 2007. This means that both import-competing and export-oriented industries whose major share of output is accounted for by consumption goods have highest levels of protection in the domestic market. But, it is important that these industries experienced a much more significant reduction in the protection level for their products in the domestic market. On the other side, some industries in the group of industries specializing in producing capital and intermediate goods lost in their value added due to their higher input costs as a result of import protection. Their situation appears to improve relatively compared with the highly protected group as the difference in the ERPs between two groups has become smaller over time, except the case of tobacco and cigarette industry, whose ERP surprisingly increased between 2000 and 2007.

3. Trade reforms and production potential

Trade liberalization can affect productivity of firms and industry in a number of ways. Increased competition, which is also called import discipline (Havrylyshyn 1990, Erdem and Tybout 2003), is expected to promote firms to increase their technical efficiency. Corden (1974) suggests that trade openness can induce more entrepreneurial efforts due to their higher returns under foreign competition. As a result, this could lead to higher efficiency. However, this argument was not firmly presented in a formal theoretical model (Tybout 1992). Implied in a different way, Tybout et al. (1991) claims that the absence of foreign competition make domestic firms fail to produce the maximum possible output from a given set of inputs and technology realising full technical efficiency. Less import protection also reduces the incidence of rent-seeking activities, which are considered to prevent innovation efforts induced by competitive pressures (Havrylyshyn 1990). The link between managerial efforts and technical efficiency under trade opening was also elaborated by Rodrik (1992) and then modelled by Horn et al. (1995). These studies suggest that more competitive pressures from import expansion force firms to increase managerial efforts to use inputs more efficiently and reduce costs. At the industry level, trade openness could increase industry productivity through share-reallocation effects as suggested by Tybout and Westbrook (1995). Fiercer competition causes less efficient firms in an industry to exit and more efficient firms survive and gain market share. As a result, resources are reshuffled from less to more efficient firms and industry productivity will improve.

Better access to international markets and foreign technologies has been considered to have significant effects on productivity in several ways. Firstly, trade liberalization leads to expansion of markets through exports, which helps firms to exploit economies of scale as the larger markets would lead to reduction of production costs (Tybout 1992)[17]. Secondly, trade liberalization facilitates the adoption and diffusion of advanced technologies and technical expertise through two effects: (i) domestic firms have more opportunities to acquire new technologies and production techniques through importing intermediate inputs, equipment and machinery; (ii) competition and widening markets create incentives for firms to invest in new technologies for more and better quality products. The important role of trade in making incentives and conducive conditions for technological diffusion has been elaborated by Grossman and Helpman (1981). In their model of innovation and growth, increased international competition and more demand for new products induce producers to adopt new and better technologies in production. By and large, the theoretical literature tends to suggest that trade liberalization has favourable impacts on productivity through a number of mechanisms.

From the above mentioned theoretical arguments, it is clear that one of the most important dimensions of the trade and productivity relationship is technical efficiency. How does one measure technical efficiency, as the neoclassical production function assumes that firms are technically efficient and produce on their production frontiers? As Kalirajan and Shand (1999) argue that in reality firms using identical levels of inputs and technology can produce different output levels due to bottlenecks in production such as poor management. Thus, firms' actual production efficiency levels may be less than their full potential efficiency levels for the given technology. Hence, it is rational to assume that not all firms are producing on their production frontiers showing the maximum potential productions. This necessitates modelling the output function in a framework that allows firms to operate inside their frontiers. The output gap between the estimated output and the actual realized output is due to technical efficiency gap, which may be due to firm-specific characteristics and

[17] It should be noted, however, that scale economies argument is also used to claim for trade protection of infant industries in the import substitution strategy. Therefore, it might be the case that trade liberalization can have a negative impact on the productivity of some import competing industries in developing countries based on economies of scale (Pavnick 2002). The net outcome of contradicting effects of trade liberalization depends on the nature of competition and market structure of each industry (Tybout 1992)

environment in which firms operate. Improvement in terms of reducing a firm's technical efficiency gap is considered as productivity improvement.

Following the above discussion, it is a central hypothesis in this paper that trade liberalization had positive impacts on the technical efficiency of the manufacturing sector which are induced by more competition pressures, both directly with more import competition and indirectly by domestic competition. The higher competition pressures are expected to force firms to respond and change to become more efficient, especially to eliminate their managerial and other operational slacks, and to obtain better input utilization.

4. Methodology and Data

4.1. Theoretical model

The stochastic production frontier model (SPF), which is the work-horse for technical efficiency analysis, was first independently introduced by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977) for cross-sectional data based on the basic framework of production frontier proposed by Farrell (1957). Subsequently, the SPF was extended to panel data (Battese and Coelli 1995, and Kalirajan and Shand 1999 among others). The stochastic frontier production function model for panel data can be defined in the following form:

$$Y_{it} = f(X_{it};\boldsymbol{\beta})\exp(v_{it} - u_{it}) \qquad (1)$$

or

$$\ln Y_{it} = \ln(f(X_{it};\boldsymbol{\beta})) + v_{it} - u_{it} \qquad (2)$$

where Y_{it} denotes the actual or observed output of the *i*th firm at time *t*, X_{it} is the *i*th firm's input vector with a corresponding vector of parameters $\boldsymbol{\beta}$ to be estimated and $f(\cdot)$ presents the production function (which can be Cobb-Douglas or Translog, etc.). The frontier or maximum possible output of the firm is presented by $f(X_{it},\boldsymbol{\beta})$, which can be achieved if the firm uses all inputs efficiently, following the best practice technique of the chosen technology. This frontier output varies due to v_{it}, which is a random error to account for statistical noise such as measurement and approximation errors. The disturbance terms v_{it} is assumed to be independently and identically distributed *(i.i.d)* normal with mean at zero and variance of σ_v^2 as $N(0,\boldsymbol{\sigma}_v^2)$. The distinct term of the SPF model u_{it} is one-sided random term,

assumed to be non-negative, i.e. $u_{it} \geq 0$ and independently distributed, which represents possible inefficiency in a firm's production or the possible efficiency gap emanating from the difference between a firm's realized output and the frontier output with a given technology and a set of inputs. Given a certain distributional assumption of the inefficiency term (for example half-normal, truncated normal or exponential), the SPF is estimated using the method of maximum likelihood. Given the existence of inefficiency effects, a firm's performance is then evaluated by the following measure of technical efficiency:

$$TE_{it} = \frac{f(X_{it};\boldsymbol{\beta})\exp(v_{it} - u_{it})}{f(X_{it};\boldsymbol{\beta})\exp(v_{it})} = \exp(-u_{it}) \qquad (3)$$

While the literature has established the practical ground that inefficiency commonly exists and prevents firms from achieving their potential output, an important question has been raised as to what explains the inefficiency of firms. It has been recognized that the inefficiency can be resulted from firm-specific characteristics (firm size, ownership and managerial skills) and market-related environmental factors affecting firm's performance (particularly market structure and government policy), which can be called non- core input factors. In determining the efficiency levels of firms, it is assumed here that trade liberalization plays a significant role, among those influential factors.

Following Battese and Coelli (1995), the non- core input factors are modelled to directly influence the inefficiency term by specifying that the u_{it} follows a general normal distribution with a non-negative truncation of the form $N(\mu_{it}, \sigma_u^2)$ and u_{it} is assumed to be a function of the non-input explanatory variables as

$$u_{it} = \delta_0 + \sum_{j=1}^{m} \delta_j z_{j,it} + \varpi_{it} \qquad (4)$$

where z_j denote the non- core input influential variables, δ_0 and δ_j are parameters to be estimated and ϖ_{it} is a random error, assumed to have a normal distribution with zero mean and variance σ_{ϖ}^2 or $N(0, \sigma_{\varpi}^2)$ such as u_{it} is obtained by a non-negative truncation of $N(\delta_0 + \sum_{1}^{m} \delta_j z_{j,it}, \sigma_u^2)$. Equation (4) is called the inefficiency effect model. Equations (2) and (4) are simultaneously estimated using the maximum likelihood method with the likelihood

function being parameterized in terms of $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \sigma_u^2 / \sigma^2$. The parameter γ ranges between 0 and 1, showing the degree of deviation from the potential output frontier due to technical inefficiency. For $\gamma = 0$, it means that all output deviations are caused by random effects while $\gamma = 1$ implies that all deviations from the frontier are due to inefficiency effects. Then, technical efficiency can be calculated for each firm per year according to the conditional expectation of $\exp(-u_{it})$, given $\varepsilon_{it} = v_{it} - u_{it}$ as follows:

$$TE_{it} = E[\exp(-u_{it} \mid \varepsilon_{it})] = \left\{ \exp\left[-\mu_{it}^* + \frac{1}{2}\sigma_*^2 \right] \right\} \cdot \left\{ \Phi\left[\frac{\mu_{it}^*}{\sigma_*} - \sigma_* \right] \Big/ \Phi\left[\frac{\mu_{it}^*}{\sigma_*} \right] \right\}, \quad (5)$$

where $\Phi(\cdot)$ is a density function of the standard normal random variable,

$\mu_{it}^* = (1-\gamma)\left[\delta_0 + \sum_{j=1}^{m} \delta_j z_{j,it} \right] - \gamma\varepsilon_{it}$, and $\sigma_*^2 = \gamma(1-\gamma)\sigma^2$.

4.2. Empirical model specification

As the study covers the manufacturing sector consisting of different industries and a wide range of firms, a more flexible functional form is used. Therefore, at the outset, a more general functional form of the Translog function is assumed to present the production technology for manufacturing firms in Vietnam:

$$\begin{aligned} \ln Y_{it} = {} & \beta_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \frac{1}{2}\beta_3 [\ln L_{it}]^2 + \frac{1}{2}\beta_4 [\ln K_{it}]^2 + \beta_5 [\ln L_{it} \ln K_{it}] \\ & + \beta_6 T + \frac{1}{2}\beta_7 T^2 + \beta_8 \ln L_{it} T + \beta_9 \ln K_{it} T + v_{it} - u_{it} \end{aligned} \quad (6)$$

where *Y* denotes the real output (here defined by value added), *L* and *K* represent the labour and capital inputs, *T* is the time trend, which acts as a proxy for technical change. Subscripts *i* and *t* present a panel data structure indicating firm and time (year). As above, v_{it} is the random error term and u_{it} is the one-sided non-negative error term representing the technical inefficiency of the firm. By the term u_{it}, the impacts of trade liberalization and other non-input factors on technical efficiency of the firms are modelled in the inefficiency model as follows:

$$\mu_{it} = \delta_0 + \delta_1 KL_{it} + \delta_2 SKILL_{it} + \delta_3 AGE_{it} + \delta_4 PRIV_{it} + \delta_5 JOINS_{it} + \delta_6 FDI_{it} + \delta_7 ERP(NRP, IM)_{jt} + \delta_8 HFI4_{jt} + \delta_9 MED_{it} + \delta_{10} BIG_{it} + \delta_{11} Y2001 + \delta_{12} Y2002 + \delta_{13} Y2003 + \varpi_{it} \quad (7)$$

where the determinants of the firm's inefficiency can be classified into three groups. The first group consists of key variables of interest, i.e. measures of trade liberalization, including the effective rates of protection (*ERP*), the nominal rates of protection (*NRP*), and import ratio (*IM*) defined as a share of the total output of the manufacturing industry *j* that the firm *i* belong to. The second group represents firm-specific characteristics, including firm capital intensity, defined as the capital-labour ratio (*KL*), share of skilled labour in firm total employment (*SKILL*), firm age (*AGE* and *AGE2*), and two firm size dummies, measured by firm total employment with three categories, i.e. small (*SM*), medium (*MED*) and big size (*BIG*)[18]. The third group covers industry-specific factors, which are represented by the competition index of the industry *j* the firm *i* belongs to. This competition index is measured by the Herfindalh index (*HFI4*). Finally, the three year dummies are included to capture the change of inefficiencies over time.

4.3. Data and variable construction

Enterprise data

This study uses two principal datasets provided by the General Statistical Office (GSO), which are the enterprise and trade datasets. The empirical analysis of firm performance is based on the sample dataset, which is available for the years 2000-03 with its size decreasing. The number of observations is more than 9,500 in 2000-01 while it is around 3,500 for the years 2002-03. A balanced panel of 1,312 observations for the period 2000-03 is chosen for the empirical analysis because of its higher representativeness of the whole manufacturing sector. The use of panel data provides us with more observations and makes it possible to examine the change of the firms' technical efficiency levels over time under trade liberalization.

While the sample survey dataset is used for evaluating the firms' performance, the general dataset of the whole manufacturing sector is important for calculating the two and four-digit

[18] Only two size dummies, *MED* and *BIG* are included in the inefficiency model to avoid perfect collinearity or the dummy trap. The definition of firm size will be explained later.

VSIC industry-specific variable such as the competition index (Herfindalh index), output and import competition index.

Trade data

The trade dataset consists of import and export data at the six-digit level HS of tariff nomenclature. In addition, data on all detailed (eight and ten-digit level) tariff schedules (AFTA, MFN, NORMAL, ACFTA), including all casual tariff adjustments during the period 2000-07 were also obtained from Central Institute of Economic Management (CIEM) and Ministry of Finance (MOF). The trade data were used to estimate the key measures of trade liberalization, including the NRPs, ERPs, import and export shares, import penetration and export orientation levels of Vietnam's trade policy regime[19]. The import competition measures were estimated by combining the import data with firm (production) data at four-digit VSIC manufacturing industry with the concordance tables obtained from COMTRADE. All estimated measures of trade liberalization were then merged with the firm data set to make a full set of data for the empirical model.

4.4. Summary statistics

Table 1 presents basic statistics for key variables. The average firm output increased consistently between 2000 and 2003. There is a clear trend of increasing labour intensity among firms. The average capital stock of the firms reduced slightly while firm employment size grew up significantly from 331.6 in 2000 to 402.5 in 2003, resulting in a reduction of firm capital intensity from 92.6 to 75.7. It is notable that the average share of skilled labour was not only at a rather fairly low level, but also went down slightly when firms increased their employment. Firms in the manufacturing sector appear quite young with the average age of 7.3 years in 2000, mainly as a result of emerging private and foreign-invested sectors. The data also reveals a clear impact of various ownership and institutional reforms with reducing entry barriers to various manufacturing industries. The Herfindalh index decreased considerably from 0.0813 in 2000 to 0.0621 in 2003. Importantly, as discussed above, significant trade liberalization took place with the reduction of both nominal and effective protection for the manufacturing sector. However, overall import response in the

[19] The NRPs and ERPs were estimated by the author.

manufacturing sector seemed to be lagged with a significant increase in the import share in 2003 after falling in 2001 and 2002.

Table 1: Summary Statistics of Key Variables: Average indicators

Variables	Unit	2000	2001	2002	2003
Output (VA)	mill VND	12,935.2	13,160.7	15,731.1	16,712.6
Number of employees (L)	persons	331.6	351.7	386.9	402.5
Capital stock (K)	mill VND	25,743.1	25,829.6	25,122.1	25,287.8
Capital-labour ratio (KL)	mill VND	92.6	88.4	80.8	75.7
Share of skilled labour (SKILL)	percent	9.0	8.9	8.6	8.7
Firm age (AGE)	years	7.3	8.3	9.3	10.3
Effective protection (ERP)	percent	65.9	58.8	54.0	49.0
Nominal protection (NRP)	percent	22.6	20.8	20.4	18.6
Import share (IM)	-	0.858	0.765	0.772	0.903
Herfindalh Index (HFI4)	-	0.0813	0.1001	0.0734	0.0621

Source: Authors' calculations from datasets.

5. Model estimation results

5.1. Model specification tests

The empirical model is estimated using the FRONTIER 4.1[20] software. The parameters of the stochastic production frontier and inefficiency model were simultaneously estimated for the whole manufacturing sector. Three alternative models have been estimated with respect to different measures of trade liberalization, namely, effective rate of protection, nominal rate of protection and import ratio (import competition).

Alternative hypotheses need to be tested to justify our SPF approach with the assumption of inefficiency effects. As suggested by Battese and Coelli (1995), generalized likelihood ratio (LR) tests are required to confirm the functional form and specification. The relevant test statistic is

$$LR = -2\{\ln[L(H_0)/L(H_1)]\} = -2\{\ln[L(H_0)] - \ln[L(H_1)]\}$$

where $L(H_0)$ and $L(H_1)$ are the values of the likelihood function under the null and alternative hypotheses respectively. Under the null hypotheses on the maximum likelihood estimates, this test statistic has an asymptotical mixed chi-square distribution. The critical

[20] For more detail about the program, see Coelli (1996).

values of the mixed chi-square distribution are obtained from Kodde and Palm (1986) at the 1 percent level of significance with the degrees of freedom equal to the number of parameters assumed to be zero under the null hypothesis. The results of all hypothesis tests are reported in Table 2.

At first, the translog functional form is tested against the alternative Cobb-Douglas form for the present dataset. The test results strongly reject the Cobb-Douglas form in favour of the translog form in all three alternative model specifications. This indicates changing relationships between inputs among firms and across manufacturing industries. Further, it shows that the translog function accounts better for the diversity of manufacturing firms. Subsequently, it is important to confirm that inefficiency matters in firm operation and depends on various firm-specific and environmental factors. This involves testing various hypotheses for the significance of $\gamma = \sigma_u^2 /(\sigma_v^2 + \sigma_u^2)$ and the joint significance of coefficients of the technical inefficiency model. The first null hypothesis, which specifies that the inefficiency effects are not stochastic (this means the variance of the inefficiency effects σ_u^2 is zero), is strongly rejected. The second null hypothesis which states that inefficiency effects are absent from the model is rejected at the 1 percent level of significance. The third null hypothesis that trade liberalization and firm and industry-specific factors do not jointly influence firm technical inefficiencies is also strongly rejected at the 1 percent level of significance. Additionally, the test results of joint significance of time factors (years) confirms that technical efficiency of manufacturing firms improved over time in all three model specifications.

Table 2: Likelihood ratio tests of hypotheses for functional forms of the stochastic production frontiers and parameters of the inefficiency effect models

Null hypothesis	$\chi^2_{0.99}$ [a] value & df	Effective rate of protection		Nominal rate of protection		Import ratio	
		χ^2 - stat	Decision to Ho	χ^2 - stat	Decision to Ho	χ^2 - stat	Decision to Ho
$\beta_3 = \beta_4 = \beta_5 = \beta_7 = \beta_8 = \beta_9 = 0$ (Cobb-Douglass form)	16.07 (6)	143.4	reject	156.4	reject	140.8	reject
$\gamma = 0$ (Mean response function)	5.41 (1)	49.0	reject	49.0	reject	49.0	reject

$\gamma = \delta_1 = \ldots = \delta_{13} = 0$ (All inefficiency effects are absent)	28.5 (14)	272.2	reject	276.2	reject	265.5	reject
$\delta_1 = \ldots = \delta_{13} = 0$ (Trade liberalization and firm and industry-specific factors have no effects on inefficiency)	27.0 (13)	108.4	reject	112.6	reject	102.0	reject
$\delta_{11} = \delta_{12} = \delta_{13} = 0$ (Efficiency not improving over time)	10.5 7.1[b] (3)	9.0	reject (at 5% level)	12.2	reject	15.6	reject

Note: (a) The critical values for the hypotheses are obtained from Kodde and Palm (1986), Table 1; (b) This critical value is at the 5% level of significance.
Source: Author's calculations.

5.2. Parameter estimates of the stochastic production frontiers

The parameter estimates of the production frontiers associated with three measures of trade liberalization are presented in Table 3. Except the coefficient of $0.5(\ln L^2)$, all other estimated coefficients of the production frontiers are statistically significant. On average, manufacturing firms have slightly increasing returns to scale with the computed scale elasticity of 1.077 and both capital and labour have nearly equal output elasticities as shown in Table A4 of the Appendix. Among manufacturing industries, the garments and leather and footwear industries (VSIC 18 & 19) appear to operate at points of slight decreasing return to scale on their output frontier with a majority of firms having the scale elasticity of less than 0.995. Another two industries, i.e. tobacco and textiles (VSIC16 & 17), have a majority of firms operating at a range of constant returns to scale. It is surprising that a large number of two-digit VSIC manufacturing industries (the rest of industries) have increasing returns to scale with a majority of firms having the scale elasticity of more than 1.05 (Table A, Appendix). This implies that a majority of firms in Vietnam's manufacturing sector have a small size in terms of capital and labour or output. Nevertheless, in the period 2000-03, it appears that the scale elasticity decreased slightly (Table A5, Appendix) as the firm size in terms of employment and value added output became larger as shown in Table 1 above.

The estimated value of γ is about 0.85 and highly statistically significant in all three model specifications. This indicates that a majority share of the deviations of firms' actual output from the frontier output is due to the inefficiency effects. Here, the question of interest is whether these deviations decreased over the period 2000-03 under the impact of trade liberalization and other non-input factors. This question will be examined in the next section.

5.3. The impact of trade liberalization and other determinants on the firms' technical efficiency

The estimated coefficients of the three inefficiency models are also presented in Table 3. It appears that all estimates are consistent across the alternative specifications in their signs and magnitudes, except, trade policy variables. In addition, while the dummy for private firms is not statistically significant, all other coefficients are individually significant at a 1 percent level of significance. This implies the important role of the trade regime and other factors in determining firm performance.

The estimation results suggest that trade liberalization has an expected positive and robust impact on firm technical efficiency across three models with alternative trade policy measures. This finding is consistent with other empirical studies. In terms of policy openness measures, reduction in nominal and effective protection contributes to improving technical efficiency of firms. In terms of trade policy outcome, a similar effect results from more imports in the total supply of the manufacturing industry at the four-digit VSIC level. In addition, the stronger improvement of efficiency appears to be associated with the reduction in nominal tariffs rather than in the effective rate of protection. This would be explained by a more intermediate impact of tariff reduction on industry and firm output prices. The significant effects of different proxies of exposure to foreign competition at the industry level, not at the firm level seem to confirm the hypothesis of competition effects of trade liberalization, which is assumed to create both incentives and challenges for firms to be more active in utilizing better available resources and reducing managerial slack to survive in the domestic market with increasing foreign competition.

Table 3: Estimation results of the stochastic production frontier and inefficiency model: Alternative measures of trade liberalization

Variables	**ERP**	**NRP**	**IM**

	Coefficient	s.e.	Coefficient	s.e.	Coefficient	s.e.
Stochastic production frontier						
Constant	0.567***	0.041	0.577***	0.038	0.546***	0.045
$\ln L$	0.542***	0.022	0.540***	0.021	0.539***	0.018
$\ln K$	0.535***	0.014	0.538***	0.015	0.532***	0.014
$0.5(\ln L)^2$	-0.006	0.021	-0.009	0.020	-0.014	0.020
$0.5(\ln K)^2$	0.083***	0.008	0.084***	0.008	0.082***	0.009
$\ln L \ln K$	-0.059***	0.012	-0.058***	0.012	-0.056***	0.012
T	-0.041**	0.017	-0.044**	0.021	-0.055**	0.023
$0.5T^2$	0.078**	0.038	0.056*	0.029	0.097*	0.056
$T \ln L$	-0.021*	0.013	-0.024*	0.013	-0.023*	0.013
$T \ln K$	0.020**	0.009	0.019*	0.010	0.021**	0.009
Technical inefficiency model						
Constant	-7.215***	1.163	-7.026***	1.347	-4.682***	0.996
Capital labor ratio (KL)	0.978***	0.115	0.972***	0.127	0.942***	0.125
Skilled labor (SKILL)	-6.545***	1.053	-7.666***	1.169	-9.163***	1.257
Age (AGE) (ln)	-1.003***	0.136	-1.079***	0.152	-1.006***	0.142
Private (PRIV)	-0.106	0.178	-0.121	0.169	-0.288	0.184
Join stock (JOINS)	-6.453***	0.936	-6.067***	0.877	-6.201***	0.822
Foreign invested (FDI)	-2.269***	0.311	-2.302***	0.344	-2.197***	0.344
Trade policy measures	**0.016*** **	**0.002**	**0.055*** **	**0.007**	**-0.109*** **	**0.024**
Herfindalh index (HFI4)	4.938***	0.725	4.123***	0.838	5.218***	0.927
Medium firm (MED)	-0.418***	0.144	-0.484***	0.153	-0.637***	0.149
Big firm (BIG)	-1.406***	0.259	-1.444***	0.241	-1.871***	0.226
Y2001	-1.354***	0.197	-1.508***	0.217	-1.953***	0.274
Y2002	-2.040***	0.254	-2.253***	0.267	-3.095***	0.368
Y2003	-2.243***	0.295	-2.299***	0.309	-2.943***	0.346
Sigma-squared (σ^2)	6.629***	0.734	6.582***	0.770	6.234***	0.646
Gamma (γ)	0.858***	0.017	0.858***	0.017	0.849***	0.018
Log-Likelihood (LLF)	-8150.6		-8148.6		-8153.9	
Average efficiency level	60.5%		60.8%		61.1%	

Notes: *,** and *** denote the significance level of 10, 5 and 1 percent.
Source: Author's calculation

The estimated coefficient of the Herfindalh index is positive in all three models, implying that high concentration associated with less competition in some manufacturing industries not only has negative effects on the performance of dynamic and efficient firms in those industries, but also allows inefficient firms to remain in the markets or to be less active in becoming more efficient. Therefore, it appears that technical efficiency was further enhanced by the reduction of the overall competition index. This means that various domestic reforms, particularly legal and institutional reforms had a significant impact on manufacturing firm performance, supplementing to external competition effects created by trade liberalization.

While more concentration has negative effects on firm technical efficiency, larger firms in terms of employment are more efficient as indicated by the highly significant coefficients of the variables *MED* and *BIG*. These effects, albeit counter-intuitive, are reasonable because the use of dummies for employment size mitigates the collinearity between market share and competition index despite a common expectation that larger firms tend to be associated with more concentrated industries. The results support the above mentioned hypothesis that larger firms are able to exploit economies of scale and operate at lower cost curves. Consequently, as already mentioned, the increasing firm size in terms of employment would contribute to reducing inefficiencies of firms over the period in question. A similar finding on the impact of competition index was found by other studies such as Driffied and Kambhampati (2003).

We now turn our attention to the effects of more particular firm-specific factors, which are controlled in the inefficiency model. As expected, we find a robust and highly significant impact of skilled labour on firm performance. A higher skilled labour share considerably increases technical efficiency. It is, however, surprising that using more capital does not improve firm efficiency as indicated by a positive, significant and robust coefficient on the capital intensity as this effect is not expected in a developing country with abundance of labour and scarcity of capital where additional capital is assumed to have increasing returns. While some studies such as Mahadevan (2002), Movshuk (2004) and Abuka (2005) find a positive effect of the capital intensity on technical efficiency, other studies such as Driffied and Kambhampati (2003) and Phan (2004) have similar findings to this study. In the light of contrasting findings, it is reasonable to argue that the efficient use of capital at firm-level is largely attributed to the firm's ability to master the newly invested machinery and equipment and technical knowledge. Therefore, the skilled labour share as low as below 10 percent on average of the manufacturing firms as shown above appears to be a responsible factor underlying the negative relationship between capital intensity and firm efficiency. The coefficient on firm age (*AGE*) is consistently and significantly negative, implying that older firms are more efficient than younger firms. This result seems to support the learning-by-doing hypothesis that older firms have accumulated more managerial and market experience.

As discussed, ownership transformation is a key element of institutional reforms, marking a distinguishing feature of the transitional economies like Vietnam and China. Therefore, the performance of firms is expected to be markedly different by ownership types. With the

SOEs being used as the common reference group, we find that both joint-stock (JVEs) and foreign-invested (FIEs) enterprises perform better than SOEs. In addition, the joint-stock enterprises seem to outperform the FDI enterprises as the coefficient of the JVEs (more than -6) is considerably larger than that of the FIEs (around -2). This finding is not a surprise given the commonly argued problems of the SOEs in their management and incentive structure. In addition, the better performance of the joint-stock enterprises gives the evidence on the positive impact of SOEs reform, under which many SOEs have been equitized and transformed into the joint-stock companies. In contrast with the joint-stock and foreign-invested firms, the private firms (PEs) are found not to have a significantly better performance compared with the SOEs. This finding is consistent with the conclusions made by several studies that, despite the removal of entry and exit barriers, the private sector has been disadvantaged in terms of accessing to important resources such as land and credit as well as continuing discrimination in the administrative system (Hakkala and Kokko 2007, World Bank 2005 and Tenev *et al.* 2003).

Finally, the significant and robust coefficients on all time dummies indicate that the technical efficiency of manufacturing firms has increased over time. The improvement of manufacturing firm performance over time implies the dynamics of changing determinants of the inefficiency effects. While the direct impact of trade liberalization has been directly modelled as a determinant of firm technical efficiency by alternative measures of trade policy and exposure to foreign competition, its indirect effects appear to be much more important in terms of incentives and competition pressures on firm operation and behaviour. This aspect will be further elaborated in examining the changing patterns of firm efficiency levels and associated efficiency determinants.

5.4. Analysis of technical efficiency level

The average efficiency scores of the whole manufacturing sector and two-digit VSIC industries are presented in Table 4. It can be seen that, in line with trade liberalization, an increasing trend of the mean efficiency level is observed in all industries and the whole sector, reflecting the time trend of reducing inefficiencies among firms as indicated in the inefficiency model. The average efficiency level increased from 55 percent in 2000 to nearly 64 percent in 2003 and the overall average is about 60.5 percent. The estimated levels of

efficiency are comparable with those reported by other studies for Vietnam such as Reilly *et al.* (2009) with nearly 62 percent for the whole manufacturing in 2002, Minh (2005) with 55 percent for textiles and garments in 2003 and for other transitional economies such as Bulgaria (John *et al*. 1998), Czechoslovakia and Hungary (Brada *et al*. 1997), and the former Soviet Union (Brock, 1999). In addition, the pace of technical efficiency increase seems to be higher in some export-oriented industries such as textiles, garments, furniture than some import-competing industries like motor vehicle, transport equipment, fabricated metal products and chemicals despite the fact that these export-oriented industries tend to have lower technical efficiency levels. However, despite the comparable level of the estimated technical efficiency, the manufacturing sector still had a significant gap (nearly 40 percent) between the actual and potential outputs, on average, in the period 2000-03.

As a fairly high aggregate level of the two-digit VSIC manufacturing industries does not allow the dynamics of efficiency changes to be seen under the impact of trade liberalization, we group sample manufacturing firms based on their trade orientation. Industry's trade orientation is defined by the import-output and export-output ratios at the four-digit VSIC level. Following Pavcnik (2002), a threshold of 15 percent is used to classify firms into three following groups[21]: (i) Less-traded group consists of industries whose import and export shares are less than 15 percent; (ii) export-oriented industries are those having export-output ratios greater than 15 percent, but export share is larger than import share; and (iii) the import-competing groups including industries having import-output ratio greater than export shares and both import-output ratio more than 15 percent. The patterns of efficiency levels of these groups are presented in Table 5. Other features of these three groups are shown in Table A7 of the Appendix. Here, it is interesting to see a common trend for a developing country such as Vietnam that the export-oriented firms appear to be more labour-intensive with the smallest capital-intensity.

[21] The choice of the threshold for export-output and import-output ratios is arbitrary and different among studies. For instance, Bergoeing *et al.* (2006) use the threshold of 10 percent for the export share and 20 percent for the import penetration ratio at the three-digit ISIC level. Wong (2008) adopts a benchmark of 35 percent for the export share and 26 percent for import share at the four-digit ISIC level. It appears that the benchmark of trade orientation level is expected to reflect the country-specific import and export structure. This study uses the cutoff-point of 15 percent based on the median values of import –output ratio (17 percent) and export-share (20 percent). It is important that the results (patterns of firm group efficiency levels) are robust to alternative thresholds between 10 and 20 percent.

Table 4: Average efficiency level by 2-digit VSIC industry, 2000-03

VSIC2	VSIC name	2000	2001	2002	2003	Average	Change[(a)]
15	Food products and beverages	50.9	58.1	63.2	64.1	59.1	13.2
16	Tobacco products	71.8	74.5	79.3	80.2	76.5	8.4
17	Textiles	48.4	51.2	59.1	59.8	54.6	11.4
18	Wearing apparel	45.8	53.6	49.1	52.9	50.3	7.1
19	Leather, leather products and footwear	53.9	61.0	60.7	62.5	59.6	8.6
20	Wood and wood products	59.3	64.0	66.3	66.8	64.2	7.4
21	Paper and paper products	59.6	62.2	64.9	64.0	62.7	4.4
22	Publishing, printing an recorded media	56.0	59.1	65.0	64.0	61.1	8.0
24	Chemicals and chemical products	65.3	71.0	70.1	70.5	69.2	5.1
25	Rubber and plastics products	53.9	58.1	63.2	61.0	59.0	7.1
26	Non-metallic mineral products	61.2	65.2	68.2	69.1	65.9	7.9
27	Basic metals	65.0	63.9	70.7	71.6	67.9	6.7
28	Fabricated metal products	53.6	59.0	54.4	56.0	55.7	2.4
29	Machinery and equipment	56.7	64.9	66.7	67.5	64.3	10.9
31	Electrical machinery	52.5	58.5	62.3	60.1	58.3	7.7
32	Radio, television and communication equipment	65.6	66.3	68.7	69.4	67.5	3.8
33	Medical, precision and optical instruments	50.6	42.9	53.1	54.9	50.4	4.3
34	Motor vehicles, trailers and semi-trailers	52.2	52.1	50.0	58.2	53.1	6.0
35	Other transport equipment	56.7	47.1	57.9	58.6	55.1	1.8
36	Furniture and other manufacturing	50.0	57.6	58.7	59.0	56.2	9.0
	Whole manufacturing	**55.0**	**60.3**	**63.1**	**63.8**	**60.5**	**8.8**

Notes: (a) Change is defined as the percentage point difference in mean technical efficiency in 2000-03.
Source: Author's calculation.

It is clear that all three groups of firms show a consistent and quite rapid trend of increasing efficiency levels. Based on the average values of other variables of inefficiency model (Table A8 of the Appendix), we observe that this trend is consistent with the reduction of the average ERPs of the less-traded and export-oriented groups. It is notable that the import-competing firms having little change in the ERPs between 2000 and 2003 still experienced improvement in their technical efficiency. In addition, while expected to be less affected by a significant reduction in the protection level as a majority of their output is sold in foreign

markets, the export-oriented industries also had a significant gain in efficiency. This can be explained by the fact that all firms have reduced their capital intensity, used more labour and consequently increased the relative skilled labour per capital ratio. In particular, between 2000 and 2003, the average employment size of the export-oriented and import-competing firms increased by 1.26 and 1.20 times while the less-traded firms also experienced an increase of 1.1 times in their employment size. The combination of enlarging employment size and keeping little changed capital stock has led to a fall in the capital intensity of all three groups. As suggested by the inefficiency effect model, these changes clearly contributed to improving firm efficiency. Therefore, it can be said that manufacturing firms have responded to more competition pressures created by trade liberalization and institutional reforms by using their available resources more efficiently as well as exploiting Vietnam's comparative advantage in labour resource. It should be noted, however, that the share of skilled labour of all three groups remained roughly the same over the period 2000-03 as shown in Table A7 of the Appendix.

Table 5: Mean efficiency level (%) by trade orientation

Trade-orientation	**2000**	**2001**	**2002**	**2003**	**Average**	**Change[(a)]**
Less-traded	56.0	60.9	65.5	65.8	62.0	9.7
Export-oriented	52.2	59.0	61.6	62.8	58.9	10.6
Import-competing	57.1	61.1	62.9	63.5	61.2	6.5
Overall	**55.0**	**60.3**	**63.1**	**63.8**	**60.5**	**8.8**

Notes: (a) Change is defined as the percentage point difference in mean technical efficiency in 2000-03.
Source: Author's calculation

It is again observed that, while having a more substantial increase in the technical efficiency, the export-oriented firms are less efficient compared with other two groups. One possible explanation is that the export-oriented firms tend to pay for higher imported input costs (with intermediate input tariffs of 12 percent compared with 5.6 percent and 9.6 percent for less-traded and import-competing industries in 2003). Moreover, while the domestic protection level was significantly reduced and various measures of export promotion were implemented during this period (2000-03), it seems that there still existed considerable anti-export biases against the manufacturing industries such as garments, footwear and plastic products where Vietnam has comparative advantage for exporting. Another significant factor is the fact that

the export-oriented industries appear to have the lowest share of skilled labour compared with other two groups despite possessing a larger employment (Table A7 of the Appendix).

Table 6: Mean efficiency level by ownership and trade orientation

Trade orientation	State-owned	Private	Joint-stock	FDI	Overall
Less-traded	64.0	57.0	72.9	67.4	**62.0**
Export-oriented	58.0	58.2	70.3	60.3	**58.9**
Import-competing	63.1	57.0	73.8	62.6	**61.2**
Overall	**62.2**	**57.5**	**72.8**	**62.7**	**60.5**

Source: Author's calculation

The patterns of the mean efficiency levels by ownership type and trade orientation group, presented in Table 6, provide some more insight into the links between ownership types and the performance of firms by trade orientation group. Overall, the private enterprises have the lowest efficiency level as suggested by the inefficiency effect model. Although the private firms are a bit more efficient than the state-owned enterprises in the export-oriented industries, the lower efficiency of the export-oriented industries appears to be driven by the major share of the private firms (about 65.8 percent of the export-oriented firms as shown in Table A8 of the Appendix). The state-owned enterprises also contributed to the low efficiency level of the export-oriented firms, but with a significantly smaller share (about 16 percent as shown in Table A8 of the Appendix). The higher efficiency levels of the less-traded and import-competing groups are attributed to the larger share and higher efficiency levels of the state-owned, foreign-invested and joint-stock firms despite the fact that the private enterprises alone account for a majority share in all three groups of trade orientation.

Despite its significant contribution to the lower level of efficiency of the export-oriented sector, the private enterprises appear to perform better in the export-oriented industries with less entry barriers and higher labour intensity. Table 6 shows that, compared with other two groups, the private enterprises in the export-oriented industries have a higher efficiency level while the firms of other ownership types are significantly less efficient than their counterparts. In addition, more private enterprises (47.2 percent) are concentrated in the export-oriented industries, which seem to be more competitive (as shown in the last panel of Table A7 of the Appendix). In terms of the temporal pattern of firm efficiency levels, the private and foreign-invested enterprises appear to have the largest gains in their technical

efficiency with 9.8 and 9.9 percentage points, followed by the state-owned firms with 2.9 percentage points and then the joint-stock enterprises with a modest gain of 2.9 percentage points (Table A9 of the Appendix).

6. Conclusions

This study has examined whether trade liberalization facilitated manufacturing firms to realize their production potentials fully using firm –level balanced panel data over the period 2000-03. By using the stochastic production frontier framework, the impact of trade liberalization was investigated by estimating the inefficiency model simultaneously with the frontier production function, in line with controlling for other important determinants of firm performance, including firm-specific characteristics and industry-specific effects.

The findings support the theoretical implications of the positive and robust impact of trade liberalization on firm performance. Reduction of protection is associated with higher firm technical efficiency over time and across manufacturing industries, while more import competition promotes firms to reduce their inefficiencies. The improvement of firm efficiency could be attributed to the direct competition effect of trade liberalization. At the same time, other important determinants of inefficiency effects have also been found to have significant and robust effects on firm technical efficiency level. While skilled labour is found to have an expected, robust and significant effect on firm technical efficiency, the finding of higher capital intensity leading to lower efficiency is not surprising given a relative low level of skilled labour among firms. It is notable that firms with larger employment appear to have higher efficiency.

Among three defined groups of manufacturing firms, the export-oriented industries appear to have lower efficiency levels, which are attributed to the remaining anti-export biases in the trade policy regime and their lower level of skilled labour employment. However, the changes in the ERPs alone are not enough to explain the gains in technical efficiency in three different trade orientation groups, particularly the import-competing firms. It is found that, to some extent, the firms have become more efficient by using more labour (increasing employment size) and, at the same time, significantly reducing capital intensity, rather than increasing the share of skilled labour in their employment. This trend is attributed to the competition-induced incentive effects of trade liberalization and other associated domestic

reforms and resulting response of manufacturing firms. It is also found that the share of skilled labour remained nearly unchanged at a low level.

A distinguishing feature of Vietnam's case is that firm performance is also significantly affected by a transition process featured by ownership type and domestic competition, which result from various domestic reforms, particularly institutional reforms. The estimation results show that these factors matter significantly in determining firm efficiency level. By taking into account these factors, our frontier model suggests that trade liberalization seem to play a more important role in making more competition pressures and opportunities for firm to become more productive in order to survive in the markets. This finding is not a surprise in the literature, but it is an important explanation for the interesting case of Vietnam that manufacturing firms have become more efficient by using more labour as their response to increasing competition. Moreover, the estimation results also indicate that, while more trade liberalization is conducive to better performance, increasing the share of skilled labour is the key for firms to achieve higher potential output in the long term, rather than using more labour because it is relatively more abundant in Vietnam. Therefore, more attention should be paid to providing incentives and support for enterprises for training their workforce (such as on-the-job training) as well as creating more opportunities for workers to upgrade their skills by themselves.

References

Aigner, D., Lovell, A.K. and Schmidt, P., 1977, 'Formulation and estimation of stochastic frontier production models', *Journal of Econometrics*, 6(1): 21-37.

Alam, I. M. S. and Morrison, A. R., "Trade reform dynamics and technical efficiency: The Peruvian Experience", The World Bank Economic Review, 14(2): 309-30.

Athukorala, P., 2005. Trade policy reforms and the structure of protection in Vietnam, RSPAS Working Paper 2005/6, Australian National University. http://rspas.anu.edu.au/economics/publish/papers/wp2005/wp-econ-2005-06.pdf (18/3/2009)

Athukorala, P., 2006. 'Trade policy reforms and the structure of protection in Vietnam', *The World Economy*, 29(2): 161-187.

Auffret, P., 2003, *Trade Reform in Vietnam" Opportunities with Emerging Challenges*, Policy Research Working Paper, The World Bank.

Bartelsman E. J. and Doms, M., 2000, "Understanding productivity: Lessons from longitudinal micro-data", *Journal of Economic Literature*, 38(3): 569-94.

Battese, G.E. and Coelli, T.J., 1995. 'A model for technical inefficiency effects in a stochastic frontier production function for panel data', *Empirical Economics*, 20: 325-32.

Battese, G.E. and Corra, G.S., 1977. 'Estimation of a production frontier model: with application to the pastoral zone of Eastern Australia', *Australian Journal of Agricultural Economics*, 21, 169-79.

Bergoeing, R., Hernando, A. and Repetto, A., 2006. *Market reforms and efficiency gains in Chile*, Paper provided by Centro de Economía Aplicada, Universidad de Chile in its series Documentos de Trabajo with number 207. http://www.webmanager.cl/prontus_cea/cea_2005/site/asocfile/ASOCFILE120050825111958.pdf (17/5/2009).

Brada, J.C., Kinh, A.E. and Ma, C.Y., 1997, 'Industrial economics of the transition: Determinants of enterprise efficiency in Czechoslovakia and Hungary, *Oxford Economics Papers*, 49(1): 104-127.

Brock, G.J, 1999. 'Exploring a regional technical efficiency frontier in the former USSR', *Economics of Planning*, 32: 23-44.

CIE (Centre for International Economics), 1998, *Vietnam's trade policies 1998*, Canberra & Sydney. http://www.thecie.com.au/publication.asp?pID=51 (20/1/2007)

CIE (Centre for International Economics), 1999, *Trade and industry policies for economic integration*, a report prepared for CIEM and UNIDO for the UNDP-funded project: Managing Vietnam's integration into the global economy, Canberra & Sydney. http://www.thecie.com.au/publication.asp?pID=46 (20/2/2008)

Coelli, T.J., 1996, 'A Guide to FRONTIER Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation', *CEPA Working Paper 96/07*,

University of New England, Armidale.

Coelli, T.J., Rao, D.S.P., O'Donnell, C.J. and Battese, G.E., 2005. *An introduction to efficiency and productivity analysis*, 2nd edition, Springer, Sydney.

Corden, M., 1974, *Trade Policy and Economic Welfare*, Clarendon Press, Oxford.

Driffield N.L. and Kambhampati, U.S., 2003. 'Trade liberalization and the efficiency of firms in Indian manufacturing', *Review of Development Economics*, 7(3): 419-30.

Farrell, M.J., 1957. 'The measurement of productive efficiency', *Journal of the Royal Statistical Society*, Series A 120: 253-81.

Fernandes, A. M., 2007, "Trade policy, trade volumes and plant-level productivity in Colombian manufacturing industries", Journal of International Economics, 71(2007): 52-71.

Grossman, G. and Helpman, E., 1981, *Innovation and Growth in the Global Economy*, MIT Press: Cambridge, Massachusetts.

Hakkala, K. and Kokko, A., 2007. 'The state and the private sector in Vietnam', *Working Paper 236*, Stockholm School of Economics, Stockholm, Sweden.

Havrylyshyn, O., "Trade policy and productivity gains in developing countries: A survey of literature", *The World Bank Research Observer*, 5(1):1-24.

Horn, H. et al., 1995, "Managerial effort incentives, X-efficiency and international trade", *European Economic Review*, 30: 117-38.

John, D., Klinedinst, M. and Rock, C., 1998. 'Productive efficiency during transition: Evidence from Bulgarian panel data', *Journal of Comparative Economics*, 26: 446-464.

Kalirajan, K. and Bhide, S., 2005, "The post-reform performance of the manufacturing sector in India", *Asian Economic Journal*, 3(2): 126-57.

Kalirajan, K. P. and Shand, R. T., 1999, "Frontier production functions and technical efficiency measures", *Journal of Economic Surveys*, 13(2): 149-172.

Krishma, P. and Mitra, D., 1998, "Trade liberalization, market discipline and productivity growth: new evidence from India", Journal of Development Economics, 62(1998): 447-62.

Levinsohn, J. and Petrin, A., 2003, "Estimating production function using inputs to control for unobservables", Review of Economic Studies, 70(2): 317-41.

Lundvall, K. and Battese, G., 2000. 'Firm size, age, and efficiency: Evidence from Keynyan manufacturing firms', *The Journal of Development Studies*, 36: 146-163.

Lundvall, K. and Battese, G., 2000. 'Firm size, age, and efficiency: Evidence from Keynyan manufacturing firms', *The Journal of Development Studies*, 36: 146-63

Mahadevan, R., 2002, 'Trade liberalization and productivity growth in Australian manufacturing industries', *Australian Economic Journal*, 30(2): 170-85.

McKinnon, R. I., 1993. *The Order of Economic Liberalization: Financial Control in the*

Transition to a Market Economy, The John Hopkins University Press, The USA.

Meeusen, W. and van den Broek, J. 1977, 'Efficiency estimation from Cobb-Douglas production functions with composed error', *International Economic Review*, 18(2): 435-44.

Minh, N.K (ed.), 2005. *Anh huong cua tien bo cong nghe den tang truong kinh te* (the impact of technological progress on economic growth), Science and Technical Publishing House: Hanoi.

Movshuk, O., 2004. 'Restructuring, productivity and technical efficiency in China's iron and steel industry, 1988-2000', *Journal of Asian Economics*, 15: 135-51.

Ngu, V.Q, 2003. 'Technical efficiency of industrial state-owned enterprises in Vietnam', *Asian Economic Journal*, 17(1): 87-101.

Nishimizu, M. and Page, J. M., 1982, "Total factor productivity growth, technological progress and technical efficiency change: Yugoslavia 1965-78", The Economic Journal, December: 920-36.

Pack, H., 1988. 'Industrialization and trade', in H. Chenery & T.N. Srinivasan (eds.), *Handbook of Development Economics*, Vol. I, Elservier Science Publishers, Holland.

Parameswaran, M., 2002, Economic reforms and technical efficiency: firm level evidence from selected industries in India, Working Paper No. 339, Centre for Development Studies, at http://www.cds.edu.in (5/11/2007).

Pavcnik, N., 2002, "Trade liberalization, exit and productivity improvements: evidence from Chilean plants", *Review of Economic Studies*, 69: 245-76.

Pavcnik, N., 2002. 'Trade liberalization, exit, and productivity improvement: Evidence from Chilean Plants', *Journal of Economic Studies*, 69(1): 245-276.

Pitt, M. M. and Lee, L., 1981, "Measurement and sources of technical inefficiency in the Indonesian weaving industry", Journal of Development Economics, 9: 43-64.

Reilly, B., Hung, P.T. and Thanh, L.D., 2009. 'Technical efficiency in the Vietnamese manufacturing sector', *Journal of International Development*, (2009), DOI:10.1002/jid.1588. (15/10/2009)

Rodrik, D., 1992, "Closing the technology gap: Does trade liberalization really help?" in G. Helleiner (ed), *Trade Policy, Industrialization and Development: New Perspectives*, Oxford University Press: New York.

Schor, A., 2004, "Heterogeneous productivity response to tariff reduction: Evidence from Brazilian manufacturing firms", Journal of Development Economics, 75(2004): 373-96.

Son, N., Diep, N.H., Lam, L.T. and Tra, N.S., 2007, *Assessing the Impact of Vietnam's Multilateral Commitments Relating to Import-Export Regulating Mechanism on Its Trade Environment*, NCIEC and ADETEF – Vietnam. http://www.adetef.org.vn/website/documents/Etudes%20compl%C3%A9mentaires/NCIEC/ Etude%20environnement%20commercial%20-%20FSP%20I%20%20-%20EN.pdf (12/11/09)

Sun, H., Hone, P. and Doucouliagous, H., 1999. 'Ecconomic openness and technical efficiency: A case study of Chinese manufacturing industries', *Economics in Transition*, 7(3): 615-636.

Tenev, S., Calier A., Chaudry O. and Nguyen, Q.T., 2003. 'Informality and the playing field in Vietnam's business sector', *Research Report No. 26976*, International Finance Corporation and World Bank.

Thai, B.A., 2005. *Trade and investment policy reform in Vietnam: Integration to the world economy and accession to the WTO*, Policy Brief No. 37, the William Davidson Institute, the University of Michigan. http://www.wdi.umich.edu/Publications/PolicyBriefs/CountrySeries#Vietnam (20/7/2008)

Thang, N., 2004, *Vietnam*, Overseas Development Institute, a study funded by Department for International Development, UK. http://www.odi.org.uk/resources/download/2270.pdf (18/9/2007)

Thang, N., Thanh, T., Dat, V. and Oostendorp, R.H., 2002. *Productivity analysis for Vietnam's textile and garment industry*, a research report by Institute for Market and Price Research, funded by IDRC/CIDA, Hanoi.

Thanh, V.T., 2005, "Vietnam's trade liberalization and international economic integration: evolution, problems and challenges", *ASEAN Economic Bulletin*, 22(1): 75-91.

Tien, Q.T., 2007. *Foreign direct investment and industrial transition: a case study of Vietnam*, unpublished Ph.D thesis, Australian National University.

Topalova, P., 2007, "Trade liberalization and firm productivity: The case of India", MIT Mimeo. www.etsg.org/ETSG2007/papers/topalova.pdf (15/1/2008)

Tybout, J. R. and Westbrook, M. D., 1995, "Trade liberalization and the dimensions of efficiency change in Mexican manufacturing industries", *Journal of International Economics*, 39: 53-78.

Tybout, J. R. and Westbrook, M. D., 1995, "Trade liberalization and the dimensions of efficiency change in Mexican manufacturing industries", Journal of International Economics, 39: 53-78.

Tybout, J. R., 1992, "Linking trade and productivity: new research directions", *The World Bank Economic Review*, 6(2): 189-211.

Tybout, J., de Melo, J. and Corbo, V., 1991, "The effects of trade reforms on scale and technical efficiency: new evidence from Chile", *Journal of International Economics*, 31: 231-50.

Tybout, J., de Melo, J. and Corbo, V., 1991, "The effects of trade reforms on scale and technical efficiency: new evidence from Chile", Journal of International Economics, 31: 231-50.

Vencappa, D., Milner, C. and Wright, P., 2006, Trade policy reforms and industry efficiency: A stochastic frontier analysis of Indian manufacturing, Paper presented at 3th Hellenic

Workshop on Productivity and Efficiency Measurement, 16-18 June 2006, Department of Economics, University of Patras, Greece. Available at http://www.hewpem.econ.upatras.gr/program.php (2/1/2008)

Wang, H. and Schmidt, P., 2002. 'One-step and two-step estimation of the effects of exogenous variables on technical efficiency levels', *Journal of Productivity Analysis*, 18: 129-144.

Wong, S.A., 2008. 'Productivity and trade openness in Ecuador's manufacturing industries', *Journal of Business Research (2008)*, doi:10.1016/j.jbusres.2008.10.009 (30/4/2009).

World Bank, 2003. *Vietnam: Deepening reforms for rapid export growth*, Synthesis Report for Vietnam's Export Study, May 2003, http://siteresources.worldbank.org/INTRANETTRADE/.../vietexports_matin.pdf (20/2/2008)

World Bank, 2005. *Vietnam Development Report 2006: Business*, World Bank Vietnam Office: Hanoi.

Zhang, A., Zhang, Y. and Zhao, R., 2001. 'Impact of ownership and competition on productivity of Chinese enterprises', *Journal of Comparative Economics*, 29: 327-46.

Appendix

Table A1: Products Subject to Quantitative Restriction

1996	1998	1999	2000	2001	2002	2003
Petroleum	Petroleum	Petroleum	Petroleum	Petroleum	Petroleum	Petroleum
Sugar	Sugar	Sugar	Sugar	Sugar	Sugar	Sugar
Fertilizer	Fertilizer	Fertilizer	Steel	Steel	Cement	
Steel	Steel	Steel	Cement	Cement	Motorcycles	
Cement	Cement	Cement	Glass	Motorcycles		
	Glass	Glass	Motorcycles	Cars		
	Motorcycles	Motorcycles	Cars	Vegetable oil		
	Cars	Cars	Paper			
	Paper	Paper	Vegetable oil			
		Electric fans				
		Ceramic tiles				
		Porcelain				
		Caustic soda				
		Bicycles				
		Vegetable oil				
		Plastics				
		Plastic packaging				

Source: CIE, 1998, p. 24; Athukorala, 2005, Table 1, p. 32.

Table A2: Nominal Rates of Protection by 2-digit VSIC Manufacturing Industry

VSIC Code	VSIC name	Nominal Protection Rate (%)				
		1997	2000	2003	2006	2007
15	Food products and beverages	28.0	24.1	21.1	18.2	16.1
16	Tobacco products	86.0	30.7	31.9	37.5	42.8
17	Textiles	31.3	35.9	35.1	32.3	15.8
18	Wearing apparel	42.1	48.9	46.2	41.2	25.0
19	Leather, leather products and footwear	20.8	21.4	20.8	18.6	18.3
20	Wood and wood products	10.2	5.9	4.4	4.1	4.0
21	Paper and paper products	24.4	16.7	16.6	10.7	9.8
22	Publishing, printing an recorded media	12.3	9.5	9.5	5.7	5.4
24	Chemicals and chemical products	15.0	6.4	5.3	4.4	3.7
25	Rubber and plastics products	22.8	13.3	13.7	13.3	12.3
26	Non-metallic mineral products	31.9	19.7	18.1	16.2	16.0
27	Basic metals	7.8	4.3	4.6	3.7	3.6
28	Fabricated metal products	8.0	5.1	5.8	4.9	4.7
29	Machinery and equipment	6.1	5.3	3.9	3.0	2.9
31	Electrical machinery	10.4	7.1	7.2	8.3	8.1
32	Radio, television and communication equipment	7.0	6.9	8.3	3.5	3.4
33	Medical, precision and optical instruments	6.9	3.7	2.6	1.3	1.2
34	Motor vehicles, trailers and semi-trailers	27.7	49.3	38.0	22.4	21.4
35	Other transport equipment	34.7	14.7	13.4	13.6	11.8
36	Furniture and manufacturing n.e.c.	16.8	21.2	19.8	17.7	17.4
	Whole manufacturing	**26.5**	**23.0**	**20.4**	**16.9**	**14.7**

Note: NRPs by sector is the average of the import-weighted NRPs of IO industries weighted by their value added. The year 1997's average NRPs are calculated from NRPs by IO industries estimated by Institute of Economics (2001).
Source: Author's calculations.

Table A3: Effective Rates of Protection by 2-digit VSIC Manufacturing Industry

VSIC Code	VSIC name	Effective Protection Rate (%)				
		1997	2000	2003	2006	2007
15	Food products and beverages	152.8	62.7	52.2	39.3	34.7
16	Tobacco products	206.3	82.7	85.7	113.9	134.9
17	Textiles	59.6	124.4	123.0	108.5	50.2
18	Wearing apparel	109.2	178.3	165.1	145.2	97.8
19	Leather, leather products and footwear	32.2	69.7	69.8	59.3	68.4
20	Wood and wood products	18.2	17.0	11.2	10.4	9.6
21	Paper and paper products	65.3	40.5	41.2	23.7	20.7
22	Publishing, printing an recorded media	25.3	13.2	13.7	6.6	6.1
24	Chemicals and chemical products	28.0	11.1	7.9	6.4	4.3
25	Rubber and plastics products	83.8	32.9	34.5	33.7	30.8
26	Non-metallic mineral products	74.9	41.8	37.6	33.9	32.7
27	Basic metals	9.7	-8.6	-6.7	-3.9	-4.1
28	Fabricated metal products	6.5	1.5	5.3	4.6	3.4
29	Machinery and equipment	-6.3	-11.7	-14.2	-9.9	-9.3
31	Electrical machinery	20.5	12.0	11.6	22.3	21.5
32	Radio, television and communication equipment	6.8	7.0	11.4	1.4	1.5
33	Medical, precision and optical instruments	10.8	1.7	-0.9	-2.9	-3.2
34	Motor vehicles, trailers and semi-trailers	88.6	75.2	57.1	32.9	31.1
35	Other transport equipment	90.7	29.9	27.4	26.7	21.2
36	Furniture and manufacturing n.e.c.	37.6	49.3	45.7	41.6	42.9
	Whole manufacturing	**91.1**	**65.6**	**50.4**	**42.7**	**36.8**

Notes: (1). ERP estimates are based on weighted NRPs by IO industries and the year 1997's ERPs are calculated from NRPs by IO industries estimated by Institute of Economics (2001). The average ERP of each sector is weighted by value added of IO industries.
Source: Author's calculations.

Table A4: Summary of input and scale elasticities

Variable	Mean	Std. Dev.	Min	Max
labor	0.542	0.144	0.065	1.046
capital	0.535	0.133	-0.088	1.071
scale	1.077	0.078	0.826	1.315

Source: Author's calculation

Table A5: Shares of three firm groups by scale elasticity and by 2-digit VSIC industry (per cent)

VSIC2	VSIC name	(1)	(2)	(3)	Total
15	Food products and beverages	11.1	12.7	**76.2**	100
16	Tobacco products	21.9	**68.8**	9.4	100
17	Textiles	25.0	38.5	36.5	100
18	Wearing apparel	**54.0**	30.3	15.7	100
19	Leather, leather products and footwear	**79.4**	15.4	5.1	100
20	Wood and wood products	19.5	18.4	**62.1**	100
21	Paper and paper products	5.1	28.4	**66.5**	100
22	Publishing, printing an recorded media	2.4	18.3	**79.4**	100
24	Chemicals and chemical products	6.1	35.0	**59.0**	100
25	Rubber and plastics products	8.4	16.2	**75.3**	100
26	Non-metallic mineral products	9.2	31.5	**59.4**	100
27	Basic metals	0.0	0.0	**100.0**	100
28	Fabricated metal products	7.3	18.0	**74.7**	100
29	Machinery and equipment	16.1	26.8	**57.0**	100
31	Electrical machinery	28.8	16.7	**54.5**	100
32	Radio, television and communication equipment	6.9	20.8	**72.2**	100
27	Medical, precision and optical instruments	0.0	20.0	**80.0**	100
34	Motor vehicles, trailers and semi-trailers	4.1	19.4	**76.5**	100
35	Other transport equipment	10.1	35.4	**54.4**	100
36	Furniture and manufacturing n.e.c.	29.4	27.1	**43.5**	100
	Whole manufacturing	**15.8**	**22.0**	**62.2**	**100**

Notes: (1) Decreasing returns to Scale (Scale elasticity <0.995); (2) Constant Returns to Scale ((0.995<=Scale elasticity <=1.05); and (3) Increasing Returns to Scale (Scale elasticity >1.05)

Source: Author's calculation

Table A6: Scale elasticity of 2-digit VSIC manufacturing industry over 2000-03

VSIC2	VSIC name	2000	2001	2002	2003	Average
15	Food products and beverages	1.116	1.115	1.113	1.113	1.114
16	Tobacco products	1.020	1.015	1.022	1.025	1.021
17	Textiles	1.038	1.036	1.033	1.031	1.035
18	Wearing apparel	0.998	1.000	0.990	0.992	0.995
19	Leather, leather products and footwear	0.959	0.953	0.948	0.949	0.952
20	Wood and wood products	1.079	1.072	1.063	1.065	1.070
21	Paper and paper products	1.077	1.077	1.068	1.072	1.074
22	Publishing, printing an recorded media	1.079	1.083	1.082	1.081	1.081
24	Chemicals and chemical products	1.080	1.078	1.074	1.074	1.076
25	Rubber and plastics products	1.097	1.089	1.084	1.084	1.089
26	Non-metallic mineral products	1.076	1.072	1.072	1.069	1.072
27	Basic metals	1.114	1.101	1.092	1.098	1.101
28	Fabricated metal products	1.103	1.097	1.092	1.092	1.096
29	Machinery and equipment	1.065	1.066	1.067	1.065	1.066
31	Electrical machinery	1.089	1.070	1.065	1.050	1.069
32	Radio, television and communication equipment	1.085	1.080	1.073	1.068	1.077
33	Medical, precision and optical instruments	1.092	1.157	1.165	1.169	1.135
34	Motor vehicles, trailers and semi-trailers	1.098	1.092	1.097	1.092	1.095
35	Other transport equipment	1.071	1.066	1.058	1.063	1.065
36	Furniture and manufacturing n.e.c.	1.051	1.051	1.038	1.035	1.044
	Whole manufacturing	**1.081**	**1.078**	**1.074**	**1.074**	**1.077**

Source: Author's calculation

Table A7: Average values of key determinants of firm inefficiency by trade orientation group

Trade-orientation	2000	2001	2002	2003	Mean
Effective rate of protection (%)					
Less-traded	83.0	67.4	60.6	57.2	67.1
Export-oriented	92.7	83.2	76.4	65.8	79.6
Import-competing	30.0	30.3	29.7	29.1	29.8
Mean	**65.9**	**58.8**	**54.0**	**49.0**	**56.9**
Import-output ratio					
Less-traded	0.042	0.036	0.042	0.046	0.041
Export-oriented	0.178	0.188	0.186	0.166	0.179
Import-competing	1.857	1.600	1.579	1.513	1.636
Mean	**0.802**	**0.701**	**0.708**	**0.681**	**0.723**
Real capital stock (mill VND)					
Less-traded	53,789.9	52,537.1	50,256.1	50,952.9	51,888.5
Export-oriented	10,527.4	11,069.2	11,275.4	11,056.0	10,980.0
Import-competing	22,961.2	23,485.6	22,586.2	23,123.8	23,037.0
Mean	**25,743.1**	**25,829.6**	**25,122.1**	**25,287.8**	**25,495.6**
Employment size (person/firm)					
Less-traded	227.1	225.6	235.6	253.1	235.3
Export-oriented	494.2	537.6	618.7	624.3	568.1
Import-competing	241.8	252.0	267.9	290.3	263.3
Mean	**331.6**	**351.7**	**386.9**	**402.5**	**368.2**
Capital – intensity (mill VND/person)					
Less-traded	126.6	126.0	117.3	114.3	121.1
Export-oriented	39.4	37.4	33.3	34.0	36.1
Import-competing	121.9	113.9	102.0	90.5	106.9
Mean	**92.6**	**88.4**	**80.8**	**75.7**	**84.4**
Skilled labor share (%)					
Less-traded	0.099	0.102	0.106	0.108	0.104
Export-oriented	0.043	0.048	0.042	0.040	0.043
Import-competing	0.128	0.119	0.114	0.117	0.119
Mean	**0.090**	**0.089**	**0.086**	**0.087**	**0.088**
Competition index					
Less-traded	0.082	0.086	0.081	0.076	0.081
Export-oriented	0.054	0.051	0.049	0.044	0.049
Import-competing	0.112	0.097	0.087	0.076	0.093
Mean	**0.083**	**0.077**	**0.071**	**0.064**	**0.074**

Source: Author's calculation

Table A8: Distribution of firms by ownership and trade orientation

Trade orientation	State-owned	Private	Joint-stock	FDI	All
Shares within each ownership type (%)					
Less-traded	37.7	20.0	27.9	15.2	23.8
Export-oriented	24.9	47.2	21.6	27.7	36.6
Import-competing	37.5	32.8	50.5	57.1	39.6
Total	100	100	100	100	100
Shares within each ownership type (%)					
Less-traded	38.1	42.8	7.0	12.1	100
Export-oriented	16.3	65.8	3.5	14.3	100
Import-competing	22.8	42.3	7.7	27.3	100

Source: Author's calculation

Table A9: Mean efficiency level (%) by ownership type over time

Ownership type	2000	2001	2002	2003	Mean	Change[(a)]
State-own	58.1	62.3	63.8	64.6	62.2	6.6
Private	51.4	57.0	60.6	61.2	57.5	9.8
Joint stock	70.8	73.2	73.1	73.7	72.8	2.9
FDI	56.6	62.4	65.3	66.5	62.7	9.9
Mean	**55.0**	**60.3**	**63.1**	**63.8**	**60.5**	**8.8**

Notes: (a) Change is defined as the percentage point difference in mean technical efficiency in 2000-03.
Source: Author's calculation