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Investment Climate and Firm Technical Efficiency in Vietnamese Manufacturing

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Abstract

This paper identifies the constraints of the investment climate on Vietnamese manufacturing technical efficiency. The empirical results show that a good quality of infrastructure and finance, an investment-friendly and transparent environment, a safe society encourage firm technical efficiency. The impacts of the investment climate on firm technical efficiency are robust to various kinds of specifications. The results highlight that foreign firms attain improvements in production efficiency over time compared to domestic firms. Also, large firms as well as foreign firms get benefits from their exports in terms of technical efficiency. However, no strong evidence supports technical efficiency improvement in Vietnamese manufacturing firms after this country became an official WTO member in early 2007.

Keywords: Vietnamese manufacturing firms; Firm-level technical efficiency; Investment climate; Time-varying inefficiency model.

1. Introduction

In the literature, it is now well accepted that investment climate can significantly and adversely impact productivity, growth and economic activity. The investment climate is defined by the World Bank (2005) as "the set of location-specific factors shaping the opportunities and incentives for firms to invest productively, create jobs and expand." Key factors affecting the investment climate are physical infrastructure, security, regulatory framework, access to finance, human capital, technological and innovation support, competition and property rights. A better investment climate improves bureaucratic performances and predictability, and contributes to the effective delivery of public goods that are necessary for productive business. Using the World Bank enterprise surveys data, Escribano and Guasch (2005) for Guatemala, Honduras and Nicaragua; Kinda (2010) for the Middle East and North Africa find clear evidence that the investment climate matters for firm performance. Interestingly, their findings come from different approaches. Escribano and Guasch study the influence of investment climate on productivity of the whole manufacturing in the three countries and then breakdown the data by country, size and age of firms, while Kinda, Plane, and Véganzonès-Varoudakis are in favour of industry specific technical efficiency impact of investment climate.

There is a somewhat poorer literature on firm productive performance effects of investment climate in transition economies. Vietnam is an interesting case to analyze in this context. After a short period of over-excitement in the first time of WTO membership from the early 2007, Vietnam has worried about the overall economic situation. Recent achievements are lower than state's potentials and capability. Economic growth quality, productivity, efficiency and competitiveness are low and improved slowly (Ninth Central Committee Conference, 2009). In fact, this country has suffered from negative impacts of global financial crisis and recession. GDP

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growth of the whole economy and GDP growth by economic sectors decreased, especially there was a tremendous decline of manufacturing.

It has come to be widely agreed that the weaknesses of the economy and the manufacturing sector that became more serious in the context of global economic crisis could be overcome to large extents if the investment climate had not created obstacles to economic development (Vietnamese Business Forum Report, 2011). However, the empirical evidence on the constraints of the investment climate on the efficiency of Vietnamese enterprises is rather limited. For example, Thanh and Duong (2009) , using firm-level cross-section data set surveyed by the World Bank in Vietnam in 2005, find that obstacles in policy, administration and social environment hinder firms from increasing their intensity of exports, but not the cases of constraints from physical infrastructure and factor markets.

Long (2011) investigates the productivity effects of technology and institutions, using a cross-sectional manufacturing firm-level data set derived from the World Bank survey in Vietnam in 2009. He documents that firm productivity differences are not only explained by differences in production factors or in technology, but also by the role of institutions. He finds no evidence of access to finance appears to affect firm performance and other institutional variables such as practices of competitors in the informal sectors, labour market issue (i.e., inadequately educated workforce), obstacles in policy and administration have different impacts depending on firm level productivity.

As for studying the effects of the investment climate on firm efficiency, that to some extent, directly related to Vietnam, Kinda, Plane, and Véganzonès-Varoudakis (2009) shows that foreign firms benefit from better investment climate, they are more efficient than domestic firms and firms (particularly small local firms) that sell more of their production to multinationals are more efficient[2].

Unlike the earlier studies use one-step stochastic frontier analysis with pooled data from developing countries, this paper applies a different econometric approach for a specific country to be able to identify the causal effects of investment climate on technical efficiency. We show that, for a particular country, time-varying inefficiency model for panel data is better than pooling data one-step stochastic frontier analysis in considering the whole manufacturing or industry specific technical efficiency impact of investment climate. Additionally, using the unique and latest data from the investment climate surveys of the World Bank in Vietnam in 2005 and 2009, it is possible to link our empirical work to the recent literature that has put the investment climate at the center of economic performance (Kinda, Plane, & Véganzonès‐Varoudakis, 2011) by providing more specific evidence.

The suitable models and the quality of the data allow us to investigate the improvement of technical efficiency by industry and the whole Vietnamese manufacturing after three years deeper integration to the world economy. Moreover, we identify whether the effect of investment climate on firm efficiency is different depending on firm size, export status and ownership. To our knowledge, these have not been investigated in earlier studies.

Previewing the empirical results we find, after controlling for the possible endogeneity of the investment climate variables and also controlling for firm specific characteristics, that the investment climate matters for firm performance. A good quality of infrastructure and finance, an investment-friendly and transparent environment, a safe society encourage firm technical efficiency. Some industries, more exposed to international competition, are more sensitive than others to investment climate deficiencies. Furthermore, the impacts of investment climate on firm technical inefficiency are robust to various kinds of specifications.

The rest of the paper is organized as follows. Section 2 provides a context for the empirical analyses by reviewing the manufacturing and the impacts of investment climate on firm performance in this sector. Section 3 presents the literature review relating to the paper. Section 4 and 5 lay down the main model to be used as framework for the empirical analyses and the data, variables construction. Section 6 discusses the main econometric results. Finally, the conclusion is presented in section 7.

2. Manufacturing Sector and Investment Climate in Vietnam

2.1. Manufacturing Sector

Vietnam has been in the early stage of

[2] This paper uses manufacturing firm data from the World Bank surveys in five developing countries (Brazil, Morocco, Pakistan South Africa, and Vietnam) in the mid-2000s.

industrialization and modernization process with increasing importance of production activities in the economy. The manufacturing industries have occupied the largest share in the GDP growth compared with others. They made around 32% of GDP growth for the periods 2001 – 2005 and 2006 – 2009.

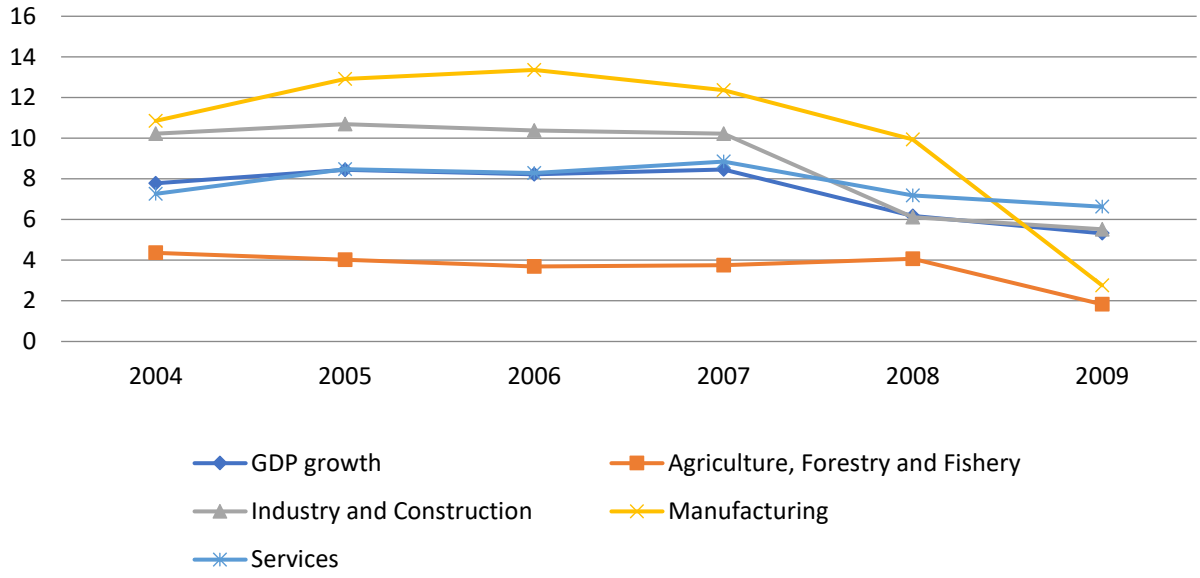

Figure 1. GDP Growth by Economic Sectors and Manufacturing (in percentages 2004 - 2009)

Source: Ministry of Planning and Investment –MPI (2010).

Table 1: Contribution of Economic Sectors and Manufacturing to GDP Growth

(in percentage of overall GDP growth)

	1996–2000	**2001–2005**	**2006–2009**
Agriculture, Forestry and Fishery	15.9	11.0	8.8
Services	35.0	37.9	44.7
Industry & Construction	49.1	51.1	46.5
+ Manufacturing	**27.2**	**31.7**	**31.9**

Source: Nguyen and Pham, 2010

However, the stagnancy in recent economic growth and the prolonged weak competitiveness of the economy indicates the limitations of manufacturing. They are low capital efficiency, labour productivity and value added, low employment creation relative to employment destruction in agriculture, heavy dependence on external markets for outputs and major inputs (MPI, 2010; Nguyen & Pham, 2010).

The years 2007 – 2009 witnessed remarkable changes in Vietnam's economic performance, from social issues to economic institutions. In the first three years of WTO membership and deeper integration to the world economy, the vulnerability to negative external shocks of the economy is more apparent. GDP growth of the whole economy and GDP growth by economic sectors decreased, especially there was an enormous decline of manufacturing from 12.37% in 2007 to 2.76% in 2009 because of the global financial crisis and rising energy price.

Different from other industries, Vietnamese manufacturing is mostly affected by international integration owing to its export-oriented characteristics. Manufacturing for domestic market was fiercely competed by foreign goods with decreasing import tax under WTO and others' commitments. Meanwhile, manufacturing for export faced declined demands from foreign markets in the period. For example, compared to 2008, agriculture intensive industries (Food and Beverage) were influenced most seriously with the growth rate in 2009 declined 63%. The growth rate of capital intensive industries (Paper, Chemical, Plastics and Rubber, Non-metallic mineral, Machinery and Equipment) was around a half and of labour intensive (Apparel and Leather, Textiles) was 40% decreased.

The improvement in production effectiveness of manufacturing industries has not been as expected when Vietnam has engaged into regional and world economy. In general, manufacturing industries have not clearly improved the technology, diversified and raised value added for Vietnamese products despite increasingly competitive pressures from globalization (MPI, 2010).

2.2. Investment Climate in Vietnam

The weaknesses of the manufacturing sector that became more serious in the context of global economic crisis could be overcome to large extents if the investment climate had not created obstacles to economic development. Table 2 presents the scores of main indicators of Vietnam's investment climate and shows up the limitations of its business environment. It highlines cases with rankings lower than the median of the sample countries.

Table 2: Ranking of Ease of Doing Business for Vietnam versus the Regional Average

	2005		2009		
	Vietnam (0ut of 181)	Average (6)	Vietnam (0ut of 175)	Average (9)	Average (6)
Overall ranking	**98**	66	**92**	87	66
Ranking for 10 factors					
Starting a business	**89**	75	**108**	106	94
Dealing with licenses	28	70	67	78	62
Employing workers	**137**	81	90	78	80
Registering property	30	56	37	87	57
Getting credit	76	50	43	75	58
Protecting investors	**170**	70	**170**	81	61
Paying taxes	**116**	75	**140**	74	82
Trading across borders	68	54	67	59	34
Enforcing contracts	**90**	71	42	89	66
Closing a business	**105**	77	124	101	86

Source: Doing Business Database of World Bank, 2009 and Urata and Ando, 2009

Notes: Average ranking is calculated for a comparison among 10 factors. Average (9) shows average ranking for nine ASEAN economies (Brunei, Combodia, Indonesia, Lao PDR, Malaysia, Philippines, Singapore, Thailand, and Vietnam). Average (6) shows average ranking for six ASEAN economies that appear in both year (Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam).

The position of Vietnam in overall ranking is not improved in 2009 compared with that in 2005. In particular, some items tend to be better such as getting credit, enforcing contracts while others are even worse. The most serious problems are in the areas of starting and closing a business, protecting investors, and paying taxes. Relating to trade activities, relative evaluations for trading across borders are improved from 54th to 34th on average in ASEAN 6 but seem not to be the case of Vietnam, 68th out of 175 in 2005 and 67th out of 181 in 2009. These may reveal the fact that Vietnam has not made use of the facilitation of international integration and trade liberalization in this period.

Urata and Ando (2009) emphasize main striking problems of Vietnamese investment climate:

- Underdeveloped infrastructure, shortages of human resources, and insufficient investment incentives.
- Non-transparency in policies and regulations relating to investment which are sudden and/or frequent changes without notification in advance.
- Complicated and/or delayed procedures concerning doing business in the fields of implementing on establishment, taxation, custom clearance, firm entry and exit as well as inconsistent interpretation and implementation of various regulations.

The following figure presents the biggest business environment obstacles as perceived by firms from the Enterprise Survey in Vietnam 2009. The first graph shows the top ten constraints in Vietnam versus the regional average (East Asia Pacific - EAP), the second presents the top three constraints broken down by different firm sizes.

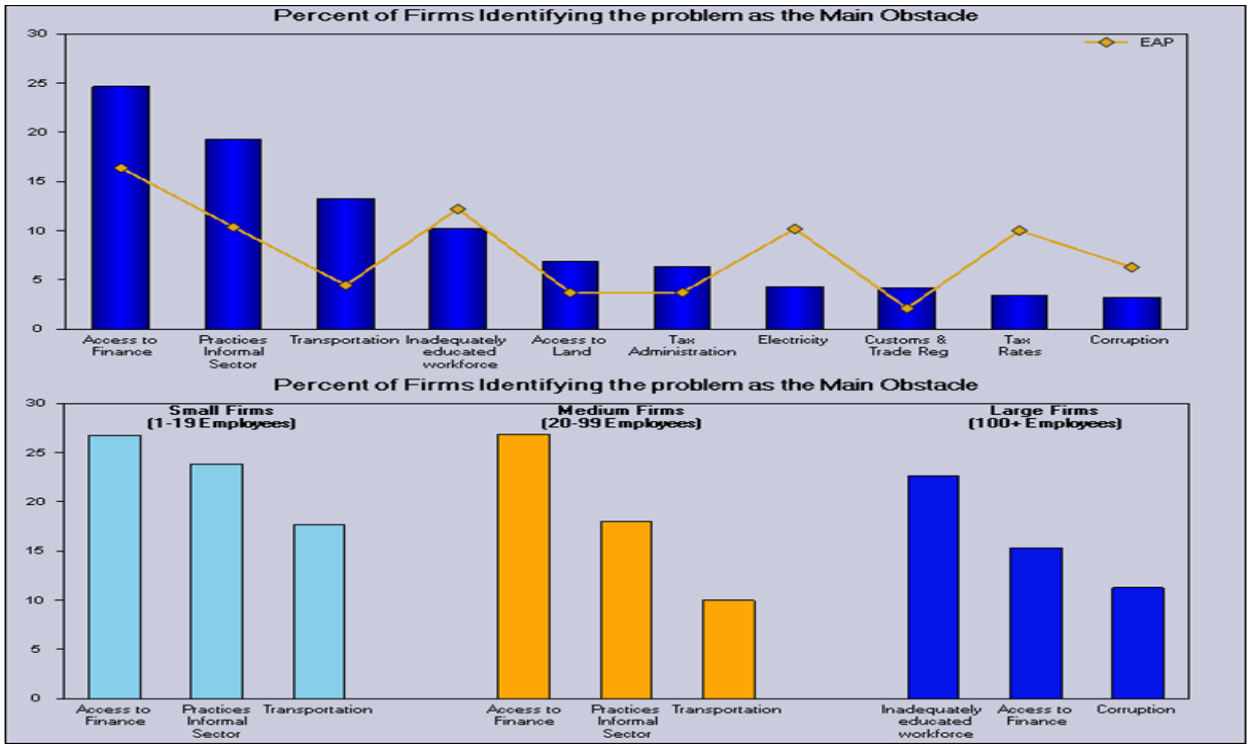

Figure 2. Business Environment Obstacles in Vietnam

Source: The World Bank Enterprise Survey – Vietnam Country Profile 2009

The result from the survey indicates the main problems for firm performance such as getting credit, practices of competitors in the informal sector, infrastructure, workforce and economic governance. These bottlenecks are reported as hindering manufacturing firms to operate efficiently.

3. Technical Inefficiency and Stochastic Frontier Analysis

Productivity and efficiency are economic aspects of firm performance and have been frequently used interchangeably in the media. Coelli, Rao, O'Donnell, and Battese (2005) present that productivity can be decomposed into three components: technical efficiency, scale economies, and technical level. The technical efficiency refers to the ability to avoid wastes, either by producing as much output as technology and input usage or by using as little input as required by technology and output production.

Hence, the analysis of technical efficiency can be output-oriented or input-oriented. The output-oriented technical efficiency refers to a firm's ability to obtain maximum output from a given amount of inputs, given the technology (Fried, Lovell, Schmidt, & Schmidt, 2008). According to this definition, the output-oriented technical inefficiency could be defined as a situation where it is possible for a firm, given the know-how, to produce a larger output from the same inputs without increasing the amount of other inputs.

Kumbhakar and Lovell (2000) provide the main reason for using technical efficiency as opposed to other types of efficiency. Different from cost, revenue and profit efficiency, technical efficiency is a purely physical notion that can be measured without the information of price and the position of an appropriate behavioral objective on producers.

Formally, the level of technical efficiency is measured by estimating the best practice efficient frontier based on a relevant sample of firms. Thus, the firms on the frontier are considered the best practice firms in the market and the efficiencies of others are measured in comparison to the efficient frontier.

(Kalirajan & Shand, 1999) explain a basic approach to calculate technical efficiency

TE = Actual output / Maximum possible output

In this equation, the actual output is observable but maximum possible output is not and must be estimated. A ratio of one in the above equation

means that the firm is technically efficient and operates on the production frontier.

Farrell (1957) is the pioneer who firstly develops the technique to empirically measure the production frontier. He uses a linear programming method to obtain the production frontier that is called deterministic frontier. This method forms the basis of the Data Envelopment Analysis (DEA) method by Charnes, Cooper, and Rhodes (1978). In this deterministic approach, no account is taken of measurement errors and other sources of random noise. All deviations from the frontier are assumed to be the result of technical inefficiency (Coelli et al., 2005).

The alternative to the DEA, the stochastic frontier analysis (SFA), originated by Meeusen and van Den Broeck (1977) and Aigner, Lovell, and Schmidt (1977) Aigner et al. (1977), uses econometric methods to estimate the frontier. The SFA uses econometric techniques to estimate the error term of the production function that is split into two uncorrelated components, providing the basis for statistical inference. One is typical statistical noise which is a double-sided random error, which presents the external shocks to the firm. The other represents the technical inefficiency which is assumed to follow a one-sided distribution. In this approach, the factors that are beyond the control of management such as business environment or investment climate, socio-economic and demographic factors and other effects can be distinguished from inefficiency. This is the key reason why stochastic frontier approach is more relevant in the context of this study.

4. Empirical Specifications

Firm technical inefficiency can be explained by exogenous factors which affect either the technology of production or the firm ability to transform inputs into outputs (Kinda et al., 2011). In the literature, these factors can be estimated in two different ways. A two-step procedure firstly estimates the stochastic production frontier and inefficiency without exogenous variables, and then the estimated inefficiency is regressed against exogenous variables in the second step. However, Kumbhakar and Lovell (2000) explain that there is inconsistency in the two-step approach because the second step regression is based on the biased estimated inefficiency from the first step. If the regression in the second step is not leant on true inefficiency then it is not meaningful to understand the determinants of variation in inefficiency.

There is another way suggesting to estimate using maximum likelihood techniques the production function frontier and the factors that explain technical inefficiency at the same time, called one-step stochastic frontier analysis. For this study, we follow one-step approach means that the parameters of the technical inefficiency and stochastic frontier model are jointly estimated but extend to the case of panel data assuming technical efficiency is time-varying.

4.1. Time-varying Inefficiency Models for Panel Data

According to Schmidt and Sickles (1984), there are three main difficulties concerning maximum likelihood methods and consistency of estimates from using cross-sectional data. First, firm technical inefficiency can be estimated inconsistently. Second, distributional assumptions of technical inefficiency are required. Third, it may be incorrect to assume that inefficiency is independent of the regressors. Each of these difficulties is potentially avoidable if a 'satisfactory' panel data set is available (Henderson, 2003).

(Coelli et al., 2005) present the three potential gains from using panel data to measure technical inefficiency. First, relaxing some of the strong distributional assumptions that are necessary to disentangle the separate effects of inefficiency and noise. Next, getting consistent predictions of technical efficiency. Finally, showing changes in technical efficiencies over time.

For panel data models, it is common to classify different structures due to whether technical inefficiency is time-invariant or time-varying. For many industries the independence assumption is unrealistic, it is expected efficient firms to remain reasonably efficient from period to period, and that inefficient firms improve their efficient levels over time (Coelli et al., 2005). Therefore, we estimate the Time-varying Inefficiency Models and check whether the technical efficiency is improved after Vietnam joined in WTO.

Consider a stochastic frontier analysis of panel data:

SFA assumes that each firm potentially produces less than it might due to a degree of inefficiency.

$$Y_{rsit} = f(L_{rsit}, K_{rsit}, D_r, D_s, D_t, \beta) f(Z_{rsit}, \delta) \exp(V_{rsit})$$

Where $f(Z_{rsit}, \delta)$ is the degree of efficiency for firm i and in the interval (0,1] and Z_{rsit} presents factors explaining technical inefficiency such as investment climate (IC) and firm-specific characteristics (C).

Taking the natural log of both sides, the general empirical equation in linear form that the parameters of the technical inefficiency and stochastic frontier model are jointly estimated can be written as follows:

$\ln Y_{rsit} = \ln f(L_{rsit}, K_{rsit}, \beta) + D_{r,s,t} + V_{rsit} - U_{rsit}$

where $\mathbf{U_{rsit}} = \ln \mathbf{f}(\mathbf{Z_{rsit}}, \boldsymbol{\delta}) = \boldsymbol{\delta_{IC}} \ln \overline{\mathbf{IC}} + \boldsymbol{\delta_C} \ln \mathbf{C_{rsit}} + \boldsymbol{\delta_o} + \boldsymbol{\varepsilon_{rsit}}$

with

Y_{rsit}: Value added of the firm i in region r and sector s during year t

β, δ: Parameters of the equation

L_{rsit}, K_{rsit}: Production factors – Labour, Capital

D_r, D_s, D_t: dummies for region, sector and year

V_{rsit}: External shocks and assumed to be independently $N(0, \sigma_v^2)$ distributed

ε_{rsit} : error term defined by the truncation of normal distribution with zero mean and σ^2 variance

Two different specifications of the technical inefficiency U_{it} (for simplicity, U_{it} is used instead of U_{rsit}) term represent for time-invariant and time-varying technical inefficiency. In the time-invariant models, $U_{it} = U_i$ with $U_i \overset{iid}{\sim} N^+(\mu, \sigma_u^2), V_{it} \overset{iid}{\sim} N(0, \sigma_v^2)$ and U_i, V_{it} are distributed independently of each other and the covariates in the model.

The time-varying decay specifications allow the technical efficiency levels to change systematically over time. These types of models take the form:

$U_{it} = f(t).U_i$ where $f(t) = \exp[-\eta(t - T_i)]$ (see Battese and Coelli (1992))

where T_i is the last period in the i-th panel, η is the decay parameter? When η = 0, the time-varying model reduces to time-invariant; if η > 0, the degree of inefficiency decreases over time and vice versa for η < 0.

A predictor of the technical efficiency for the i-th firm is defined as: $TE_i = E\{\exp(-U_i) | (V_i - U_i)\}$

$$= \left\{ \frac{1 - \Phi(\sigma_* - \mu_{*i}/\sigma_*)}{1 - \Phi(-\mu_{*i}/\sigma_*)} \right\} \exp\left(-\mu_{*i} + \frac{1}{2}\sigma_*^2\right)$$

with $\mu_{*i} = -(V_i - U_i) - \dfrac{\sigma_v^2}{\sigma_u}$ and $\sigma_* = \sigma_v$

and Φ(.) represents the distribution function of the standard Gaussian random variable.

5. Data Descriptions and Variables

5.1. Descriptions of Data

The data are drawn from the enterprise surveys in Vietnam conducted by the World Bank in 2005 and the period 2009 – 2010[3]. These surveys collect the data on inputs and outputs, firm characteristics in the last fiscal year with retrospective basis (one to three years before), and as well as quantitative and qualitative indicators of the investment climate. They provide subjective evaluations of obstacles and other objective information of cost and productivity on the themes of infrastructure, human capital, governance, and finance.

The database for estimating is an unbalanced panel of Vietnam in the period 2003 – 2004 and 2008/2009. For the investment climate (IC) variables, observations are available for the years 2004, 2008 and 2009 but not for 2003. In order to use as many observations as possible to benefit from the law of large numbers, it is able to assume that, unless there is a structural break, the IC variables do not change much from one year to the next. In fact, what can change from one year to the next is the reaction of the firm facing a certain investment climate, but that depends on the firm's perceptions of the impact of investment climate and on the time required for firm to implement the corresponding adjustments (Escribano & Guasch, 2005; Kinda et al., 2009). Under these hypotheses, it is possible to allow the coefficients of certain IC variables to change from one year to the next while maintaining the values of the IC variables constant during 2003 and 2004. For analysis, we get 2,809 observations available. In this sample, enterprises come from 13 manufacturing industries in five regions Red River Delta, Central North, Mekong River Delta, Southern Central Coast, and South East.

5.2. Variables Descriptions

All variables are expressed in logarithms, except the ones that are expressed as a percent, and all nominal variables are deflated by the producer price index (PPI). The dependent variable (*Value added*) and two production function variables (*Labour, Capital*) are in Vietnam Dong (VND) and adjusted by PPI base year 2000. In accordance with the theory, firm characteristics such as *Export, Foreign ownership, ISO certificate, Training employee, Manager's experience, Capacity utilization, Internet access,* and *Working hours* are included. The explanatory variables of interest – investment climate variables are distinguished into four categories: Infrastructure, Business-Government Relations, Crime and Legal Environment, Finance and Labour, depend on the context of Vietnam and available data

[3] The Second World Bank Enterprise Surveys took place in Vietnam from June 2009 to January 2010.

from the two enterprise surveys. The quality of Infrastructure consists of four variables: Obstacle for the operation of the enterprise caused by *Duration of power outages, Losses due to power outages, Electricity problem* and *Days to clear customs for imports*. In fact, infrastructure deficiencies are considered as a burden for enterprise operations and investment (Humphreys & Banerji, 2003). Business-Government Relations are defined by six variables: Obstacle for the operation of the enterprise caused by *Payments to deal with bureaucracy faster, Percentage of time spent dealing with regulations, Tax administration problem, Customs and Trade regulation problem, Permit problem and Corruption problem*. Crime and Legal Environment are represented by three variables: Obstacle for the operation of the enterprise caused by *Security cost, Crime problem, and Practices of competitors in informal sectors*. These above reveal the capacity of the government to provide an investment-friendly and transparent environment and a safe society to the business sector. Finance and Labour include four variables: Obstacle for the operation of the enterprise caused by *Access to finance, Loan, Labour regulation problem* and *Worker problem*. Finance and human capital constitute essential factors of firm performance. Access to finance and the quality of educated workforce are always the main concerns of manufacturing in emerging economies[4].

5.3. Endogeneity of the Investment Climate Variables

One of the econometric problems that we have to face in estimating models above is the possible endogeneity of the IC variables due to the qualitative nature of investment climate factors (Kinda et al., 2009). Following the methods presented by Escribano and Guasch (2005), the two complementary procedures are used to correct for the endogeneity of the IC variables[5]. First, the region-industry average of the firm level investment climate variables ($\overline{IC}$) instead of the crude IC variables is created to reduce the degree of endogeneity of the IC variables. This also helps to mitigate the effect of missing IC observations for some firms. Then the investment climate perception variables are used together with IC variables[6]. Furthermore, in some cases, we restrict the sample to the firms that are less likely to choose their location by excluding large firms or foreign ownership firms.

5.4. Investment Climate Variables Selection

The econometric methodology applied for the selection of the IC variables goes from the general to the specific (e.g., Escribano and Guasch, 2005). Starting from a general model with all variables (in Appendix 1 - Appendix 4) included at once, we then reduce this general model to a simple one with relevant (significant) variables. In the reduction process, we do not delete all insignificant variables at once. In detail, the less significant variables are eliminated one by one but to ensure the existence of at least one IC variable from each broad category (Infrastructure, Business-Gorvernment Relations, Crime and Legal Environment, Finance and Labour) for interpretive purposes. Then the final estimated model is efficiently estimated once insignificant or irrelevant variables are deleted. The estimated explanatory variables of the regression models of Table 4 to 7 are selected in this way. These regression results are consistent and allow interpreting the estimated coefficients and their signs with confidence.

6. Empirical Results and Discussion

We firstly estimate the stochastic production frontiers by industry to discover which sectors have technical inefficiency component. Next, using time-varying inefficiency models we consider what the impacts of investment climate are on these inefficiency sectors, and finally we provide further analyses and robustness checks.

Table 3 presents the estimation results of the production frontier by industry. Unlike other manufacturing industries, the sum of the coefficients

[4] See the Appendix 1 – 4 for definition and construction of all variables used in this paper.

[5] Enterprise surveys contain production function data for the last year and one to three years before. However, investment climate indicators refer to only one year. Hence, it is not possible to use the natural instruments like lagged IC variables as traditional instrumental variable approach.

[6] The investment climate perception variables present firms' feedbacks on obstacles they face for operation and growth, ranked from 'no problem' through 'minor', 'moderate', 'major' and 'very severe' problems. Endogeneity of the perception variables is also taken into account using region-sector average. These variables are weak instruments for IC variables in the best case. They are not highly correlated to IC variables.

relative to labour and capital is just equal or less than one in Plastics and Rubber, Textiles. The two industries are probably the most exposed to the competition in the developing country like Vietnam.

Furthermore, stochastic frontier analysis displays that eight out of thirteen industries get technical inefficiency. They are Apparel and Leather (A & L), Paper, Food, Textiles, Plastics and Rubber (P & R), Non-Metallic Mineral Products (N M M), Machinery and Equipment (M & M), and Construction Materials (C M).

The manufacturing sector is heterogeneous so that firms in the various industries could be affected differently by the same factors. Table 4 and 5 present the impacts of firm characteristics and investment climate on firm technical efficiency per each of eight inefficient industries that are indicated from Table 3. The parameters of the production functions are estimated jointly with the parameters of the investment climate and firm characteristic variables. However, to make the empirical results more readable we present them in separate tables.

Table 4 shows that elasticities of capital and labour are different from each industry. Construction Material, Machinery and Equipment seem to be capital intensive industries. Meanwhile, Apparel and Leather, Paper, Food, Textiles, Non-Metallic Mineral Products look like more intensive in labour. The results furthermore indicate that firm characteristics such as export activities, training employee, getting ISO certification and manager's experience positively and significantly effect on firm technical efficiency. Apparel and Leather, the most labour-intensive industry in the sample, improve its performance by training its workforce. Paper industry gets benefit from exporting and training its labour. Technical inefficiency in Textiles is decreased in enterprises that having ISO certificate and their managers get more years of working experience in the industry. Surprisingly, the experience of managers in Construction Material industry can hinder the improvement of firm efficiency.

The results from Table 5 confirm that investment climate deficiencies harm firm performance. Unfortunately, these are true for all aspects of the investment climate but quite different from each industry. All of the inefficient industries face obstacles from security cost and crime problem except Non-Metallic Mineral Products. In some industries, for example: Construction Material, Food, Textiles, most constraints of investment climate just come from these issues. Machinery and Equipments, Plastics and Rubber are more sensitive to investment climate constraints than the others. The obstacles from duration of power outages, security cost and especially the problem of corruption hurdle the firm performance in Machinery and Equipment industry. The business efficiency of Plastics and Rubber is reduced by constraints from payments to speed up bureaucratic issues, cost of security and inadequately educated workforce. Meanwhile, Paper and Non-Metallic Mineral Products are mainly influenced by defeciencies in the quality of infrastructure (losses due to the power outages and days to clear customs for imports).

Comparing with the econometric results from pooling data SFA, evidences from time-varying inefficiency models for panel data are better in terms of expected signs and statistical significance of coefficients[7]. Furthermore, information on the change of technical efficiency from time-varying inefficiency model could tell something about the concerned problem: there is a little improvement or evenly decreased in technical efficiency in some manufacturing industries after three years WTO membership.

Further analyses

Our former regressions confirm the choice of estimating the time-varing inefficiency models by industry. They are random effects time-varying inefficiency models because our estimates may be unreliable if fixed-effects models are used when the number of enterprises in each industry is small (Coelli et al., 2005). For further analyses and robustness checks of firm technical efficiency impact of investment climate, we estimate these models for the whole manufacturing with sector, time, and region fixed-effects. The fixed-effects models can be estimated in a standard regression framework using dummy variables.

For all firms in the manufacturing industries, in general, it seems that investment climate obstacles but not firm characteristics effect on firm technical efficiency. The results from pooled SFA and

[7] We have considered the pooled SFA. However, the results are not reliable despite bootstrapping and controlling for heteroskedasticity. The results are reported in *Appendix 5*.

unbalanced panel are not so different but less statistically significant information provided than from balanced panel. They show up the obstacles caused by security cost and access to finance. Interestingly, most constraints of investment climate appear significantly in the observations of balanced panel model, except finance access. These might be come from the fact that the firms have more time operating in the industry so are easier to get access to credit. Their main concerns are number of days to clear customs for imports, payments to speed up bureaucracy issues and especially the practices of competitors in the informal sectors.

Breakdown by size and ownership

The breakdown by size and ownership allow testing for the robustness of impacts of firm characteristics and investment climate constraints on firm efficiency.

Considering the breakdown by firm size, the results in Table 7 show that most coefficients with expected signs are statistically significant. Large firms get benefits from exporting, meanwhile the practices of competitors in informal sectors, the security cost, and the days to clear customs for imports hinder their performance. The investment climate obstacles from business-government relations seem not to significantly hurdle them. However, the pictures of small firms are very different. Their business efficiency is harmed by government regulations, power outages, and finance access. However, it is useful in terms of public governance, to take into account that the operations of informal sectors increase their technical efficiency. It might come from the fact that business law has still not functioned properly (Thanh & Duong, 2009). Interestingly, compared to small and large firms, medium enterprises are the least sensitive to investment climate obstacles. Their technical efficiency is negatively affected by security cost and power outages.

The Table 7 also presents the classification by firm ownership. Foreign ownership firms are less influenced by investment climate constraints than local firms. Their performance is only affected by security problems (crime, expenditure on security), while investment climate obstacles caused by Business-Government relations (proxied by payments to deal with bureaucracy 'faster') and security cost significantly worsen domestic firms in term of technical efficiency. In fact, foreign firms have more power in lobbying policy makers and attracting high qualified workers.

Moreover, from the empirical results, exporting of foreign firms significantly improves their technical efficiency and especially, foreign firms increase their technical efficiency over time of period study.

7. Conclusion

Using time-varying inefficiency models for the World Bank Investment Climate surveys in 2005 and 2009, this is the first paper that identifies the constraints of investment climate on Vietnamese manufacturing firm technical efficiency. The results empirically show that a good quality of infrastructure and finance, an investment-friendly and transparent environment, a safe society encourage firm technical efficiency. The impacts of investment climate on firm technical inefficiency are robust to various kinds of specifications. Security problem emerges as the most popular constraint. Some industries such as Machinery and Equipments, Plastics and Rubber are more sensitive than others to investment climate deficiencies. These are also the cases of small firms and domestic-owned enterprises.

The results also highlight that foreign firms attain improvement in production efficiency over time compared to domestic firms. In addition, large firms as well as foreign firms get benefit from their export in term of technical efficiency. This finding is in line with the study of Le (2010), who evidences that exporting has no significant influence on the technical efficiency of Vietnamese domestic manufacturing SMEs. Remarkably, we find no strong evidence supports for technical efficiency improvement in Vietnamese firms after this country became an official WTO member in early 2007.

Table 3: Technical Inefficiency by Industry

Dependent variable: Value added													
Others		**Apparel & Leather**	**Wood & Furniture**	**Paper**	**Food**	**Textiles**	**Garment**	**Chemical**	**Plastics & Rubber**	**Nonmetallic mineral**	**Machinery & Equipment**	**Electronics**	**Construction materials**
Capital	.449*** (0.000)	.446*** (0.000)	.391*** (0.000)	.409*** (0.000)	.529*** (0.000)	.484*** (0.000)	.415*** (0.000)	.388*** (0.000)	.575*** (0.000)	.408*** (0.000)	.573*** (0.000)	.556*** (0.000)	.631*** (0.000)
Labor	.610*** (0.000)	.667*** (0.000)	.634*** (0.000)	.610*** (0.000)	.596*** (0.000)	.528*** (0.000)	.652*** (0.000)	.854*** (0.000)	.223*** (0.000)	.756*** (0.000)	.505*** (0.000)	.739** (0.001)	.706*** (0.000)
Intercept	8.24***	8.17***	9.45***	10.76***	7.82***	8.77***	8.63***	9.15***	9.81***	9.41***	7.26***	6.41*	4.63***
H0: No inefficiency component	.021 (1.000)	1.29*** (0.000)	.009 (1.000)	1.421*** (0.005)	1.66*** (0.000)	1.50*** (0.006)	.0203 (1.000)	.0354 (1.000)	3.03*** (0.000)	2.64*** (0.017)	.980*** (0.066)	.863 (0.368)	1.340*** (0.025)
Observations	230	188	254	121	433	204	74	137	148	88	192	46	174

Notes: (1) Estimated equation for Stochastic Production Frontiers by industry is as follows: $\ln Y_{rit} = \beta_L \ln L_{rit} + \beta_K \ln K_{rit} + D_r + D_t + \beta_o + V_{rit} - U_{rit}$

(2) p-value is reported in parentheses. ***, **, and * denote significance level of 1%, 5%, and 10% respectively.

Table 4: Time-Varying Inefficiency Models by Industry

Dependent variable: Value added								
	C M	**A & L**	**Paper**	**Food**	**Textiles**	**P & R**	**N M M**	**M & E**
Capital	0.609***	0.247***	0.358***	0.360***	0.647***	0.411***	0.324**	0.506***
Labour	0.385**	0.830***	0.546***	0.633***	0.571***	0.480**	0.694***	0.470***
Firm characteristic variables (regressed on firm technical inefficiency)								
Export	-0.005		-0.02***			0.007	0.007	-0.001
Training	0.020	-0.371*	-0.530*	0.314		-0.332	0.270	-0.265
Foreign	-0.005			-0.005				
ISO			-0.116	-0.541	-0.982**	-0.018	0.779	
Manager'sexp	0.420***	-0.066		-0.029	-0.249*			
Hours		0.847				0.856	0.563	-1.055
Mu	0.557	-1.114	-5.811	-10.003	-10.714	-12.549	-2.535	3.124*
Eta	0.059	-0.118*	0.009	-0.049	-0.022	0.416***	-0.024	-0.096
Observations	131	152	62	113	113	72	65	135

Notes: (1) ***, **, and * denote significance level of 1%, 5%, and 10% respectively

(2) Intercept included.

Table 5: Investment Climate and Technical Inefficiency by Industry

	C M	A & L	Paper	Food	Textiles	P & R	N M M	M & E
Infrastructure								
Losses power	-0.303	-0.003	-2.714	0.026		-0.221	0.536*	0.164
Power outages			1.984**					0.976*
Electricity problem					5.088			
Custom clearance	1.458	-0.077	2.407**	-0.549	-5.690		1.213*	-1.175
Business-Government								
Regulation dealing		-0.131	-0.067	-0.146	0.034	0.141	-0.416	
Bureaucracy faster	-1.010	0.545**	0.392		-0.488	1.209**	-5.761	0.524
Corruption problem					3.410			4.512*
Crime and Legal								
Crime			0.056	1.471**	0.834*	0.847	0.098	0.347
Security	0.185**	0.167**	0.431***	0.240***	-0.038	0.331***		0.202*
Informal practices				0.353				
Finance and Labour								
Finance access pro				-0.453		-0.744		
Worker problem						2.187**		

Notes: (1) Investment climate variables are regressed on firm technical inefficiency.
(2) ***, **, and * denote significance level of 1%, 5%, and 10% respectively
(3) Excluding large firms in Food industry.

Table 6: Pooled and Panel Data Models for Manufacturing Industries

Dependent variable: Value added			
	Pooled SFA	Unbalanced panel	Balanced panel
Capital	0.356***	0.350***	0.469***
Labour	0.532***	0.572***	0.529***
Firm characteristics (regressed on firm technical inefficiency)			
Export	0.004*	0.003	-0.002
Training	-0.080	-0.047	-0.235
Manager's Exp	-0.046	-0.057	0.077
Hours	-0.359	-0.252	-0.245
Investment climate (regressed on firm technical inefficiency)			
Losses power	-0.029	-0.024	-0.020
Power outages	0.010	0.099	-0.052
Electricity problem	0.115	0.113	-0.532*
Custom clearance	0.185	0.209	0.521**
Regulation dealing	0.012	0.022	0.074
Bureaucracy faster	0.072	-0.016	0.306**
Crime	0.122	0.115	-0.128
Security	0.184***	0.192***	0.192***
Informal practices pro	-0.203	-0.184	0.628***
Finance access problem	0.511**	0.560*	-0.228
Mu		5.002	-4.397
Eta		-0.040	0.054
Observations	588	589	387

Notes: (1) ***, **, and * denote significance level of 1%, 5%, and 10% respectively.
(2) Regressions include intercept, region, sector and year dummies
(3) Excluding large foreign firms in Pooled SFA and Unbalanced Panel due to heteroskedasticity

Table 7: Time-varying Inefficiency Models by Size and Ownership

Dependent variable: Value added					
	Size			**Ownership**	
	Small	**Medium**	**Large**	**Foreign**	**Domestic**
Capital	0.336***	0.377***	0.402***	0.343***	0.373***
Labour	0.587	0.638***	0.520***	0.521***	0.664***
Firm characteristics (regressed on firm technical inefficiency)					
Export	0.002	0.004	-0.003***	-0.007***	-0.002
Hours	-1.778***	0.002	-0.181	0.404	-0.327*
Investment climate (regressed on firm technical inefficiency)					
Losses power	0.047	-0.058	-0.036	-0.079	-0.035
Power outages	0.673**	0.274**	-0.079	-0.234	0.009
Electricity problem	1.526**	0.454	-0.091	-0.315	0.118
Custom clearance	0.330	0.182	0.269*	0.312	0.173
Regulation dealing	0.235***	-0.050	0.018	-0.048	-0.009
Bureaucracy faster	-0.474	-0.036	0.046	-0.174	0.141*
Crime	-0.247	0.154	-0.128	0.464*	0.106
Security	0.236**	0.202***	0.188***	0.179***	0.193***
Informal Practices	-0.815**	-0.167	0.332***	-0.220	0.049
Finance access pro	1.404***	0.370	-.595***	0.083	-0.123
mu	0.329	2.784***	2.857***	-1.379	4.830
eta	0.121	0.029	0.033	0.167***	-0.047
Observations	89	504	887	185	1348

Notes: (1) ***, **, and * denote significance level of 1%, 5%, and 10% respectively.
(2) Regressions include intercept, region, sector and year dummies. For small firms, only sector dummy due to few observations.

Appendix

Appendix 1: General Information at Plant Level and Production Function Variables

General Information at Plant Level	Industrial classification	Other manufacturing, Apparel & Leather products, Wood & wood products, incl. furniture, Paper, Food, Textiles, Garments, Chemicals, Plastics & rubber, Non-metallic mineral products, Basic metals & Fabricated metal products, Machinery and equipment, Electronics, Construction materials
	Regional classification	Red River Delta, Central North, Mekong River Delta, Southern Central Costal, South East
Production Function Variables	Sales	Used as the measure of output for the production function estimation (in VND adjusted by PPI - base year 2000)
	Value added	Value of total sales minus costs of raw materials and energy (in VND adjusted by PPI - base year 2000)
	Employment	Total number of workers.
	Capital stock	Book value of all fixed assets (in VND adjusted by PPI - base year 2000)
	Labour cost	Total expenditures on personnel (in VND adjusted by PPI - base year 2000)

Appendix 2: Firm Characteristic Variables

Training	dummy variable =1 if the plant provides training to its employees than on the job
Export	Percentage of the establishment's sales were exported directly
Foreign ownership	Percentage of firmed is owned by foreign private
Manager's experience	Top Manager's years of working experience
Working hours	Hours per week normally operate
ISO certification	Firm has ISO Quality certification
Capacity utilization	percentage of capacity utilized
Internet access	dummy variable = 1 if the plant has used email or a website in its interactions with clients or suppliers.

Appendix 3: Investment Climate Variables

Infrastructure	Duration of power outages	Average duration of power outages suffered by the plant in hours.
	Losses due to power outages	Value of the losses due to the power outages as a percentage of sales
	Days to clear customs for imports	Average number of days that it took from the time the plant's imports arrived to the point of entry until the time the plant could claim them from customs.
Business-Government Relations	Percentage of time spent dealing with regulation	Percentage of time in a typical week spent by management dealing with bureaucracy/regulation.
	Payments to deal with bureaucracy faster	Payments to "speed up" bureaucratic issues as a percentage of sales.
Finance	Loan	Dummy variable = 1 if the plant reports that it has a bank loan.
Crime	Security cost	Expenditure on security related items by the plant as percentage of sales.

Appendix 4: Investment Climate Perception Variables

Infrastructure	Electricity problem	Ranking by the plant of electricity as a problem for its operations and growth.
Business-Government Relations	Tax administration	Ranking by the plant of tax administration as a problem for its operations and growth.
	Customs and Trade regulation problem	Ranking by the plant of trade regulation as a problem for its operations and growth.
	Permit problem	Ranking by the plant of permit and business registration as a problem for its operations and growth.
	Corruption problem	Ranking by the plant of corruption as a problem for its operations and growth.
Crime and Legal Environment	Crime problem	Ranking by the plant of crime a problem for its operations and growth.
	Competitor problem	Ranking by plant of practices of competitors in the informal sector as a problem for its operation and growth
Finance and Labor	Finance problem	Ranking by the plant of access to finance as a problem for its operations and growth
	Labour regulation problem	Ranking by the plant of labour regulation as a problem for its operations and growth.
	Worker problem	Ranking by plant of inadequately educated workforce as a problem for its operations and growth.

Appendix 5: Pooled Data SFA by Industry

Dependent variable: Value added								
	C M	**A & L**	**Paper**	**Food**	**Textiles**	**P & R**	**N M M**	**M & E**
Capital	0.650***	0.279***	0.246***	0.363***	0.690***	0.152	0.313**	0.606***
Labor	0.405**	0.859***	0.401***	0.531***	0.473***	0.245	0.692***	0.417***
Firm characteristic variables								
Export	-0.004		-0.018***			0.005	0.007	-0.004
Training	-0.009	-0.120	-0.561***	0.290		0.502	0.344	-0.301
Foreign	-0.004			-0.004				
ISO			-0.045***	-0.417	-0.640**	0.157	0.795	
Manager's Exp	0.375**	-0.031		0.011	-0.244**			
Hours		0.582	1.745***			0.101	0.553	-0.998*
Investment climate variables								
Losses power	-0.060	-0.076	-1.494***	0.101		-0.551	0.509*	0.008
Power outages			0.193***					0.299
Electricity problem					2.673			
Custom clearance	0.723	-0.017	0.956***	-0.590	-3.571		1.152*	0.001
Regulation dealing		-0.126	-0.081***	-0.112	0.015	-0.138	-0.417	
Bureaucracy faster	-0.452	0.356*	-0.082***		-0.153	2.540	-5.627	-0.191
Corruption problem					1.588			1.373
Crime			-0.637***	1.164**	0.475	0.741	0.107	0.319
Security	0.139**	0.132*	0.389***	0.253***	-0.016	0.342**		0.162*
Informal practices				0.192				
Finance access pro				-0.099		0.184		
Worker problem						1.685**		
lnsig2v	-0.688	-0.97***	-35.252	-0.558**	-1.15***	-33.584	0.368	-0.585
lnsig2u	-0.623	-0.604**	-0.340	-0.586	0.162	0.347	-0.226	-0.524
Observations	131	152	60	113	113	72	65	135

Notes: (1) ***, **, and * denote significance level of 1%, 5%, and 10% respectively
(2) Excluding large firms in Food industry. Considering Paper industry only in two years 03 – 04.
(3) Firm's characteristic and investment climate variables are regressed on firm technical inefficiency.
(4) Intercept included.

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