

Industrial Policy and the Development of State-Owned Enterprises after Equitization*, **

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I. Introduction

Since 1986, the beginning of the renovation program known as “Doi Moi”, Vietnam has achieved high economic growth. The GDP growth rate had reached a peak of 9.54% in 1995 ; 10 years after the “Doi Moi” began. This achievement was the result of many factors, among them, (1) the emergence of the private sector which had not existed in the economy before the renovation and (2) reorganization in the State-owned Enterprises (SOEs) sector in the form of equitization (converting the firm’s ownership from state-owned into joint stock and the state may or may not hold any share of the newly established firm). However, the economic development was not stable over the past 20 years. The GDP growth rate had reduced sharply during the period 1996-1999 and dropped to the trough of 4.77% in 1999. From the year 2000, the economy has shown a recovery trend and the GDP growth rate reached 8.48% in 2007.¹⁾ Nevertheless, whether the country can sustain the economic growth rate of over 7% per year as it was planned is still an open question.

To date, there have been a number of research papers published concerning toward the sustainable development of Vietnam. At the macro level, the nature of development was analyzed by Tho (2001) ; Doanh L. D. et al. (2002). The former analysis has shown that labor productivity had been growing steadily during the research period 1986-2000 and that the FDI and the reallocation of the labor force was greatly contributing to the enhancement of the overall productivity. The later have shown that the nature of development

* In this paper, the term stock enterprises refer to those originated from the State-owned Enterprises and had finished the process of changing their form of ownership. The new definition of State-owned Enterprise is : “State-owned Enterprises (SOEs) are enterprises having more than 50% of the registered capital owned by the State.” (Section 22 Article 4 Enterprise Law, dated November, 29th 2005).

** This paper was presented at the seminar held in Osaka University of Economics on April, 12th 2008. The author appreciate comments by the participants of the seminar. I also appreciate comments by an anonymous referee of this journal.

1) The General Statistic Office (GSO) web page (<http://www.gso.gov.vn/>).

in recent years after the renovation tends to be extensive. Total Factor Productivity (TFP)—an indicator of the sustainable development—has been declining since 1997 even though the stock of capital is still contributing to the economic growth.

At the micro level, the competitiveness of the firms which is evaluated through the estimation of their productivity was analyzed. Utilizing the Data Envelopment Analysis (DEA) method, the productivity and the technical efficiency of firms in the banking industry was examined in Hung (2007), the efficiency of the firms in the construction industry was analyzed by Minh Ng. K. and Long G. T. (2007). Minh Ng. K. et al. (2007) examined the efficiency of the firms in the metal ware industry while Minh Ng. K. and Dong V. Q. (2007) examined the efficiency of the aquaculture-processing industry. According to their analyses, the level of technical efficiency in the examined industries was very low. For example, Minh Ng. K. and Dong V. Q. (2007) have found that the technical efficiency level in the aquaculture-processing industry varied from 41.2% in one model to 67.6% in another model. These research works tried to identify the factors that cause the technical inefficiency of the firms for helping them to improve the efficiency and as a result, enhancing their competitiveness.

Given the fact that the State-owned Enterprises (SOEs) engaged in a variety of business fields in the economy and that many of them had changed their ownership from SOEs to the stock enterprises during the reorganization process, the efficiency of the equitized/privatized SOEs not only affects the industries where they are engaged in but also affects the firms in other industries that have business transaction with them. They also affect the efficiency of the just established private sector where they are now belonging. In addition, the industrial policies had been implemented for helping these equitized/privatized SOEs to improve their efficiencies. The two policies are launched with the promulgation of the Decision 44/1998/ND-CP dated June, 29th 1998 and its revisions and the Resolution 01/2004/NQ-CP dated January, 12th 2004. These two policies use corporate income tax exemption as an incentive for firms to equitize and/or to register on the stock market. The indirect policy was implemented during the period 2004–2007. Thus, the question on the efficiency of these stock enterprises and the efficiency of the government policy has been put forth. This paper examines the effect of corporate income tax exemption policy toward the development of SOEs after equitization and tests the existence of technical inefficiency in these firms.

This paper is organized as following : After the Introduction, section II will review the historical development of the State-owned Enterprises in the context of the renovation process. Section III will introduce the source of data and the structure of the sample data to

be utilized. Section IV establishes the empirical models and explains the roles of each dependent variable. Section V provides the empirical results. Section VI giving some conclusions and suggestions based on the regression results. The appendices review the theoretical analysis of the Stochastic Production Frontier and Technical inefficiency estimation.

II. Historical overview

Actually in Vietnam, the State-owned Enterprises' (SOEs) reform began in 1981, well before the development of the renovation program, when the "Three-plan System" was launched. Under that system, SOEs acquired a small degree of autonomy. They could sell their products to the free market according to the given market prices²⁾ after completed "the first two plans" which was ordered by the government.

The SOEs only acquired a full degree of autonomy after the Government's Decision 217-HDBT was promulgated in November, 1987. Under this decision, SOEs are capable of making their own marketing strategy in accordance with the market's demand.

During the period 1989-2000, under the Radical and Comprehensive Reform Package, the government had reduced substantially the subsidies given to the SOEs. Only after the subsidies were cut, SOEs could see how inefficient they were. While the development of the private sector was not viable, the inefficiency of the SOEs sector had contributed to a loss of 2.6% of the industrial output growth rate in 1989 and to a burden of the unemployment issue. The centrally owned SOEs had to cut off 7% of their labor force while the labor force of the provincial SOEs had been cut down by 16%.

During the early 1990s, the SOEs reform took the form of dissolution and/or merger. This could be considered as a turning point in the development of SOEs as they started to diversify their production, from service sector like transportation to manufacturing sector or to expand their fields of business within the manufacturing sector. Although the number of SOEs had been reduced from 12 thousands in the early 1990s to 5873 firms in 1995 and the government budget deficit had been brought down, there still existed the question of efficiency in these SOEs as the GDP growth rate fell down to 4.77% in 1999.

From the second half of the 1990s, the SOEs reform took the form of equitization. Equitizing the SOEs is the most important phase in the SOEs reorganizing, reforming program launched by the government. Nevertheless, the speed of equitization has not been as fast as expected. By the end of 2000, only 10% of the 5700 SOEs were equitized

2) Doanh L. D. et al. (2002), p. 13.

and most of them were small enterprises.³⁾ Only after the stock market was set up in 2000, the speed of SOEs' equitization has been fostered. During the period of 5 years (2001-2005), 2347 SOEs have been equitized and 104 reorganizing projects were approved in principle.⁴⁾

On Jun, 14th 2005, the Prime Minister had approved the list of equitized SOEs which could be posted on the stock markets of Vietnam in Hanoi (HASTC) and Ho Chi Minh (HOSE). Following the Decision 528/QĐ-TTg, 44 central enterprises among the SOEs in Corporations, 22 provincial SOEs and 9 SOEs under the management of Ministries or equivalent institutions have been sold through bidding on the stock markets. In addition, 112 SOEs in State-owned Corporations, 49 provincial SOEs and 17 SOEs under the establishment and management of Ministries or their equivalent institutions were allowed to be listed on the stock market. This was a continuous step towards the complete elimination of the SOEs those are established by the local governments and/or ministries or equivalent organizations completely. According to this Decision, the total number of stock enterprises to be listed on the stock market was 253 firms.

Aiming at fostering the process of transforming the SOEs into the stock enterprises, the government has implemented two supporting policies. One policy directly influences the transformation process. The other indirectly creates incentive for SOEs to transform themselves into the stock enterprises.

The direct supporting policy was implemented with the promulgation of Decision 44/1998/ND-CP dated June, 29th 1998 which was revised by the Decision 64/2002/ND-CP dated June, 19th 2002 and latter by the Decision 187/2004/ND-CP dated November, 16th 2004.

Under these decisions, the government aims at enhancing the competitiveness of these stock enterprises. Moreover, the successful of this transformation process will enable the government to rationalize its scarce capital in developing the public and welfare sectors. In order to helps these stock enterprises in raising their owned capital, upgrading their production technologies, and improving their management capability, the government's commitment to support these stock enterprises was reiterated steadily throughout the three Decisions mentioned above.⁵⁾

Under these Decisions, the stock enterprises, considered as equivalent as the newly

3) Industrial department, Ministry of Planning and Investment, 1999.

4) Ministry of Planning and Investment (2006).

5) Refer to Article 13 Chapter II (Decision 44/1998/ND-CP), Article 26 Chapter IV (Decision 64/2002/ND-CP) and Article 36 Chapter V (Decision 187/2004/ND-CP).

established enterprise, are regulated by the Domestic Investment Promotion Law which was promulgated in 1994 and was revised in 1998. Pursuant to these two documents—the Government’s Decision 187/2004/ND-CP dated November 16th, 2004 and the Domestic Investment Promotion Law—the Ministry of Finance issued circular on giving preferential to the stock enterprise. According to this circular, any equitized enterprise will be given the first 2 consecutive years of corporate tax exemption and the next 2 consecutive years of 50% corporate tax reduction.

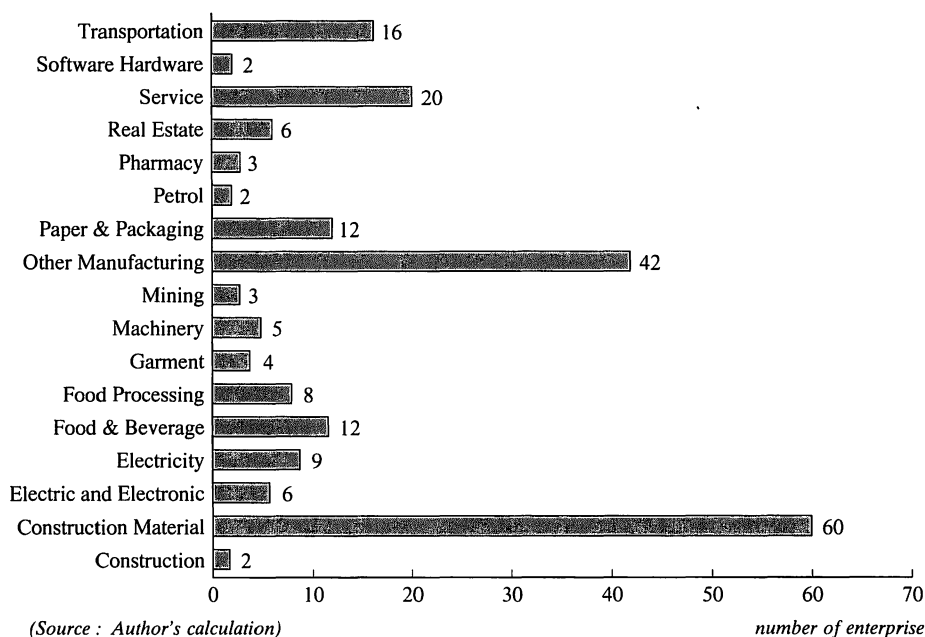
The indirect support policy was implemented with the promulgated of the Government Resolution 01/2004/NQ-CP on some measurements to implement the plan of development in 2004 and government’s budget, dated January, 12th 2004. Pursuant to this Resolution, the Ministry of Finance had issued the Document 11924TC/CST dated October, 20th 2004 on giving preferential treatment toward any enterprise which is registered for the first time on the securities markets (HASTC and HOSE). Under this Document, the first time registered stock enterprises were given a preferential treatment of 2 consecutive years exempted 50% from the corporate income tax. This document was valid until December, 31st 2007.

Given the combination of these two policies, a stock enterprise in principal, may enjoy a maximum of 4 consecutive years exempted from the corporate income tax in the first scheme or 2 consecutive years exempted from the corporate income tax and in the next 4 consecutive years, the firm will be enjoying a 50% reduction in the corporate income tax in the second scheme.

III. Data

By the end of 2007, there were 274 firms listed on the Vietnam Stock Markets, in which 123 firms are registered on the Hanoi Securities Trading Center (HASTC); the other 144 firms registered on the Ho Chi Minh Stock Exchange (HOSE); and 7 other firms have just been informed to register on the stock market and therefore their related information have not yet been uploaded. Within the list of 274 firms above, 212 firms (78%) were originated from the SOEs. The distribution of the 212 stock enterprises according to the industry is summarized in Chart 1; from this chart, there are 156 firms engaged in the manufacturing industries, the others engaged in the finance and service sectors.

It should be noted that this classification is based on the original field of business registered when firms were equitized/privatized. In fact, many of these firms have already diversified their products and moved into other fields of business. Some service companies

Chart 1 Stock Enterprises Distribution by Industry

are now engaging in food processing, garment.

The sample data are drawn from the population of 156 stock enterprises above. The detailed data are extracted from their Annual Balance Sheets, Annual Financial Reports and Explanations, and the Cash Flow Reports of the year 2006 after they were audited. Also, some data such as number of employees and the structure of employees, year of established, year of privatized/equitized are drawn from their announcements provided when they started their privatization/equitization or when they raised their registered capital and from their annual reports.

With the restrictions on the stock enterprises in the manufacturing industry, only 82 firms (52% of the population) have the available and audited data for our analysis. Table 1 provides some descriptive information about these stock enterprises. It should be noted that there are some additional information besides those listed on Table 1. According to the field of business, the sample data includes 30 firms in the construction material industry, 13 firms in the food and beverage industry, food processing industry. 5 firms in the paper and packaging industry, 4 firms in the machinery industry, 3 firms in the garment and textile industry and the rest are belonging to other manufacturing industries. In this sample, the number of firms listed on the HOSE has a large share (62%) and the number of firms engaged in the export activities is small (31%). Also, the numbers of firms declared to be exempted from the Corporate Income Tax on the 2006 fiscal year are 31 firms,

Table 1 Descriptive analysis of sample stock enterprises

	N	Minimum	Maximum	Mean	Std. Deviation
No of establishments	82	1	15	2.6	2.6
Registered Capital (VND) ⁶⁾	82	3	900	79.5	158.8
Number of employees (person)	82	19	5,287	932.8	1,072.5
Number of Long-term Employees (person)	82	11	5,287	768.3	941.8
Under Graduate Employees (person)	80	4	361	87.8	87.9
Experiences since established (year)	82	5	54	27.6	13.4
Experiences since privatized/equitized (year)	82	1	16	5.7	2.9
Experiences since listed on Stock market (year)	82	1	8	2.7	1.8

(Source : Author's calculation)

according to the information on the Profit Loss Reports.

Other information could also be drawn from the sample data indicated in Table 1. Firstly, the sizes of the firms are quite varied when they were privatized/equitized. From this sample data, it is found out that 15 firms having the registered capital of less than or equal to 10 billion VND,⁷⁾ more than 50% of them having the registered capital of less than or equal to 5 billion VND. Although, some of these stock enterprises are raising their registered capital since the moment their equitization have been completed, the sample data are included both Small and Medium-sized Enterprises (SMEs) and Large Enterprises.

Secondly, many of these firms spun-off from the mother companies before they were privatized/equitized. Also, some of these SOEs were either being merged or split during the process of their historical development. The minimum of 5 years of experience since the time they were established as mentioned in Table 1 may not reflect the true value of experience in doing business they have had.

Because the sample data has been collected from the audited reports, the value of observations reflects their performance precisely. Nevertheless, this sample data still has some defects. Although the numbers of establishments in the observed firms are quite varied, with 42 firms having more than one establishment, the data for analysis is only

6) This is the register capital by the time SOEs were equitized. These firms have raised their register capital to more than 10 billion VND. For example, one firm had raised its register capital from 7 billion VND by the time it equitized to 10.5 billion VND by the end of 2006.

7) According to the "Decree of the Government on Supporting for development of small and medium enterprises (SMEs)" dated 23rd November, 2001, the Small and Medium Enterprises are defined as those "independent business and production establishments that have register their business under the current legislation, have the registered capital of less than VND 10 billions or the average number of annual employees of less than 300"—Article 3.

available at the firm's level. Another defect is the small sample size issue. To overcome the defect of small sample size, taking the result of the Olson, et al. (1980) analysis into account,⁸⁾ the methodology to be utilized in this report is the Corrected Ordinary Least Square (COLS).

IV. Empirical Models and Variables

The empirical models to be utilized here are based on the Cobb-Douglas production in the translog form. The basic models are as following

$$\ln va = \alpha + \beta_1 \ln k + \beta_2 \ln l + \sum_{j=3}^M \beta_j x_j + G_{TE} + \varepsilon \quad (1)$$

$$\ln va = \alpha + \beta_1 (\ln r \ln k_A) + \beta_2 \ln l + \sum_{j=3}^M \beta_j x_j + G_{TE} + \varepsilon \quad (2)$$

$$\ln(va/l) = \alpha + \beta_1 \ln(k/l) + \sum_{j=2}^M \beta_j x_j + G_{TE} + \varepsilon \quad (3)$$

Model (3) controls for the variation in labor due to the high correlation between labor and capital.⁹⁾ In these models, the variables are defined as following :

Value Added (va) of each firm is defined as equivalent to the Net Sale value after excluding the cost of raw materials and intermediate goods.

With respect to the Capital variable, on the one hand, Capital (k) is defined as the sum of the owned capital at the closed balance plus the average of the sum of the inventories at the opened and the closed balance. On the other hand, Capital (k_A)—the gross book value of the plants and equipments—is defined as the sum of the fixed tangible capital at the closed balance and the cumulative depreciation.

Capital ratio (r)—the ratio of the net to gross book value of the plants and equipments—is defined as the ratio of the fixed tangible capital to the Capital (k_A) calculated above.

Labor cost (l_i) is defined as total wage payment plus other expenditure through the welfare funds.

Policy variable (G_{TEi}) is introduced in order to search for the difference in the output between the groups of firms subject to corporate tax exemption and the other group. The reason why I ignore the lag of one year's effect or so is because most of these stock enterprises did not register to apply the corporate tax exemption policy at the same year when

8) Olson, et al. (1980), p. 80.

9) See Table A. 1 in the Appendix : The Correlations and the Variance-covariance Tables.

they were equitized. Often, it was one year after the transformation has been completed.

$$G_{TEi} = \begin{cases} 0 & \text{if firm was exempted from the corporate income tax} \\ 1 & \text{if firm was paid corporate income tax} \end{cases}$$

The ratio of consignment cost to the production cost (r_{cc}) is used to test the degree of utilizing the market and producing what they could do better than the markets do. On the one hand, this variable examines the effect of outsourcing or relying on the market to the output of the firm. On the other hand, it is also used as a policy variable to evaluate the effect of changing ownership (from SOEs to stock enterprises) to the growth of the firm's output because the consignment cost of SOEs before the renovation did not exist or had minor effect.

The ratio of the long-term loans over the total resources¹⁰⁾ (r_{LR}) examines how well the firm is doing business with the money borrowed from the financial institutions (The ratio of long-term loans over the owned capital may be used instead of to examine the structure of resources toward the output growth of the firm).

Liquidity constraint (r_{LQ}) is defined as the ratio of the sum of after tax profit plus depreciation cost divided by net sale. From Kiyota K. et al. (2005), it is the variable reflecting the capability to acquire new technology of a firm. If it is true, the corporate tax exemption may helps to increase this capability of the firm, and the government could reach its target of helping these stock enterprisers in acquiring new technologies.

Finally, the residual part (ε) will be decomposed into the white noise and the technical inefficiency.

V. Regression results

Table 2 and Table 3 provide information about the productions based on a small sample data of 82 stock enterprises¹¹⁾ which were originated from the state-owned enterprises. In Table 1, the Core models examine only the effects of capital (k) and labor (l) to the value added (va). Latter, these core models are added the other independent variables which include the effect of the Corporate Income Tax Exemption policy (in Core 1 plus G policy and Core 2 plus G policy) and the effects of other variables (Full 1). Due to the problem of multicollinearity between $\ln(l)$ and $\ln(k)$, Table 3 examines the effects of these variables with a control on the variation of the labor (l) factor. The Core models are used for the estimation of the Stochastic Production Frontier. The other models are used

10) In a balance sheet, the total resources are always equal to the total assets.

11) Although the original sample data has 90 observations, 8 were excluded due to the outlier's issue.

Table 2 : Production function (Sample period 2006)Explained variable : Value Added ($\ln(VA)$) in the form of Nature Logarithm

Variable name	Code	Core 1	Core 1 plus G policy	Core 1 plus xs	Core 1 plus r_{LR}, r_{CC}	Full 1	Core 2
Labor	$\ln(l_i)$	0.587** (7.761)	0.590** (8.013)	0.597** (8.495)	0.597** (8.726)	0.600** (8.952)	0.886** (16.316)
Capital	$\ln(k_i)$	0.367** (4.962)	0.357** (4.963)	0.343** (4.991)	0.343** (5.146)	0.336** (5.141)	
Capital_ALS	$\ln(R) \ln(k_i)$						-0.006 (-0.725)
$\left(\frac{\text{long-term loans}}{\text{total resources}} \right)$	r_{LR}			1.089* (2.474)	1.091* (2.528)	0.954* (2.229)	
Liquidity constraint	r_{LQi}			0.017 (0.027)			
$\left(\frac{\text{consignment cost}}{\text{production cost}} \right)$	r_{CC}			0.692** (3.701)	0.693** (3.812)	0.678** (3.806)	
Government Policy	(G_{TEi})		0.252** (2.324)			0.203* (2.408)	
Constant		1.363 (1.864)	1.383 (1.943)	1.393* (2.099)	1.394* (2.117)	1.400* (2.170)	2.861** (3.704)
Adjusted R ²		0.821	0.831	0.853	0.855		0.767
Sample size	N	82	82	82	82	82	82
Sigma u square	σ_u^2	0.4456** [2.95648]			0.3287** [2.4256]		
Sigma v square	σ_v^2	0.0529 [1.25]			0.0505 [1.149]		
Lambda	λ	2.9031			0.2551		
Adjusted constant		0.8304** [6.3544]			0.9366** [7.9838]		

**. Significant at the 0.01 level (2-tailed)

*. Significant at the 0.05 level (2-tailed)

The t-value are denoted in the () and the asymptotic t-value are denoted in the [].

to examine the effects of the government's policies. The ratio of long-term loan to total resources (r_{LR}) together with the ratio of consignment cost to production cost (r_{CC}) are used to evaluate the effects of the equitization/privatization policy. The other two variables, (the liquidity constraint (r_{LQi}) together with the dummy variable government policy (G_{TEi})) are used to evaluate the Corporate Tax Exemption policy.

From the regression results, model Core 2 once examined by Aigner, et al. (1977) does not help to explain the variation of the value added in the observed State-owned enterprises. A small sample of observations could be one of the reason of this issue. Besides, the exchange rate could be the other reason of this issue. The exchange rate when

Table 3 : Production function (Sample period 2006)Explained variable : $\ln (VA/L)$

Variable name	Code	Core 3	Core 3 plus G policy	Core 3 plus αs	Core 3 plus r_{LR}, r_{CC}	Full 3
Capital/Labor ratio	$\ln (k_i/L)$	0.387** (5.493)	0.381** (5.538)	0.370** (5.595)	0.370** (5.776)	0.365**
$\left(\frac{\text{long-term loans}}{\text{total resources}} \right)$	r_{LR}			1.024* (2.329)	1.025* (2.380)	0.889* (2.073)
Liquidity constraint	r_{LQi}			0.012 (0.018)		
$\left(\frac{\text{consignment cost}}{\text{production cost}} \right)$	r_{CC}			0.690** (3.673)	0.691** (3.781)	0.677** (3.769)
Government Policy (Exemption=0)	(G_{TEI})		0.245* (2.264)			0.198* (1.980)
Constant		0.693** (5.156)	0.624** (4.63)	0.527** (3.864)	0.527** (4.085)	0.485** (3.770)
Adjusted R ²		0.265	0.301	0.390	0.398	0.420
Sample size	N	82	82	82	82	82
Sigma u square	σ_u^2	0.4919** [3.36396]			0.3551** [2.52133]	
Sigma v square	σ_v^2	0.0385 [0.874]			0.0445 [1.219]	
Adjusted constant		0.1334 [1.0461]			0.0515 [0.4238]	

**, Significant at the 0.01 level (2-tailed)

*, Significant at the 0.05 level (2-tailed)

The t-value are denoted in the () and the asymptotic t-value are denoted in the [].

plants and equipments were bought at a much lower rate than the exchange rate of the year 2006. As model Core 2 is not statistically significant, we exclude the analysis of model Full 2 which is the extension of model Core 2 above.

With the other two models, except the liquidity constraint (r_{LQi}) variable, all other variables are found significant, especially the consignment cost to production cost (r_{CC}) variable has shown a consistent effect to the value added with highly significant.

VI. Conclusion

The regression results (in Table 2 and Table 3) provide some implications. With respect to the equitization/privatization policy, the empirical results find out the positive effect to the equitized enterprises. This effect is indirectly reflected by the combination of the two variable consignment cost to production cost (r_{CC}) and the long - term loan to total resources (r_{LR}). It was often said that SOEs have had advantages in mobilizing capital

from the financial institutions for their operation,¹²⁾ although the efficiency of these investments had not been discussed. Nevertheless, in a broad picture, the inefficiency of the SOEs in the past which not only included the inefficiency in using the borrowed capital but also included the inefficiency in operating with the capital allocated by the government, was the main reason that leads to the SOEs reform through equitization/privatization process. Besides, the compact production process is one of the major characteristics of the SOEs in the past. As we can see, there is a positive effect to the value added of the firm of the two aforementioned variables. A relative increase in the share of long-term loan in the total resources and/or a relative increase in the share of the consignment costs to the production cost could help to increase the value added of the firm. This is because the share of these factors is still low. Referring to the Table A.5 in the Appendix, on average, the long-term loans account for only 8.2% of the total resource or the consignment cost accounts for 16.3% of the production cost. Also, this is a good effect to the economy as the new demand for the consignment emerged may help to establish the supporting industries for these firms.

With respect to the dummy variable government policy (G_{TEi}), which is also significant, the picture is that firms which are the beneficiaries of the corporate tax exemption policy are having a little higher value added level as compared with those firms not enjoying that policy. Nevertheless, it could be said that the corporate tax exemption policy does not bring out the effect as the government expected when combine this variable (G_{TEi}) with the Liquidity constraint variable (r_{LQi}) in the model. The reason is that, as in Kiyota K. et al. (2005), Liquidity constraint variable indicates the ability of the firm to renew its production technology and that one of the sources to increase the variable come from the after tax profit, nevertheless, the Liquidity constraint is not significant in any models and the difference in the value-added between the group of firms exempted from the corporate income tax and the other group is very small.

Finally, there still exists the technical inefficiency in the examined stock enterprises. There are substantial variations of the observed output below the frontier. More efforts should be done to find out factors which could improve the technical efficiency of the firms as well as the effect of the efficiency to the TFP of the firm, a factor that guarantees the growth of the firm in an ever changing business conditions. More data need be collected for examining the improvement of technical efficiency in 2007 as compared with that of 2006.

12) Doanh, et al. (2002) p. 25.

Appendices

1. The Correlations and the Variance-covariance Tables

Table A. 1 : The Correlations of Variables in Model 1

	Ln (<i>va</i>)	Ln (<i>l</i>)	Ln (<i>k</i>)	$\left(\frac{\text{long-term loans}}{\text{total resources}}\right)$	Liquidity Constraint	$\left(\frac{\text{consignment cost}}{\text{production cost}}\right)$
Ln (<i>va</i>)	1	0.878**	0.832**	0.208	0.063	0.189
Ln (<i>l</i>)		1	0.782**	0.115	−0.043	0.011
Ln (<i>k</i>)			1	0.097	0.105	0.001
$\left(\frac{\text{long-term loans}}{\text{total resources}}\right)$				1	0.149	0.032
Liquidity Constraint					1	0.152
$\left(\frac{\text{consignment cost}}{\text{production cost}}\right)$						1

** . Correlation is significant at the 0.01 level (2-tailed).

Table A. 2 : The Variance-Covariance Table of Variables in Model 1

	Ln (<i>va</i>)	Ln (<i>l</i>)	Ln (<i>k</i>)	$\left(\frac{\text{long-term loans}}{\text{total resources}}\right)$	Liquidity Constraint	$\left(\frac{\text{consignment cost}}{\text{production cost}}\right)$
Ln (<i>va</i>)	1.247	1.092	1.060	0.026	0.006	0.023
Ln (<i>l</i>)		1.239	0.993	0.014	−0.004	0.001
Ln (<i>k</i>)			1.300	0.012	0.009	0.000
$\left(\frac{\text{long-term loans}}{\text{total resources}}\right)$				0.012	0.001	0.000
Liquidity Constraint					0.006	0.001
$\left(\frac{\text{consignment cost}}{\text{production cost}}\right)$						0.012

Table A. 3 : The Correlation Table of Variables in Model 3

	Ln (<i>va/l</i>)	Ln (<i>k/l</i>)	$\left(\frac{\text{long-term loans}}{\text{total resources}}\right)$	Liquidity Constraint	$\left(\frac{\text{consignment cost}}{\text{production cost}}\right)$
Ln (<i>va/l</i>)	1	0.523**	0.189	0.215	0.367**
Ln (<i>k/l</i>)		1	−0.023	0.226*	0.086
$\left(\frac{\text{long-term loans}}{\text{total resources}}\right)$			1	0.149	−0.014
Liquidity Constraint				1	0.215
$\left(\frac{\text{consignment cost}}{\text{production cost}}\right)$					1

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Table A. 4 : The Variance-Covariance Table of Variables in Model 3

	$\text{Ln } (va/l)$	$\text{Ln } (k/l)$	$\left(\frac{\text{long-term loans}}{\text{total resources}}\right)$	Liquidity Constraint	$\left(\frac{\text{consignment cost}}{\text{production cost}}\right)$
$\text{Ln } (va/l)$	0.303	0.214	0.011	0.009	0.053
$\text{Ln } (k/l)$		0.554	-0.002	0.013	0.017
$\left(\frac{\text{long-term loans}}{\text{total resources}}\right)$			0.012	0.001	0.000
Liquidity Constraint				0.006	0.004
$\left(\frac{\text{consignment cost}}{\text{production cost}}\right)$					0.068

Table A. 5 : Descriptive analysis of the Variables

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Value added ($\ln (va)$)	82	12.217	17.562	15.140	1.117
Labor ($\ln (l)$)	82	11.040	16.310	13.766	1.113
Capital ($\ln (k)$)		12.823	18.162	15.524	1.140
$\left(\frac{\text{long-term loans}}{\text{total resources}}\right)$	82	0.000	0.631	0.082	0.110
Liquidity constrained	82	0.013	0.435	0.123	0.079
$\left(\frac{\text{consignment cost}}{\text{production cost}}\right)$	82	0.000	1.820	0.163	0.261

2. Stochastic Production Frontier

The estimation of technical inefficiency must always goes with the estimation of the production frontier, because technical inefficiency is defined as the distance below that production frontier. After the work of Aigner et al, (1977), the stochastic production frontier estimation has been actively discussed. Especially, the *Journal of Econometrics* reserved the whole volume 13 (1980) to run the estimation methods and revolving issues on these methodologies. From their works, the production frontier was defined as following

$$y_i = f(x_i, \beta) + v_i - u_i \quad (\text{A.1})$$

In this model, the performance of the firms (outputs) is divided into three influential components. The first component is the maximum output $f(x_i, \beta)$ given the current technology $f(\cdot)$ employed and the quantities of the combination of input factors x_i . The second and third variables are assumed to be distributed independently. The second component is the error term or noise v_i which refers to factors that affect the firms' performance but outside their control. This noise term is supposed to be independently and identi-

cally distributed as normal distribution $N(0, \sigma_v^2)$. The last component (u_i) represents the technical inefficiency, that is the factor having minus effects on the firms operation and under their control such as the rate of defect and/or damage outputs. Firms could improve their operation efficiency by lowering the technical inefficiency. The technical inefficiency variable is assumed to be identically and independently distributed as Half-normal Distribution which could be described as following :

$$f(u) = \begin{cases} \frac{\sqrt{2}}{\sqrt{\pi}\sigma_u^2} e^{-\frac{u^2}{2\sigma_u^2}} & \text{for } u \geq 0 \\ 0 & \text{for } u < 0 \end{cases} \quad (\text{A.2})$$

Function (A.1) tells us that the production frontier is specified by $(f(x_i, \beta) + v_i)$ which stochastically varies in accordance with the variation of the variable v .¹³⁾

3. Technical inefficiency.

To evaluate the technical inefficiency, the concepts of the moments of a distribution are employed. The general equation of the raw moments for a discrete distribution is $\mu_n = E(x^n)$. The first moment is the mean of this distribution. With the mean in hand, the central moments about the mean (μ) can be calculated as $\mu_n = E(x - \mu)^n$. Hence, the first moment about the mean is 0 while the second moment about the mean is named the variance.

From the assumptions that the noise (v_i) is identically and independently distributed as $N(0, \sigma_v^2)$ and the technical inefficiency (u_i) is identically and independently distributed as Half-normal Distribution, the joint density distribution of the two variables established in Aigner et al. (1977), Olson et al. (1980) and Torii (2001) is the following :

$$f(\varepsilon) = \frac{2}{\sigma} f^*\left(\frac{\varepsilon}{\sigma}\right) \left[1 - F^*\left(\frac{\varepsilon\lambda}{\sigma}\right)\right] \quad -\infty \leq \varepsilon \leq +\infty \quad (\text{A.1})$$

Where $\sigma = \sigma_v^2 + \sigma_u^2$, $\lambda = \sigma_u/\sigma_v$, $\varepsilon \equiv v - u$ and $f^*(\cdot)$, $F^*(\cdot)$ are the standard normal density and distribution functions. The first 6 central moments of the disturbance ε is specified as following

$$\mu = \sqrt{\frac{2}{\pi}} \sigma_u^2 = E(\varepsilon) = E(u) \quad (\text{A.2})$$

$$\mu_2 = \sigma_v^2 + \frac{\pi-2}{\pi} \sigma_u^2 = V(\varepsilon) = V(u) \quad (\text{A.3})$$

13) Function A.1 becomes the deterministic production frontier when $\sigma_u^2 = 0$.

Table A. 6 : Classification of Enterprises by Capital and Employee (as of 1995) in Vietnam

Ownership	Total	Capitalization (billion VND)					Number of employees			
		<5	5-10	10-20	20-30	>30	<100	100-199	200-499	>500
State owned (SOEs)	5,873	4,376	691	421	141	253	4,087	190	263	1,333
Foreign owned	692	353	104	96	42	97	406	15	33	238
Limited liability	4,242	4,123	72	26	10	11	3,276	105	142	719
Private owned	10,916	10,882	26	4	1	3	8,120	165	351	2,280
Joint stock	118	90	12	9	4	3	92	3	3	20
Cooperative	1,867	1,827	22	12	3	3	1,096	38	97	636
Household	1,879,402	1,879,402					1,879,402			

(Source : Industrial department, ministry of planning and investment, 1999)

$$\mu_3 = \sqrt{\frac{2}{\pi}} \left(1 - \frac{4}{\pi}\right) \sigma_u^3 \quad (\text{A.4})$$

$$\mu_4 = 3\sigma_v^4 + 6\left(1 - \frac{2}{\pi}\right) \sigma_v^2 \sigma_u^2 + \left(3 - \frac{4}{\pi} - \frac{12}{\pi^2}\right) \sigma_u^4 \quad (\text{A.5})$$

$$\mu_5 = 10\sqrt{\frac{2}{\pi}} \left(1 - \frac{4}{\pi}\right) \sigma_v^2 \sigma_u^2 + \sqrt{\frac{2}{\pi}} \left(7 - \frac{20}{\pi} - \frac{16}{\pi^2}\right) \sigma_u^5 \quad (\text{A.6})$$

$$\mu_6 = 15\sigma_v^6 + 45\left(1 - \frac{2}{\pi}\right) \sigma_v^4 \sigma_u^2 + 15\left(3 - \frac{4}{\pi} - \frac{12}{\pi^2}\right) \sigma_v^2 \sigma_u^4 + \left(15 - \frac{6}{\pi} - \frac{100}{\pi^2}\right) \sigma_u^6 \quad (\text{A.7})$$

Equating these equations with the first 6 moments calculated from the residual of the OLS, the parameters of the noise and the technical inefficiency and their asymptotic t-value could be estimated as following :

$$\bar{\sigma}_u^2 = \left(\sqrt{\frac{\pi}{2}} \left(\frac{\pi}{\pi-4} \right) \mu_3 \right)^{\frac{2}{3}} \quad (\text{A.8})$$

$$\bar{\sigma}_v^2 = \mu_2 - \left(\frac{\pi-2}{\pi} \right) \bar{\sigma}_u^2 \quad (\text{A.9})$$

The constant term in the OLS is then adjusted by the factor of $-\sqrt{\frac{2}{\pi}} \bar{\sigma}_u$. This is the reason why the model was named Corrected OLS.

References

- Aigner, D., Lovell, C. A. K. and Schmidt, P. (1977) "Formulation and Estimation of Stochastic Frontier Production Function Models", *Journal of Econometrics*, 6, pp. 21-37.
- Doanh, L. D., Thanh, V. Tr., Huong, Ph. Th. L., Minh, D. H. and Thang, Ng. Q. (2002) *Explaining Growth in Vietnam*, Global Development Network.
- Fox, John (1991) *Regression Diagnostic—An Introduction*, Sage Publication.
- Hung, Ng. V. (2007) "Measuring Efficiency of Vietnamese Commercial Banks : An Application of

- Data Envelopment Analysis”, pp. 60-70 ; in Minh, Ng. Kh., Long, G. T. (2007), *Technical Efficiency and Productivity Growth in Vietnam*, Publishing House of Social Labor.
- Kiyota, K., Okazaki, T. (2005) “Foreign Technology Acquisition Policy and Firm Performance in Japan, 1957-1970 : Micro-aspects of Industrial Policy”, *International Journal of Industrial Organization*, 23, pp. 563-586.
- Ministry of Planning and Investment (2006) *Five-year Socio-economic Development Plan 2006-2010, (Kế Hoạch Phát Triển Kinh Tế-Xã Hội 5 Năm 2006-2010 ; Nhà xuất bản Lao động—Xã hội)*, Publish House of Social Labor.
- Minh, Ng. Kh., Mai, D. Th., and Dong, V. Q. (2007) “Relative Efficiency and Productivity Dynamics of the Metalware Industry in Hanoi”, pp. 17-28 ; in Minh, Ng. Kh., Long, G. T. (2007), *Technical Efficiency and Productivity Growth in Vietnam*, Publishing House of Social Labor.
- Minh, Ng. Kh., Dong, V. Q. (2007) “Parametric and Non-parametric Estimates of Technical Efficiency for Aquaculture-processing Firms in Vietnam”, pp. 29-44 ; in Minh, Ng. Kh., Long, G. T. (2007), *Technical Efficiency and Productivity Growth in Vietnam*, Publishing House of Social Labor.
- Minh, Ng. Kh., Long, G. T. (2007) “Efficiency of Construction Firms in Vietnam : Assessment by Parametric and Non-parametric Approaches”, pp. 45-59 ; in Minh, Ng. Kh., Long, G. T. (2007), *Technical Efficiency and Productivity Growth in Vietnam*, Publishing House of Social Labor.
- Olson, J. A., Schmidt, P. and Waldman, D. M. (1980) “A Monte Carlo Study of Estimators of Stochastic Frontier Production Function”, *Journal of Econometrics*, 13, pp. 67-82.
- Stevenson, R. E. (1980) “Likelihood Function for Generalized Stochastic Frontier Estimation”, *Journal of Econometrics*, 13, pp. 67-82.
- Tho, D. Tr. (2001) “National Report—Vietnam”, pp. 322-347 in APO (2004), *Total Factor Productivity Growth, Survey Report*, The Asian Productivity Organization.
- Torii, Akio (2001) *Efficiency in Japanese Industry* (written in Japanese : *Nippon Sangyo no Keiei Kouritsu*), NTT Publishing Co., Ltd.

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(Received April 21, 2008)