# EVALUATING PERFORMANCE OF VIETNAMESE MANUFACTURING ENTERPRISES

PHAM THI THU TRANG

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**Graduate School of International Cooperation Studies**

**Department of Economic Development and Policies**

**Academic Adviser: Professor Nobuaki MATSUNAGA**

**Student number : 106I803I**

**Name : PHAM Thi Thu Trang**

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## EXECUTIVE SUMMARY

The Vietnamese economy has observed a tremendous change since the Renovation in 1986 with the transformation from a centrally planned to a market oriented economy along with opening the economy to the world. As a result, salient growth was accompanied with impressive social changes, improved income level and living standard. In this context the manufacturing industry has emerged as an engine of growth.

Nonetheless, its heavy dependence on capital and labor associated with small contribution of the Total Factor Productivity (TFP) to Gross Domestic Product has raised growing concerns of national productivity and competitiveness. Low productivity and instability of the Vietnamese economy affected its growth and made the economy vulnerable since the global financial crisis of 2008 in particular.

Enterprise performance determines national productivity and competitiveness. Hence, it is such a need to evaluate firm performance in order to find a way to improve national productivity and competitiveness. In 2008, the global crisis and the resultant national economic slowdown have seriously affected enterprise performance. There are, however, not many studies examining the effects or comparing firm performance before and after the crisis.

This thesis aims to evaluate performance of Vietnamese manufacturing firms in terms of efficiency and productivity. In particular, it is to evaluate the enterprises' efficiency performance, to investigate the determinants of efficiency, and to compare their productivity change pre- and post-global crisis. In this thesis, efficiency performance is assessed through cost efficiency rather than technical efficiency like previous studies. This is the first study assessing cost efficiency performance for manufacturing firms in Vietnam and comparing firm operation in terms of productivity before and after the global crisis.

It makes use of firm-level data from the Enterprise Survey in 2008, 2010 and 2012. The two-stage Data Envelopment Analysis (DEA) method is applied to measure efficiency levels and examine determinants of efficiencies. In the first stage, the DEA method is utilized to calculate cost efficiency as well as technical efficiency. The allocative

efficiency is extracted from the two efficiency measures as the ratio of cost efficiency to technical efficiency. The metafrontier is employed to compare efficiency levels of different enterprise groups. In the second stage, the Tobit model is employed to investigate the determinants of these efficiency measurements.

It appears that the average cost efficiency of Vietnamese manufacturing enterprises is 38.9%, while average technical efficiency is 58.0% and average allocative efficiency is 69.9%, suggesting great room for reducing production cost by improving these efficiencies. While the average technical efficiency tends to be lower over time, the average allocative efficiency records improvement, but at a slower pace. Efficiency analysis by scale shows that Large Enterprises (LEs) perform better than Small and Medium Enterprises (SMEs), but the group-production frontier of SMEs places closer to the meta-production frontier. For ownership types, State Owned Enterprises (SOEs) report the highest level of technical efficiency and cost efficiency, but they are at the farthest to the meta-production frontier and the meta-cost frontier, respectively. Meanwhile, Foreign Invested Enterprises (FIEs) are the most allocatively efficient and their technology is the closest to the benchmark technology of the whole sample. Domestic Private Enterprises (DPEs) lag behind two counterparts in terms of all efficiency measures. Regarding manufacturing sectors, high technology sectors seem to perform better than medium and low technology sectors.

The efficiency measurements are used as the dependent variables in the Tobit models to examine factors driving efficiency performance. Explanatory variables contain firm characteristics, financial leverage, concentration degree, FDI spillovers, and business environment, which is represented by the province-level data from the Provincial Competitiveness Index survey. It is found that firm's age and size positively relate to firm's efficiency. DPEs seem to be less efficient, while FIEs are more allocatively efficient and cost efficient than SOEs. The negative effects of capital intensity on technical efficiency and cost efficiency are found that are consistent with low skilled laborers, while human capital promotes efficiency performance. Firms' efficiency levels tend to be opposite to their amount of loan. Whereas, higher competition stimulates better usage of resources and lower production cost. With regard to the FDI spillovers, while horizontal effects register positive impacts on efficiency, vertical effects record moderate impacts, implying a weak inter-industrial connection between domestic producers and multinational company affiliates. The Provincial Competitiveness Index and its sub-indices (Land access and security of tenure, Transparency and access to information, Time costs and regulatory compliance, Informal charges, Proactivity of provincial leadership, Labor policy, and Legal institutions) stimulate allocative efficiency and cost efficiency, but not technical efficiency.

In the third part, productivity (partial productivity and TFP) are calculated and compared for two periods 2007-2009, 2009-2011 and for overall period 2007-2011. In terms of single factor productivity (labor productivity and capital productivity), it appears that almost all manufacturing enterprises achieved a positive growth rate of productivity. By enterprise scale, LEs are more productive. In terms of ownership, FIEs record the highest growth of productivity, whereas SOEs the slowest growth of productivity.

Based on the result in the first part a new productivity index (the Cost Malmquist productivity index) is utilized as a proxy of TFP change in the presence of cost inefficiency. The cost Malmquist productivity index and its components (Overall efficiency change, Cost-Technical change, Price effect change, Allocative efficiency change, Technical efficiency change and Technical change) are calculated by the nonparametric (DEA) method. It is found that manufacturing enterprises have positive TFP growth over the period 2007-2011, which originates from improvement of allocative efficiency and price effect. Positive TFP growth is also attributed to improvement of overall efficiency and cost-technical efficiency. Negative growth of the Malmquist productivity index is the consequence of technical efficiency decline and technical regress. Notably, technical regress is more severe over time.

In conclusion, there is large room for Vietnamese manufacturing enterprises to reduce production cost and perform much better at the full efficiency level. These enterprises record improvement of productivity before and after the global financial crisis. Poor performance of SMEs and DPEs should be a greater concern of the government. In addition, ensuring the equality across enterprises with different ownership types, improvement of human capital, increasing FDI spillover effects and enhancing business environment are the keys to stimulate the efficiency. Meanwhile, decline of technical efficiency and technical regress cause a concern about innovation and technology at the national level and enterprise level.

Through the evaluation of performance of Vietnamese manufacturing firms, several policy implications can be suggested to stimulate national productivity and competitiveness. A level playing field should be secured by removing favorable treatments for SOEs, MNC affiliates and "connected" domestic firms and by offering equal opportunities to access credit, land, information, technology and business supports for SMEs and DPEs. Greater support to young enterprises in the business registration process and in stimulating their operation is needed. Quality of FDI should be the core of FDI attraction to improve technology transfer between FIEs and domestic firms and to raise the contribution of FDI to the Vietnamese economy. Finally, a better business environment at national-level and local-level should be encouraged. At the national-level, removing bottlenecks of infrastructure, regulations and labor force is needed, while increasing investment for science and technology, research and development as well as for improving adequate technicians and researchers are necessary. At the provincial-level, legal and institutional reforms should be kept implementing.

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ADB | Asian Development Bank |
| AE | Allocative Efficiency |
| AEC | Allocative Efficiency Change |
| APO | Asian Productivity Organization |
| BTA | Bilateral Trade Agreements |
| CAGR | Constant Annual Growth Rate |
| CE | Cost Efficiency (Overall Efficiency) |
| CEC | Cost Efficiency Change |
| CIEM | Central Institute of Economic Management |
| CIP | Competitiveness Industrial Performance |
| CM | Cost Malmquist Productivity Index |
| CPI | Consumer Price Index |
| CRS | Constant Returns to Scale |
| CSEC | Cost-Scale Efficiency Change |
| CTC | Cost-Technical change |
| DoE | Department of Economics, University of Copenhagen |
| DPEs | Domestic Private Enterprises |
| ECNA | Economic Committee of National Assembly |
| EuroCham | European Chamber of Commerce in Vietnam |
| FDI | Foreign Direct Investment |
| FIEs | Foreign Invested Enterprises |
| FPI | Foreign Porfolio Investment |
| FTA | Free Trade Agreements |
| GCI | Global Competitiveness Index |
| GDP | Gross Domestic Product |
| GSO | General Statistic Office |
| GR | The graph of production technology |
| GTZ | The Deutsche Gesellschaft für Technische Zusammenarbeit |
| ICOR | Incremental Capital Output Ratio |
| IFC | International Finance Corporation |
| IIP | Index of Industrial Production |
| ILO | International Labour Organization |
| ILSSA | Institute of Labour Science and Social Affairs |
| IM | Malmquist Productivity Index |
| IMF | International Monetary Fund |
| ISIC | International Standard Industrial Classification |
| LEs | Large Enterprises |
| LURC | Land Use Right Certificate |
| MDRI | Mekong Development Research Institute |

| | |
|---|---|
| MFP | Multifactor Productivity |
| MLE | Maximum Likelihood Estimate |
| MNC | Multinational Company |
| MOIT | Ministry of Industry and Trade |
| MPI | Ministry of Planning and Investment |
| MVA | Manufacturing Value Added |
| NCRS | Nonconstant Returns to Scale |
| OEC | Overall Technical Change |
| OECD | Organisation for Economic Co-operation and Development |
| PCI | Provincial Competitiveness Index |
| PEC | Price Effect Change |
| PPI | Production Price Index |
| PTEC | Pure Technical Efficiency Change |
| R&D | Research and Development |
| S&T | Science and Technology |
| SEC | Scale Efficiency Change |
| SFA | Stochastic Frontier Analysis |
| SFM | Stochastic Frontier Model |
| SFPF | Stochastic Frontier Production Function |
| SMEs | Small and Medium Enterprises |
| SOEs | State Owned Enterprises |
| TC | Technical Change |
| TE | Technical Efficiency |
| TEC | Technical Efficiency Change |
| TFP | Total Factor Productivity |
| UNDP | United Nations of Development Programme |
| UNIDO | United Nations Industrial Development Organization |
| US$ | American Dollar |
| VCCI | Vietnam Chamber of Commerce and Industry |
| VICR | Vietnam Industrial Competitiveness Report |
| VNCI | Vietnam Competiveness Initiative |
| VND | Vietnam Dong |
| VPC | Vietnam Productivity Center |
| VRS | Variable Returns to Scale |
| VSIC | Vietnam Standard Industrial Classification |
| WB | The World Bank |
| WDI | World Development Indicators |
| WEF | World Economic Forum |
| WTO | World Trade Organization |

# CHAPTER 1

# INTRODUCTION

## 1.1. Background of the Study

The Doimoi (Renovation) in the end of 1986 has changed the socio-economic situation of Vietnam significantly. The reform process that was evaluated as a "structural adjustment" transformed from the central planned to a market oriented economy concentrated on diversifying types of ownership, amending the price setting and allocative system, meliorating the financial, monetary and banking system, and improving and strengthening foreign relationships (T. N. Le, 2006). As a result, social and economic successes were reported. The country turned from food shortage, high inflation, and high rates of poverty at that time to a fast-growing country (World Bank, 2012). Over the period 1990-2010, the average GDP growth rate is 7.3% per annum. The economy, moreover, has transformed from an agricultural economy to one with a higher contribution of industry and the service sector to GDP. Thanks to the high economic growth rate, income per capital has improved remarkably, from USD294 per capita in 1994 to USD1165 per capita in 2008. And, from one of the poorest countries at the end of the 1980s, Vietnam joined the team of lower middle income countries in 2010. Simultaneously, deep social changes are illustrated through sharp poverty reduction from 58% in 1992 to 14.5% in 2008 (World Bank, 2012) and higher living standard. The country also opened the economy, attracted foreign investors, integrated internationally and officially became the 150th member of the World Trade Organization (WTO) in January 2007.

In Vietnam, the manufacturing sector has emerged as an engine of economic growth. By 2011, the sector made up around 30% of the economic growth and 95% of industry's value added growth, accounting for 65% of merchandise export. The macroeconomic and manufacturing achievements are associated with enterprise activities. Since 2000, enterprises have registered sharp development, especially in the number of firms and number of employees. Also, manufacturing firms have accounted for 16-25% of total firm number and generated 45.0-51.5% of total jobs.

The factor-driven growth model, which is characterized by capital's reliance combined with low skilled-labor abundance contributed to high economic growth, especially during the period 1995-2007. However, the reliance seems to be more severe when those factors have been used up and their effects have diminished (Breu, Dobbs, Remes, Skilling, & Kim, 2012). In particular, population is aging and the share of skilled labor has recorded little improvement. Additionally, high investment to GDP ratio has induced lower investment effectiveness. Meanwhile, at the national level, contribution of total factor productivity (TFP) on economic growth has remained modest as a result of slower TFP growth.

Over time, the no longer appropriate factor-driven growth model has raised concerns about the economy's competitiveness and productivity. According to the Vietnam Competitiveness Report 2010, the economy is at a low productivity level and its competitiveness is worrisome at the macroeconomic and microeconomic levels (Ketels, Nguyen, Nguyen, & Do, 2011). Vietnam's productivity is quite low in comparison with other countries, especially manufacturing productivity was much lower than those of regional countries. Ohno (2013) states that since the 2000s productivity and competitiveness have not registered much improvement. McKinsey Global Institute's special report of Vietnam (2012) emphasizes that since growth-driven factors would change and economic growth no longer depends on labor abundance and investment's overuse, strengthening productivity in association with macroeconomic stabilization is the key solution for sustaining the salient growth in the two decades after the Doimoi (Breu et al., 2012).

The factor-driven growth model has caused the economy instable and vulnerable, which, in part, appeared through high inflation, trade deficit, budget deficit, currency devaluation, etc. (To & Nguyen, 2012). In 2008, the Global Financial Crisis caused bigger losses for advanced economies, which mostly are trade partners of Vietnam, and directly caused the country's decline in trade growth and FDI inflows. Indirectly, the crisis attested the economy's vulnerability, which led to economic recession, and subsequently influenced enterprise performance. In this context, enterprises have suffered extreme difficulties in both supply and demand sides that induced an increasing number of dissolved and suspended enterprises. Realizing the urgency, Decision 339/ND-TTg issued on September 19, 2013 by the Prime Minister approving an overall scheme on economic restructuring aims to switch to a new economic growth model ensuring quality of economic growth, improving effectiveness and competitiveness of the economy.

National competitiveness, as the concept proposed by Nguyen (2008), "refers to a nation's ability to create and sustain economic growth, and raises the standard of living of its citizens by improving national productivity in condition of a market economy" (Nguyen, 2008, p. 28). From the definition, it is clear that productivity is the source of competitiveness. As mentioned in Porter (2000, p. 35, as cited in Nguyen, 2008) and Porter (2001, p. 6, as cited in Nguyen, 2008), national productivity is decided by enterprises' productivity. The importance of enterprise community on an economy was also emphasized by Fried, Lovell, & Schmidt (2008), Commander & Svejnar (2007), Amores & ten Raa (2014). Hence, investigating enterprise performance is fundamental for enhancing productivity and competitiveness in micro, meso and macro levels.

In this situation, assessing firm performance is such a need in order to stimulate national productivity and competiveness. This study, therefore, evaluates the performance of Vietnamese manufacturing enterprises by asking: How do they perform? How to stimulate their performance? How their productivity changed in the context of the Global Financial Crisis and domestic economic recession? Policy implications yielding from the study will be a good reference for policy makers in the process of restructuring the economy.

### 1.2. Objectives of the Study

This study aims to evaluate performance of Vietnam's manufacturing enterprises to improve productivity and competitiveness at the national-level and firm-level. The specific objectives are:

1. To evaluate the efficiency performance of Vietnam's manufacturing enterprises in terms of cost efficiency, technical efficiency, and allocative efficiency.
2. To investigate sources of efficiency performance.
3. To compare the productivity change of Vietnam's manufacturing enterprises pre- and post-global crisis.

By doing so, this study intends to answer following research questions:

1. How efficiently do Vietnamese manufacturing enterprises perform?
2. Did they perform better over time, in terms of efficiency improvement?
3. Do larger firms operate better than smaller firms?
4. Are SOEs less efficient than others? Are foreign firms inefficient?
5. Which sectors perform better?
6. What factors drive the three efficiency measurements?
7. Did the productivity of manufacturing enterprises change before and after the 2008 global crisis?
8. Which factors contributed to TFP change?

### 1.3. Justification for the Study

Firm performance, following Santos & Brito (2012), is a subset of organizational effectiveness that covers operational and financial outcomes. According to Amornkitvikai (2011), there are five indicator groups of firm performance in terms of financial and economic aspects, i.e. financial performance, productivity, efficiency, growth, and other indicators. Among those measures, efficiency and productivity have received much attention. Efficiency and productivity are usually used to assess firm performance as successful indicators (Fried et al., 2008, p. 10).

In the field of productivity studies, productivity growth and Total Factor Productivity (TFP) are commonly measured. Productivity connects to efficiency in the aspect that productivity growth equals technical efficiency, technical progress and economies of scale (Coelli, Rao, O'Donnell, & Battese, 2005, pp. 3-4).[1] Input-oriented technical efficiency refers to the ability to reduce the inputs with a given set of outputs, while output-oriented technical efficiency measures the ability to maximize outputs with a given set of inputs and technology. If information of input prices is available, input mix allocative efficiency, implying the optimal input combination (with price information) to produce a given output at minimum cost, can be calculated. The combination of input-oriented technical efficiency

[1] If input prices are availaible, productivity growth covers the changes of technical efficiency, allocative efficiency, scale efficiency and technical progress (T. Coelli, Estache, Perelman, & Trujillo, 2003a, p. 11).

and input mix allocative efficiency is called cost efficiency, referring to a firm's ability to produce a given output at minimum cost (Coelli, Estache, Perelman, & Trujillo, 2003, p. 12; Coelli et al., 2005, p. 5).[2]

The basis of the new growth model mentioned in Decision 339/ND-TTg is improvement of input-used efficiency through stimulating technical efficiency, allocative efficiency and technical progress that lead to the improvement of allocation and usage of resources, national productivity and competitiveness. To keep the track of transferring to a new growth model, the author assesses firm operation through efficiency performance and productivity performance. In particular, efficiency performance is examined via technical efficiency, allocative efficiency and their composed measure: cost efficiency, or economic efficiency, or overall efficiency. To date, most studies on firm efficiency in Vietnam are about technical efficiency. Technical efficiency is an important measure, but not enough for the evaluation of firm performance. Besides enhancing technical efficiency, an enterprise or an economy should learn how to allocate resources optimally to minimize production cost, which is important to improve its competitiveness. Theoretically, cost is one indicator of firm-level competitiveness. Depperu & Cerrato (2005) claims that cost and efficiency are indices of competitiveness as "cost and productivity are good signals of competitiveness". Cost, apart from delivery, flexibility, and quality, was four main factor of manufacturing strategy defined by Amoako-Gyampah & Acquaah (2008). Furthermore, Seth (1995) suggested that cost efficiency is a good indicator to measure the ability to survive of small and medium enterprises.

### 1.4. Uniqueness, Significances and Contributions

This study contributes to the literature in that this is the first empirical study on cost efficiency for manufacturing firms in Vietnam. The existing studies on the Vietnamese manufacturing industry or manufacturing enterprises have concentrated on technical efficiency (Vu, 2002; Nguyen, Giang, & Bach, 2007; Hoang, Carlin, & Pham, 2008; Tran, Grafton, & Kompas, 2008; C. L. V. Le, 2010; Chu & Kalirajan, 2010; Pham, Dao, &

[2] Farrell (1957) called allocative efficiency is price efficiency and cost efficiency is overall efficiency. So, in this study, overall efficiency and cost efficiency are used interchangeably.

Reilly, 2010; Phan & Ngo, 2012; Pham, 2013; Vu, 2013). Few studies on cost efficiency are for banks (Vu & Turnell, 2010) or a sector (Nguyen, 2005; Pham, 2006). Since to be fully cost efficient a firm must be technically efficient and allocatively efficient, cost efficiency is a more comprehensive measure than technical efficiency. Therefore, through assessing cost efficiency, technical efficiency and allocative efficiency are also examined. The evaluation, subsequently, will facilitate the economic restructuring.

Moreover, being different than current studies on technical efficiency that engage output-oriented technical efficiency, this studies deals with input-oriented technical efficiency. In addition, since input prices vary across firms, a new model proposed by Tone (2002) and Cooper, Seiford, & Tone (2007) that takes account of input prices for the measurement of technical efficiency is applied.

This study also remarks its uniqueness by using the metafrontier method to measure and compare efficiency of different groups of manufacturing enterprises. To date, there is no study does the same method for manufacturing industry in Vietnam. Sources of efficiency are also examined grounded in the efficiency results.

This study is the first quantitative study examining manufacturing enterprises performance pre- and post- the 2008 global crisis. Most studies analyse the impacts of the global crisis on Vietnam's economy (Pham, 2009; Riedel & Clayton, 2009; Nguyen, Pham, & Phung, 2010; Abbott & Tarp, 2011), effects of the crisis and economic recession on labor (Pham, 2009; Cling, Razafindrakoto, & Roubaud, 2010; GSO & IDR, 2010; Nguyen et al., 2010; Le, Nguyen, Nguyen, Nguyen, & Phung, 2013; MPI, MDRI, & UNDP, 2013), and poverty (Le et al., 2013; MPI et al., 2013). With regard to the enterprise operation, only one study by MPI et al. (2013) analyses firm performance by using firm-level data over the period 2008-2012 to draw an overview picture of enterprises operation during the economic slowdown. Firm operation is examined through changes in revenue, profit, number of employees, wage, survival or exit state; however, it does not consider other aspects of enterprise operation, i.e. efficiency or productivity performance. Hence, by doing this study the author hopes to show how manufacturing enterprises have performed before and after the global financial crisis with regard to productivity.

Apart from the earlier mentioned advantage, this paper goes further than current studies on productivity that make use the production function approach and TFP change is decomposed into technical efficiency change, technical progress and scale efficiency change (Nguyen, To, & Vu, 2006; Nguyen, Pham, Nguyen, & Nguyen, 2012; Tran & Ngo, 2014).[3] Since the approach does not involve input prices as well as allocation of input bundles, productivity composition obtained from the approach is not comprehensive (Maniadakis & Thanassoulis, 2004). Following Maniadakis & Thanassoulis (2004)'s approach and combining with findings in Chapter 5 that Vietnam's manufacturing enterprises in are cost inefficient, this paper measures and decomposes TFP growth in the context of cost inefficiency for manufacturing enterprises in Vietnam and marks the first study in this field.

### 1.5. Structure of the Study

This study contains eight chapters that are outlined below. Chapter 1 represents the background of the study including the national productivity and competitiveness and economic instabilities, the impact of enterprise performance to an economy's operation; objectives of the study and research questions; justification of the study; significances and contributions.

Chapter 2 consists of three contents: overview of the Vietnamese economy since the Renovation; development of enterprises; the global economic crisis and its impact on the Vietnam's economy and enterprise performance.

Chapter 3 begins with conceptual framework to support the terminologies and methodologies sections. The section on terminologies covers definitions of efficiency, i.e. technical efficiency, allocative efficiency and cost efficiency, and productivity, i.e. single factor productivity, Total Factor Productivity (TFP). Methodologies to measure these efficiencies and productivity are in the second section. Among them, the selected method for this study and the reasons of the choice are represented.

[3] The concept productivity mentioned here is Total Factor Productivity (TFP). Details of those studies are in Section 7.1.3.

Chapter 4 focuses on the data used in empirical models. Data are from two main sources. Firm-level data from the Enterprises Survey in 2008, 2010 and 2012 were in a data cleaning process and resulted in a balanced panel data including 5034 observations. Fundamental data at firm-level are employed to measure efficiency and productivity. Provincial-level data on the Provincial Competitiveness Index coming from the same named survey combined with other firm-level data are used to investigate determinants of firm efficiency performance. Moreover, the Input-Output Table 2007 is employed to calculate variables.

In Chapter 5, results of efficiency performance of manufacturing enterprises are introduced and discussed. Efficiency measurements defined through the metafrontier and group frontiers including cost efficiency, technical efficiency, and allocative efficiency are classified and analysed by time, by scale, by ownership and by sector.

Chapter 6, based on the efficiency results of Chapter 5, investigates the factors driving efficiency performance of manufacturing enterprises. Examined determinants encompass firm characteristics (firm size, firm age, location, capital intensity, human capital), financial leverage, concentration degree, spillovers of FDI, and business environment. Empirical models are applied for the whole sample, sub-sets by size and ownership.

Chapter 7 examines the change of productivity pre- and post-global crisis with regard to single factor productivity (labor productivity, capital productivity) and TFP. Furthermore, TFP change is decomposed into some elements, especially technical efficiency change, allocative efficiency change and technical change, which connect with efficiency measurements in Chapter 5.

Chapter 8 summarizes the main results, conclusions of Chapters 5, 6, 7 on efficiency performance, sources of efficiency and productivity changes of Vietnam’s manufacturing enterprises. After that, policy implications for the whole study extracted from these results are introduced in the third section of this chapter. This chapter also indicates scope of further research.

# CHAPTER 2

# OVERVIEW OF VIETNAM'S ECONOMY, ENTERPRISE DEVELOPMENT AND IMPACTS OF THE GLOBAL FINANCIAL CRISIS ON THE ECONOMY AND ENTERPRISES

## 2.1. Overview of the Vietnamese Economy

### 2.1.1. Overview of the Macroeconomy

The central planning mechanism, in which production of all economic establishments follows plans of the state, was implemented in the north of Vietnam from 1954 and applied to the south from 1975. This mechanism generated resources for the war in the south, but led to various consequences because of unrealistic goals, i.e. distortion, shortage of inputs, wastefully used resources, no promotion of production and creation, inefficiency (Harvie and Tran, 1997). As a result, there were very few business incentives, no sign of a market, and goods supply did not meet the demand (Vo & Nguyen, 2006). In this situation, on the basis of some "fence breaking" activities over the period 1976-1986, at the Sixth National Congress in December 1986, the Renovation (Doimoi) was enacted officially.

The reform process that was evaluated as a "structural adjustment" transformed from the central planned economy to a market economy concentrated on diversifying types of ownership, amending the price setting and allocative system, meliorating the financial, monetary and banking system, and improving and strengthening foreign relationships (T. N. Le, 2006). It included two stages, i.e. the economic reform, and the transition to the market reform. The economic reform during 1986 to 1989, which concentrated on agricultural reforms, financial reforms, price and trade liberalization, state enterprise reforms and FDI attraction, was to overcome food shortages, hyperinflation and structural imbalance. The transition to the market economy since 1989 was put into a speed-up stage after economic reform with attention being paid to continuing price liberalization, financial reforms, SOE reforms, exchange rate devaluation, interest rate reforms, fiscal reforms, private sector encouragement, external economic policy reforms, legal system reforms and social reforms (Harvie and Tran, 1997). Consequently, there witnessed a radical change in economic and social aspects. The GDP was kept at a high growth rate since the Renovation.

In particular, the average annum growth rate in the five-year period from 1991-1995 to 2006-2010 was in the range of 5.1%- 8.2%, and higher than the annum growth rate of 4.4% in the period 1986-1990.[4] The economy witnessed impressive growth of GDP in period 1992-1997 with annual rate of 8.8%. Then, the Asian Financial Crisis is considered as the main reason of the economic slowdown during 1998-1999. In this duration, the lower economic growth resulted from lower growth of all economic sectors, especially the service sector. The economic recovery started in 2000 with the growth rate of 6.8%, followed by another period of significant growth since 2002. Although, the annual average growth rate of GDP in this period (2002-2007) was 7.9%, lower than the previous stage, it was the second highest growth rate in Asia, after China. The current GDP in 2012 is over US$ 155 billion and is tenfold that in 1990.

The economy has transformed from an agricultural economy to one with higher contribution of industry and the service sector to GDP. The trend is shown clearly in 1992 with the decline share of agriculture from 40.5% to 19.7%, and the decreasing trend has been continuous. Meanwhile, the industry and construction sector witnessed an increase in GDP share from 27.3% to 41.0% over the period 1992-2012, the services sector has represented a small variation around 38%. Inside the industry and construction sector, since 1992, the industry sector has accounted for 19%-35% of GDP whereas the manufacturing industry has been between 12.3% to 21.2% of GDP.

Thanks to GDP's high growth rate, GDP per capital has improved remarkably. GDP per head at current price in 2012 was US$1755 compared to US$98 per head in 1990. Moreover, on the basis of the World Bank's standard, with GNI per capita of US$1160, Vietnam became a lower middle income country in 2010. As the result of the increasing tendency of GDP per capital, the poverty rate went down steadily from 58.0% in 1993 to 14.5% in 2008 (World Bank, 2012). Subsequently, the first three millennium goals, i.e. eradication extreme poverty and hunger, achieving universal primary education, and promotion of gender equality and empowerment of women, were achieved before 2015.

[4] Affected by the Asian financial crisis in 1997-1998, the average GDP growth in period 1996-2000 was 5.1% compared to 8.2% in 1991-1995 (GSO).

**Table 2-1. Some Indicators of the Macroeconomy**

| | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| **Growth rate (%) *** | | | | | | | |
| GDP | 5.09 | 9.54 | 6.79 | 8.44 | 6.42 | 6.24 | 5.25 |
| Industry | 1.74 | 13.90 | 10.78 | 10.64 | 6.60 | 8.16 | 6.22 |
| Manufacturing | -6.34 | 13.55 | 11.68 | 12.92 | 8.38 | 11.0 | 5.8 |
| **GDP structure by sectors (%)** | | | | | | | |
| Agriculture, forestry and fishery | 38.7 | 27.2 | 24.5 | 21.0 | 18.89 | 20.08 | 19.67 |
| Industry and construction | 22.7 | 28.8 | 36.7 | 41.0 | 38.23 | 37.9 | 38.63 |
| Industry | 18.8 | 21.9 | 31.4 | 34.7 | 31.24 | 31.52 | 32.53 |
| Manufacturing | 12.3 | 15.0 | 18.6 | 20.6 | 17.95 | 18.02 | 17.39 |
| Services | 38.6 | 44.1 | 38.7 | 38.0 | 42.88 | 42.02 | 41.7 |
| **GDP structure by ownership (%)** | | | | | | | |
| State sector | | | 40.18 | 38.38 | 33.46 | 32.68 | 32.57 |
| Private sector | | | 53.51 | 47.86 | 48.85 | 49.27 | 49.35 |
| Foreign sector | | | 6.30 | 13.76 | 17.69 | 18.05 | 18.08 |
| GDP per capita (current US$) [a] | 98.0 | 288.0 | 433.3 | 699.5 | 1333.6 | 1543.0 | 1755.3 |
| Merchandise export/GDP (%) [a] | 37.1 | 26.3 | 43.1 | 56.3 | 62.3 | 71.5 | 73.5 |
| Merchandise import/GDP (%) [a] | 42.5 | 39.3 | 46.5 | 63.8 | 73.2 | 78.8 | 73.0 |
| Manufacturing, VA (% of GDP) | 12.3 | 15.0 | 18.6 | 20.6 | 20.2 | 19.7 | 19.4 |
| Manufactured exports (% of merchandise exports) [a] | | 46.7 | 54.0 | 69.4 | | 70.1 | 69.4 |

Source: GSO, WDI (a)

Note: * From 1986 to 2009, the constant GDP relied on the base year 1994. Since 2010 a new base year 2010 has been applied.

Merchandise trade has recorded impressive growth. Export value rocketed from US$1.95 billion in 1990 to more than US$114.6 billion in 2012. Meanwhile, import value increased from US$2.57 billion to US$113.7 billion. On average, merchandise exports and imports grew annually 22.2% and 19.8% in period 1991-2000 and 17.4% and 18.4% in period 2001-2010, respectively. Accompanying the rapid increase of merchandise export value, its share to GDP rose from 37.1% in 1990 to 62.3% in 2010. In 2012, the merchandise trade accounted for more than 146.5% of GDP.

Under the effect of FDI attraction policies, particularly, the issuing of the Law on Foreign Investment in 1987, the initial foreign invested project registered in 1988 and FDI has become an important investment source. Until 2011, there were nearly 15,000 registered projects with around US$230 billion of the registered FDI in which US$89 billion has been implemented. Investment of the foreign-invested sector has contributed one-fourth of the total investment and FDI is considered an important driving force, compared to some countries in the region (UNCTAD, 2008).

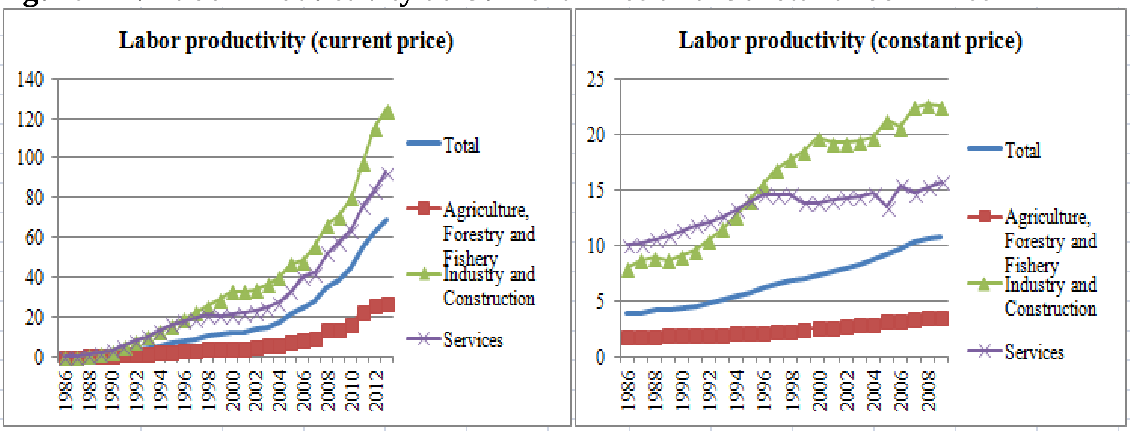
### 2.1.2. Productivity Performance of the Vietnamese Economy

Since productivity performance plays an essential role in sustaining long term economic growth of a country (APO, 2014), this section represents productivity performance in Vietnam through two common measurements: labor productivity and Total Factor Productivity (TFP).

#### *2.1.2.1. Labor Productivity*

Labor productivity determined by GDP at current price divided by number of working employees exhibits a continuously increasing tendency. As illustrated in Figure 2-1, GDP at current price to number of workers, jumped to VND 68.7 million per worker, 3217 times higher than the level of VND 0.02 million per worker in 1986. However, at constant price, national labor productivity is observed with much smaller growth. At 1994 price, labor productivity in 2009 is VND 10.8 million per worker, only 2.8 times higher than VND 3.9 million per worker in 1986.[5] Notably, labor productivity at constant price remarks a deceleration (Table 2-2).

**Figure 2-1. Labor Productivity at Current Price and Constant 1994 Price**




Source: GSO

Note: In terms of labor productivity at constant 1994 price, data from 2010 is not reported here because the basic price switched to the 2010 price since 2010.

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[5] GDP, published by GSO, is in two based year, 1994 and 2010. GDP at 1994 price is from 1986-2009, GDP at 2010 price is available since 2010.

**Table 2-2. Average Growth Rate of Labor Productivity per Annum (%)**

| | Total | Agriculture, Forestry and Fishery | Industry and Construction | Services |
|---|---|---|---|---|
| 1990-2000 | **5.05** | 2.59 | 7.69 | 2.22 |
| 2001-2005 | **4.78** | 4.63 | 1.58 | -0.53 |
| 2006-2009 | **4.17** | 2.37 | 1.38 | 4.04 |
| 2010-2013 | **3.49** | 3.33 | 2.46 | 1.23 |

Source: GSO

Note: Labor productivity is calculated by GDP at constant price. 1) By 2009: GDP at 1994 price. 2) Period 2010-2013: GDP at 2010 price.

**Table 2-3. Labor Productivity by GDP at Constant Basic 2011 PPP Price per Worker (Thousand of US$, as of 2012)**

| | 1970 | 1980 | 1990 | 2000 | 2010 | 2012 |
|---|---|---|---|---|---|---|
| Singapore | 30.6 | 43.2 | 64.5 | 95.3 | 113.7 | 114.4 |
| Japan | 26.3 | 37.6 | 53.9 | 60.3 | 66.2 | 66.9 |
| Hong Kong | 21.5 | 35.6 | 56.2 | 69.8 | 95.8 | 96.9 |
| Malaysia | 12.4 | 19.0 | 25.0 | 36.4 | 45.0 | 46.6 |
| Korea | 8.3 | 13.4 | 25.2 | 40.0 | 53.8 | 54.8 |
| Thailand | 5.1 | 7.1 | 11.1 | 16.9 | 21.8 | 22.9 |
| Indonesia | 5.1 | 8.1 | 10.6 | 13.1 | 18.1 | 20.0 |
| China | 1.0 | 1.5 | 2.3 | 5.6 | 14.5 | 16.9 |
| Philippines | 9.1 | 10.7 | 9.8 | 11.3 | 13.7 | 14.7 |
| India | 3.5 | 3.9 | 3.9 | 4.8 | 6.4 | 11.9 |
| Vietnam | 2.3 | 2.4 | 2.7 | 4.7 | 7.4 | 7.9 |
| Lao PDR | | | 3.2 | 4.5 | 7.1 | 7.9 |
| Myanmar | | | 1.5 | 2.3 | 6.1 | 6.7 |
| Cambodia | | | | 2.7 | 4.1 | 4.6 |

Source: APO (2014)

At the regional level, Vietnam's labor productivity has not registered much ranking improvement despite its relatively high growth rate. According to APO (2014), the average annual labor productivity growth rate (GDP basic price at 2011 PPP) was 5.4% during 1990-2000, after China with 8.9% per year. Over the period 2000-2012, Vietnam's labor productivity reduced to 4.4%, lower than that of China (9.1%), Myanmar (8.9%), India (5.1%), and Lao PDR (4.6%). Also, Vietnam has remained on the bottom step of the labor productivity ladder. Importantly, the labor productivity gap between regional countries and Vietnam has become wider. It is especially true with India, which remarked a significant improvement to US$11.9 thousand in 2012 from US$6.4 thousand in 2010, lower than that of Vietnam in the same year.

*2.1.2.2. Total Factor Productivity and the Factor-Driven Growth Economy*

Total Factor Productivity, which is the ratio of aggregate output to aggregate input (Coelli et al., 2005a, p. 62), is a more comprehensive measure of a country's production efficiency compared to single factor productivity such as labor productivity. TFP growth, therefore, is the residual of output growth after taking account of input growth; and it measures aggregate impact of innovation, managerial skill, business environment and external factors (Nishimizu & Page, 1982; Pham, Dinh & Nguyen, 2013, p. 86). TFP, moreover, is considered as a sign of economic prospect in the long-term. In terms of regional comparison, Vietnam is on the middle step of the regional ladder of TFP growth. According to APO (2014), the annual average TFP growth rate of Vietnam in the period 1970-2012 is 1.7%, among the group of Thailand, Sri Lanka, Hong Kong, Korea, but lower than China.

For an economy, if the contribution of inputs growth to economic growth predominates the contribution of TFP growth, it might be the case of factor-driven growth. For Vietnam, various studies on TFP, shown in Table 2-4, share a common point that TFP growth has decelerated and its contribution to economic growth has reduced over time. According to APO (2014), TFP growth averaged 1.5% per year in the period 2000-2012, nearly half of that during 1985-2000. For the period 2000-2011, Nguyen (2012) found a significant drop in TFP growth in 2008-2011 (0.7% annually) compared to that in 2000-2007, before the global crisis (1.97% annually). The same situation happened to the economy around the 1997 Asian financial crisis with a bigger decline.

Along with lower growth, contribution share of TFP growth to economic growth has gone down. This clear tendency can be seen in V.A. Le (2006), Ketels et al. (2011), VPC (2011), Nguyen (2012), Bui (2013) and APO (2014). VPC (2011) found that TFP growth made up 21.8% of GDP growth in period 2001-2005, but in the next five years, it constituted only 16.4% of GDP growth. Bui (2013) even revealed a bigger reduction in portion of TFP growth to GDP growth, from an average of 22.6% in the period 2000-2006 to 6.4% in 2007-2012. More importantly, the diminishing contribution of TFP growth and labor growth to GDP growth, in combination, expose the increasing share of capital growth. It indicates that capital has been the greatest driving factor of economic growth, which subsequently increases growth's reliance on capital. Comparing to regional countries, which have registered structural improvement with increasing proportion of TFP growth to economic growth, Vietnam has kept the factor-driven growth model.[6]

**Table 2-4. TFP Growth Estimation for Vietnamese Economy**

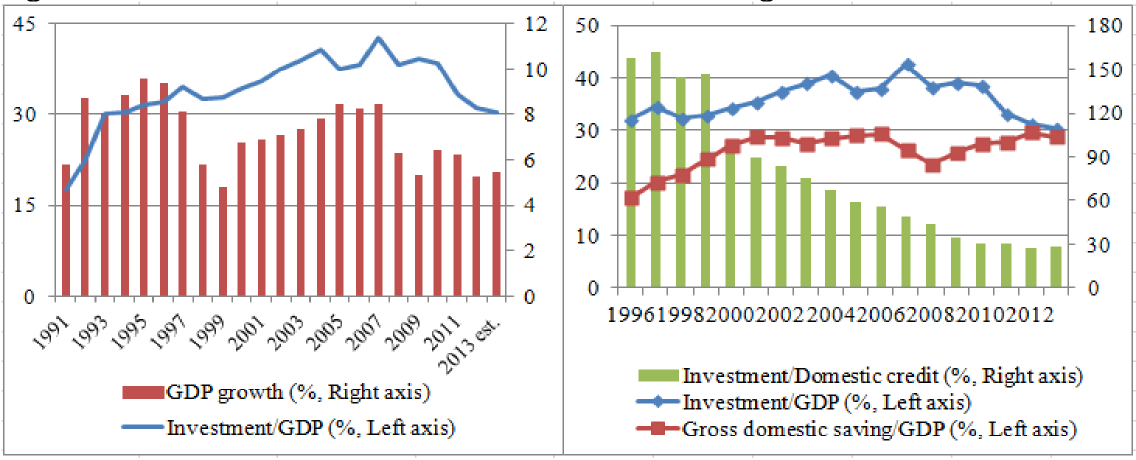
| Author(s) | Period | Contribution to GDP growth (%): Capital | Labor | TFP | TFP growth rate (%) |
|---|---|---|---|---|---|
| Kertels et al. (2011) | 1990-2000 | 34.00 | 22.00 | 44.00 | |
| | 2000-2008 | 53.00 | 19.00 | 26.00 | |
| Bui (2013) | **2000-2012** | **67.69** | **23.07** | **9.24** | |
| | 2000-2006 | 49.95 | 27.42 | 22.63 | |
| | 2007-2012 | 69.33 | 24.23 | 6.44 | |
| Nguyen (2012) | **1990-2011** | | | **19.60** | **1.42** |
| | 1990-1997 | | | 24.50 | 1.95 |
| | 1998-1999 | | | -26.60 | -1.40 |
| | 2000-2007 | | | 25.80 | 1.97 |
| | 2008-2011 | | | 11.50 | 0.70 |
| Ohno (2009) | 1995-1999 | | | 40.0 | 3.22 |
| | 1990-2007 | | | 40.1 | 2.59 |
| Park and Park (2005) | 1991-2000 | | | 16.5 | 1.07 |
| | 2001-2007 | | | 29.8 | 2.21 |
| V.A. Le (2006) | **1986-2002** | **36.97** | **23.43** | **39.60** | **2.77** |
| | 1986-1997 | 25.55 | 26.13 | 48.32 | 3.39 |
| | 1998-2002 | 64.36 | 16.96 | 18.68 | 3.44 |
| VPC (2012) | **2001-2010** | **55.65** | **25.21** | **19.14** | |
| | 2001-2005 | 53.79 | 24.37 | 21.84 | |
| | 2006-2010 | 57.63 | 25.96 | 16.41 | |
| APO (2014) | **1970-2012** | **Non-IT capital: 37.00 IT capital: 4.00** | **29.00** | **31.00** | **1.70** |
| | 1970-1985 | 27.00 (2.00) | 50.00 | 22.00 | 0.80 |
| | 1985-2000 | 29.00 (3.00) | 25.00 | 44.00 | 2.90 |
| | 2000-2012 | 53.00 (6.00) | 20.00 | 21.00 | 1.50 |

Source: Nguyen (2012) and author's compilation

[6] For instance, according to the APO (2014) database, during the period 1985-2000, the share of TFP growth to economic growth of Thailand was 22%, Indonesia (17%), Malaysia (7%), Philippines (30%). In 2000-2012, the share of corresponding countries are 51%, 35%, 25%, 34%, respectively.

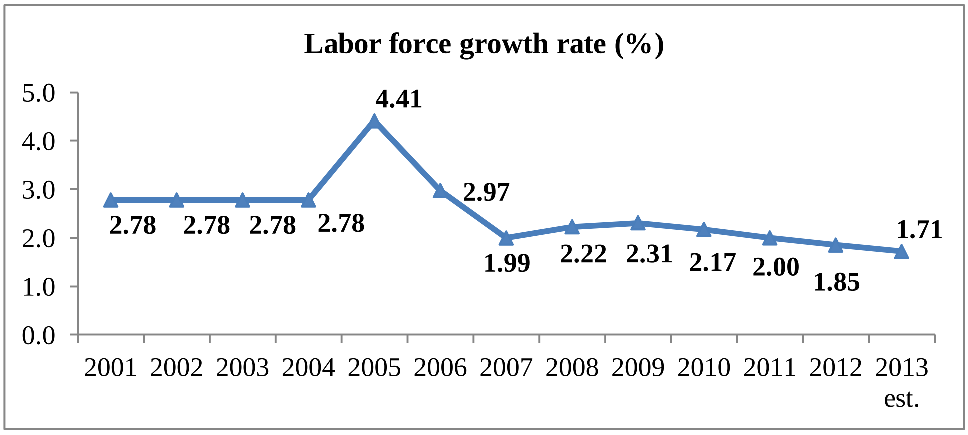
The factor-driven growth model resulted in a high economic growth rate in the early stage, but it seems to be inappropriate in recent years. Without counting years under the Asian financial crisis's effect (1998-1999), growth depending on investment started since 2000. More and more investment capital was required to guarantee the same GDP growth rate yearly, and consequently, the ratio of investment to GDP kept increasing year by year. For example, investment made up 34.2% in 2000 and peaked to 40.7% in 2004. After falling down in 2005, it gained higher proportion of 42.7% GDP in 2007. Since 2010 investment ratio has reduced as a consequence of public investment restraint policy against the threat of public debt and high inflation. Figure 2-2 illustrates a wider gap between GDP growth rate and ratio of investment to GDP, implying decreasing investment effectiveness and increasing investment dependence for economic growth.

**Figure 2-2. GDP Growth Rate, Investment, Gross Saving and Domestic Credit**




Source: GSO (Investment, GDP) and WDI (Gross Domestic Saving), ADB (Domestic credit)
Note: GDP growth: Data by 2009 are on 1994 price, data from 2010 are on 2010 price.

**Figure 2-3. Trend of Vietnamese Labor Force over time**




Source: GSO

Investment effectiveness is usually evaluated by the Incremental Capital Output Ratio (ICOR). Higher ICOR value indicates lower effectiveness of investment. A study by Bui (2011) revealed that ICOR measured by both investment capital and gross formation capital has increased over time. In particular, by investment capital, average ICOR in the period 2000-2005 is 4.89, lower than 7.43 in period 2006-2010. Similarly, corresponding ICOR by gross formation capital in the two periods are 3.04 and 4.40, respectively, suggesting lower effectiveness of investment. To finance such high investment to GDP ratio, credit and money supply was expanded, especially during the period 2003-2007. Subsequently, the expanding monetary policy caused high inflation in 2008 and 2011. One reason of higher dependence of growth on credit and money supply, in return, is that less domestic credit has been used for production, but for other purposes. The ratio of investment to domestic credit has significantly decreased from nearly 100% in 2000 to around 28% in 2013, suggesting that non-invested credit might be used for stock or real estate and induced the stock and real estate bubble in 2007-2008 (Figure 2-2).

Labor's contribution to GDP growth is moderate and decreasing as a result of decelerated labor force. In 2007 workforce growth significantly dropped from 4.41% in 2005 to around 1.99%, lower than that during 2001-2006 (Figure 2-3). Obviously, labor force's growth has become lower since 2007. Moreover, the population has been aging, while the share of skilled labor has recorded little improvement. In 2013, the population over 65 years old accounted for 7.2% of the total population, increasing from 6.6% in 2009 (GSO, 2010, 2013c). According to the Labor Force survey, the employed population with technical training and qualifications increased from 14.6% to 17.9% over the period 2010-2013 (GSO, 2014b).

In sum, the factor-driven growth model resulted in a high economic growth rate for Vietnam in the early years. However, the dependence on factor inputs, especially investment, has become more severe, while effectiveness of labor and capital has decreased steadily along with a declining contribution share of TFP growth. This fact led to macroeconomic instability that was clearly exposed by the global crisis.

### 2.1.3. Overview of the Manufacturing Sector

#### *2.1.3.1. Contribution to Economic Growth*

The manufacturing industry plays a very important role in economic growth and the industrialization process of Vietnam. This sector, as in Vietnam Industrial Competitiveness Report (VICR) 2011, is the core of impressive economic growth since the Renovation. During the past 20 years, the sector has witnessed a significant development. The manufacturing value added (MVA) climbed up from US$0.8 billion in 1990 to US$5.8 billion in 2000 and US$23.8 billion in 2011. Manufacturing value added is in association with economic growth, but has achieved a higher growth rate than that of industry and GDP growth. Furthermore, the manufacturing industry contributes more than 30% of GDP growth and nearly 95% of industry value added growth in 2011.

Manufactured exports have supported the export success. Its export value in 2012 is US$79.5 billion, nearly twenty-times higher than the export value in 1997, and accounts for 69.4% of merchandise exports, while manufactured exports' growth rate have been higher than merchandise exports' growth rate (World Bank, 2014). The manufacturing industry also contributes to job creation by attracting nearly 7 million employees in 2011, accounting for 13.8% of total working employees up from 5 million employees in 2005 (GSO, 2013b).

#### *2.1.3.2. Vietnam's Manufacturing Industry Remains Low in Competitiveness*

Though considered an engine of economic growth, the manufacturing sector of Vietnam still has low competitiveness in comparison with some neighboring countries and in structural analysis. The Competitiveness Industrial Performance (CIP)'s ranking introduces noticeable improvement of Vietnam's industrial performance.[7] Vietnam's CIP ranked 72 out of 129 in 2000 and then improved into 64 out of 134 in 2005 and 54 out of 135 in 2010, while no neighboring country recorded such improvement (Figure 2-4). The manufacturing industry has reported impressive achievement in both value and growth rate

[7] The CIP index "captures the ability of countries to produce and export manufactures competitively, as well as the structural change towards high value added, technology intensive sectors" (MOIT & UNIDO, 2011).

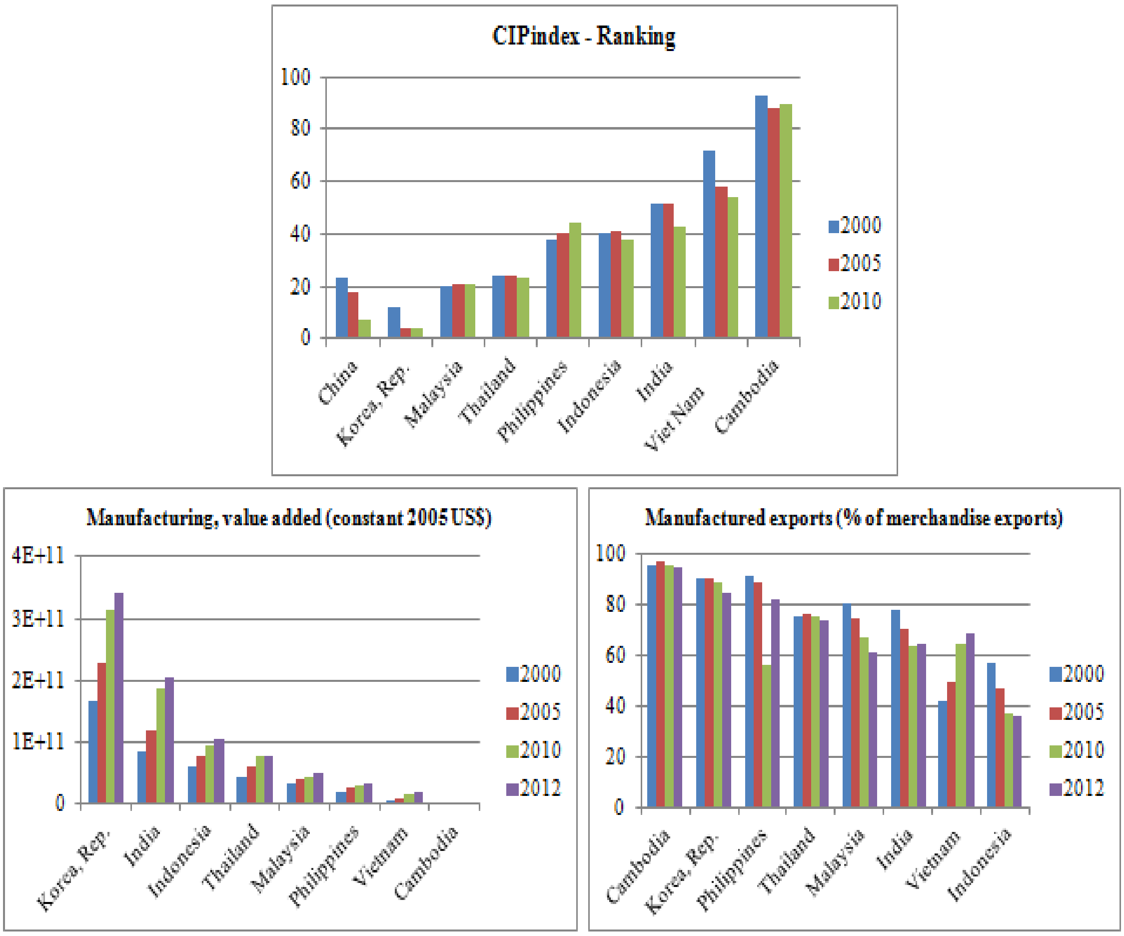
of MVA, but its value added per capita is behind some countries, and only ranks higher than Cambodia and India.[8]

In terms of the technological structure by manufacturing value added, there was a slight increase in the proportion of high and medium-technology products. Meanwhile, the share of low-technology industries has reduced to less than one half, but remains dominant (Table 2-5). In terms of proportion in total exports, despite the striking achievement in exporting, the share of manufactured exports in merchandise exports of Vietnam is one of the lowest in the region and only higher than those of Indonesia, India, and Malaysia (Figure 2-4). In a similar picture with the product structure, export of low-technology products has went down but remained the largest share of total manufactured exports. It means the structure change inside the manufacturing industry is small and trade liberalization has not motivated the change of products and export structure (MOIT & UNIDO, 2011).

The low competitiveness of manufacturing industries reflects the failure in enhancing national competitiveness and increasing technological level in both manufacturing products and manufactured export as a consequence of a lack of a clear and consistent strategy in strengthening competitiveness and a lack of concern about fundamental policies in ensuring a stable and competitive business environment and supporting policies in human resource development, technology import, research and development and so on (To, 2012). Hence, specific industrial policies for the development of private entrepreneurship and new manufacturing activities are necessary. Moreover, in order to move up to a higher level of competitiveness and technology, to create more value added, and to improve industrial diversification, changing to technology intensive and knowledge driven manufacturing activities is necessary (MOIT & UNIDO, 2011).

[8] The countries including Taiwan, Korea, Malaysia, Thailand, China, Indonesia, the Philippines, and Singapore are selected by the criteria: (1) neighboring countries, (2) intermediate competitors and (3) future competitors, and (4) role models.

**Figure 2-4. Manufacturing Performance**




Source: UNIDO

**Table 2-5. Manufacturing Product Structure and Export Structure by Technology Classification**

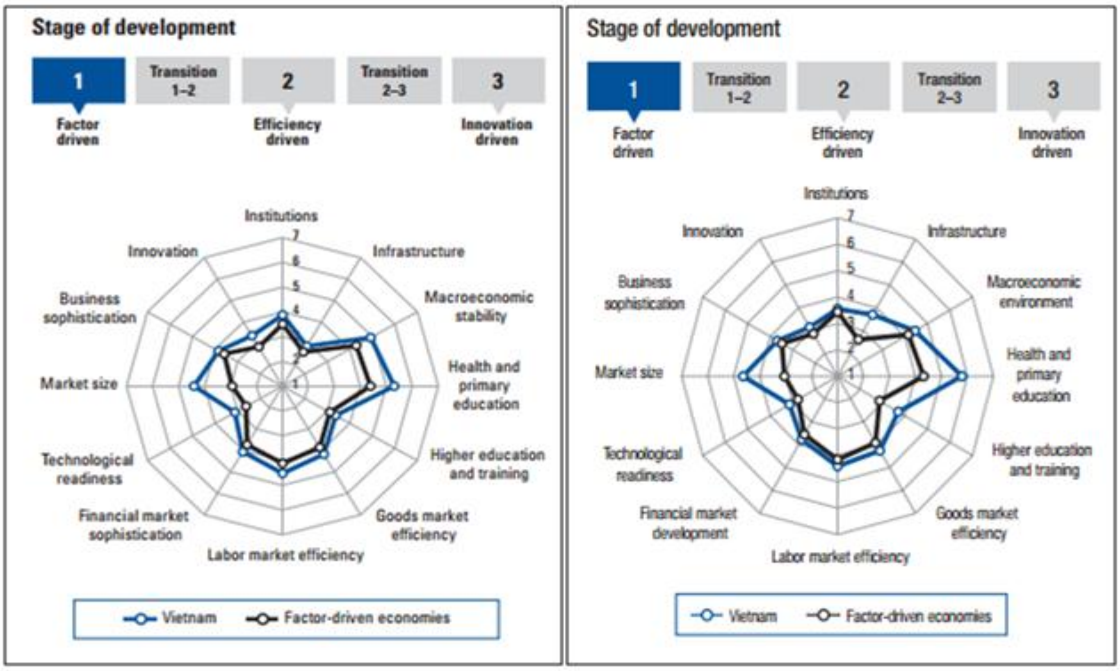
| **Product structure by manufacturing VA (%)** [a] | **2000** | **2010** |
|---|---|---|
| Low-technology manufacturing | 59.0 | 47.9 |
| Medium-low technology manufacturing | 20.8 | 28.8 |
| Medium-high technology manufacturing | 16.3 | 17.5 |
| High technology manufacturing | 3.9 | 5.9 |
| **Export structure (%)** [b] | **2000** | **2010** |
| Resource-based manufacturing | 13.8 | 12.6 |
| Low-technology manufacturing | 64.7 | 59.5 |
| Medium-technology manufacturing | 10.3 | 13.8 |
| High-technology manufacturing | 11.1 | 14.2 |

Source: UNIDO (a) and UNCOMTRADE (b)
Note: Export structure by technology classification is calculated to SITC Rev.3 (UNIDO, 2011). Product structure by technology classification is calculated to ISIC Rev. 3 by OECD. The classification by ISIC Rev. 2 provides the same classification as export structure (UNIDO, 2011). However, due to data unavailability, the author must use OECD's classification.

## 2.1.4. Some Characteristics of the Business Environment

Recently, the government of Vietnam has put effort into improving the business environment, i.e. reforming regulations, building infrastructure, paying attention to education and training and so on. As a result, Vietnam has received higher ranks of evaluation from the World Bank in the Doing Business measurement. In 2013-2014, the country ranks 70 out of 148 countries, compared to 75 out of 133 in 2009-2010. However, the business environment, especially the three bottlenecks, i.e. infrastructure, regulations and labor force, remains to be concerned by investors and enterprises.

**Figure 2-5. The Global Competitiveness Index (GCI) of Vietnam**




**GCI 2008-2009** **GCI 2013-2014**

Source: Schwab & Porter (2008), Schwab & Sala-i-Martín (2013)

### *2.1.4.1. Infrastructure*

The role of infrastructure to national productivity and competitiveness as the leading factor was confirmed through an empirical study by Nguyen (2008). Nevertheless, infrastructure, including the transportation system, electricity supply, telecommunications and so on, is one of the biggest constraints on Vietnam's competitiveness, as indicated by the Global Competitiveness Report series from 2006-2007 to 2013-2014. Following the report, inside the infrastructure pillar, quality of overall infrastructure, road, port infrastructure and quality of electricity supply are the most problematic factors (World Economic Forum, 2014).

Since the 1990s, the government has paid attention to constructing infrastructure and made achievements that contribute to economic development. During 1995-2000, the investment in infrastructure ranged from 6%-12% GDP, compared to the infrastructure investment rate of 9.5% of Taiwan over the period 1970-1990, and 8.7% of Korea in 1960-1990 (Nguyen, 2010). The huge investment resulted in infrastructure development and enhancement.[9] Nonetheless, road system development has not matched projects of industrial clusters (Nguyen, 2010). And, the non-uniformity of port and road infrastructure as well as the inefficient cargo-handling facilities and out-of-date technology lessen the cargo delivering efficiency (IFC et al., 2012; Blancas et al., 2014).

The logistic cost in Vietnam is not competitive compared with regional countries. According to Blancas et al. (2014), the logistic cost of Vietnam ranks in the middle in Southeast Asia. However, some logistic obstacles have been introduced in relation with low quality of the infrastructure system: the fragmented network with little connection among ports, land system, airports and industrial zones, the high dependence on trucking rather than on cheaper rail, facilitation payments, long lasting and unclear custom processes.

Hydro power has been the largest source of generated electricity accounting for 46% in 2012, and a big gap in power volume in the wet season and dry season is still problematic.[10] Electrical outages have become a regular phenomenon each summer and negatively impact production and living.

In sum, infrastructure quality and efficiency has not come along with the high investment rate (Nguyen, 2010). The low ranking of infrastructure quality as mentioned before raises questions of infrastructure efficiency, which originates from the lack of an

[9] For instance, during the period 2007-2011, road length increased from more than 66,000 kilometers to 206,633 kilometers; in terms of bridges, the number increased from 28,336 to 31,333 corresponding with an increase in length from 656,313 meters to 945,944 meters

[10] Electricity is generated from hydro power (46%), gas (30%), coal (17%), oil (3%) and import (4%) (US Commercial Service, 2013).

overall strategy that links the infrastructure system to the economic development strategy and master plans,[11] fragmented and inefficiency projects, long-lasting and complicated procedures (Kauffmann, 2011; Blancas, Isbell, Isbell, Tan, & Tao, 2014) is still a big concern.

#### *2.1.4.2. Regulations*

On the road to reform, the government has built and adjusted the regulation framework for the improvement of the business environment, including promoting enterprise development or attracting investment. For example, the introduction of the Law on Foreign Investment in Vietnam in 1987 as the improvement of Investment Charter in 1977 was recognized as a liberal foreign investment law and opened the door for foreign investors (Harvie & Tran, 1997).

In 1988, legal rights for the private sector were issued as the official recognition of the private sector. Then, the introduction of Law on Private Enterprises in 1990 resulted in the establishment of the first private enterprises. However, high requirements and complicated procedures prevented the setting up of private enterprises, and only 49,000 firms was established during the 1990s (D. B. Le, 2010). The Law on Enterprise in 1999 was enacted with an effort to remove or ease constraints of the former law and create more freedom in doing business. Consequently, the number of private enterprises registered yearly increased rapidly (D. B. Le, 2010). In spite of the achievements, the weak preparation and inconsistency in implementing, lack of transparency, the shortage of resources to implement, monitor the law, and contradiction of regulations, and unequal treatment to different ownership types limited effects of the law (Ho, n.d.).

Aiming to create an equal playing field for public and private enterprises, address the shortcomings of the Law on Enterprise 1999 and address international requirements, the Law on Enterprises 2005 was promulgated as the unification of the Law on Enterprise

[11] Especially, road system development is inappropriate to projects of industrial clusters (Nguyen, 2010). Moreover, the non-uniformity of port and road infrastructure as well as the inefficient cargo-handling facilities due to its deep-inside rivers position and out-of-date technology lessen the cargo delivering efficiency (IFC et al., 2012; Blancas et al., 2014).

1999, adjusted Law on SOEs 2003 and Law on Foreign Investment 2000. Some important changes of this law are (i) classifying enterprises by business form, not by type of ownership, (ii) significantly permitting business autonomy for foreign investors and Foreign Invested Enterprises, (iii) providing more choices for investors in selecting an appropriate business form, (iv) lessening the duration for approving business registration certificates, (v) new content to improve company management. In addition, greater transparency, simplified procedures and so on were presented to enhance confidence and trust of Foreign Invested Enterprises and Domestic Private Enterprises. At the same time, the Law on Investment 2005 was enacted as a merger of Law on Incentives for Domestic Investment 1998 and Law on Foreign Investment.

**Table 2-6. List of Regulations relating to Enterprises and Investment**

| Name | Year issuing | Remarks |
|---|---|---|
| Law on Foreign Investment | 1987, 1990, 1992, 1996 and 2000 | |
| Law on Incentives for Domestic Investment | 1998 | |
| Law on Private Enterprises | 1990 | |
| Law on Companies | 1990 | |
| Law on State Owned Enterprises | 2003 | |
| Law on Investment | 2005 | Replaces the Law on Foreign Investment in 1996, 2000 |
| Law on Enterprises | 1999, 2005 | Replaces the Law on Enterprise in 1999, Law on SOEs in 2003 and Law on Foreign Investment in 1996, 2000 |

Source: Author's compilation

The birth of the unified Law on Enterprise and Law on Investment and other regulations was recognized as the effort to reduce administrative procedures and consequently, time and cost of enterprises and investors. Nonetheless, the complex regulation system with the appearance of laws, decrees, decisions and regulations under laws has led to overlaps and contradictions of regulations (Tran, Grafton, & Kompas, 2009). Furthermore, the limited regulation dissemination has prevented the awareness of enterprises. According to SMEs surveys in 2002, 2005 and 2007, around 55%, 50% and 65%, respectively of SMEs were unaware of the Law on Enterprise although they were directly under the law's effect (Rand & Tarp, 2007; Rand, Silva, Tarp, Tran, & Nguyen, 2008). Additionally, the regulations have only supported the registration of enterprises, not their implementation afterward (Truong, 2013).

Another concern is that the implementation of legislation has not definitively followed regulations' ideas. For instance, the different treatment between foreign and domestic investors still exists despite the aim of making an equal environment for investors of the two laws. In addition, complicated administrative procedures and implementation varying across provinces cause arbitrariness, red tape and corruption (Tran et al., 2009). Corruption is quite common and takes many forms such as facilitation payments to customs and police, bribes, using public funds for individual benefit and so on. In the logistics field, facilitation payments account for 10%-15% of the total origin cost to import or export a container. Around 26.5%-41.2% of SMEs paid bribes during 2005-2011 and the money accounts for 0.4-0.68% of total revenue (in 2004 price), and getting connected to public services and dealing with taxes and tax collectors are the two main reasons for paying bribes (Rand et al., 2008; CIEM, DoE, & ILSSA, 2010, 2014; CIEM, DoE, ILSSA, & UNU-WIDER, 2012). Therefore, more transparent information, i.e. clear and open administrative processes, and simpler procedures are needed to avoid corruption and promote confidence of domestic and foreign investors (Blancas et al., 2014; IFC et al., 2012).

***2.1.4.3. Finance***

Credit access is the biggest constraint in doing business for private enterprises according to the Enterprise surveys of the World Bank and the SMEs survey of ILSSA and CIEM. Around 25% of respondents face financial access problems, and it is more severe with SMEs (World Bank, 2010). However, only 29.4%-39% of SMEs applied for formal loans and 19%-29% of enterprises among them had problems in obtaining loans (Rand & Tarp, 2007; Rand et al., 2008; CIEM et al., 2010; CIEM et al., 2012). The reasons for not applying for formal loans ranked from more to less important are no debt desire, complicated procedures, inadequate collateral and high interest rate. Retained earnings, therefore, are a main source of enterprises' investment, which financed 66% and 74% of total new investment of SMEs in 2005 and 2007 (Rand & Tarp, 2007; Rand et al., 2008). Informal credit is another financial source, and it is important when firms cannot access formal loans. During the period 2007-2011, 65%-77% of SMEs did not obtain a formal loan but an informal one (Rand et al., 2008; CIEM et al., 2010; CIEM, DoE, ILSSA, et al., 2012).

#### *2.1.4.4. Workforce*

Vietnam has a high proportion of young labor force. In 2012, the labor force 15 years old and over made up 59.2% of the total population, in which 76.2% of the labor force is at the age of 15-49.[12] Nevertheless, the proportion of younger workforce has declined in opposition to the increasing trend of the workforce (World Bank, 2013). In the period 2005-2012, on average, the total labor force grew 2.3% annum, but the labor force of age 15-49 only increased 0.9% per year. In the circumstance of an aging population, labor quality, therefore, must be addressed (World Bank, 2013). However, the low quality labor causes worry for foreign investors and domestic enterprises, especially it makes difficult in recruitment. Over the period 2010-2013, only 14.6%-17.9% of the employed population has technical training and qualification (GSO, 2013a). Enterprises, therefore, have faced two obstacles in hiring employees that are the lack of skilled worker--"skills gap", and the lack of employees in some occupations--"skills shortage" (World Bank, 2013).

Recently, education and training have received the government's attention. The public expenditure on education and training increased year by year, from 3.24% of GDP in 2001 to 6.00% of GDP in 2011. However, the unbalanced educational structure with concentration on undergraduate education rather than vocational training has resulted in an inappropriate workforce structure. At the micro-level, few connections between training institutions and enterprises have led to the mismatch in employment supply and demand. As a result, many firms have operated on-the-job training programs for newly recruited employees and existing workers in fulfilling their skill requirements. 8.5% of the surveyed

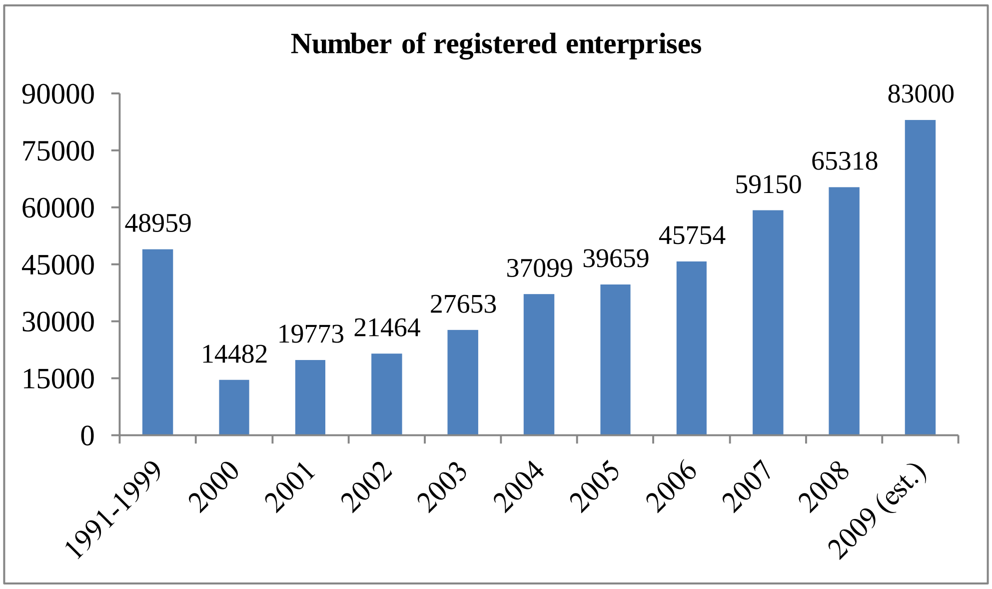
[12] The population of Vietnam in 2012 was 88.773 million persons, the labor force was 52.581 million persons, 39.902 million persons in the labor force are at the age of 15-49 years old.

SMEs have a training program for new employees in 2011 and 6.8% for old ones (CIEM, DoE, ILSSA, et al., 2012).

### 2.2. The Development of Enterprises since Doimoi

The Doimoi, with the approach of diversifying economic ownership, resulted in the boom of enterprises, job creation and contribution to socio-economic development. Accompanied with the issuance of the Law on Foreign Investment in 1987, the foreign investment first contributed to Vietnam's economy in 1988. As mentioned previously, the first regulation giving legal framework to the private sector was passed in 1991. However, the high barrier for business registration resulted in a trivial number of registered enterprises. During the 1990s, only 49,000 enterprises registered (D. B. Le, 2010).

**Figure 2-6. Number of Registered Enterprises**




Source: D. B. Le, (2010) from Agency for Enterprise Development, Ministry of Planning and Investment.

The issuance of Law on Enterprise 1999 boosted the number of registered enterprises. During period 2000-2005, there were total of 160,130 new enterprises, increasing over 22% annum. At the end of 2005, the issuance of Law on Enterprise 2005, the Law on Investment 2005, passed at the same time, was recognized as a big effort to make a level playing field for all sectors and unify the legal framework for domestic and foreign investors. Consequently, in 2011, there were more than 324,691 enterprises, in total, nearly eightfold than those in 2000.

**Table 2-7. The Development of Enterprises in Numbers**

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TOTAL** | **42288** | **51680** | **62908** | **72012** | **91756** | **112950** | **125092** | **149069** | **192179** | **236584** | **279360** | **324691** |
| Micro | 53.53 | 54.10 | 52.53 | 51.31 | 53.45 | 56.18 | 61.00 | 61.22 | 62.52 | 66.24 | 67.15 | 66.75 |
| Small | 34.04 | 34.93 | 37.08 | 38.97 | 38.20 | 36.60 | 32.36 | 32.49 | 32.19 | 29.07 | 28.31 | 28.75 |
| Medium | 4.37 | 3.81 | 3.63 | 3.45 | 3.15 | 2.83 | 2.63 | 2.64 | 2.27 | 2.06 | 2.01 | 2.11 |
| Large | 8.05 | 7.16 | 6.75 | 6.27 | 5.20 | 4.39 | 4.01 | 3.65 | 3.02 | 2.63 | 2.53 | 2.39 |
| **SOE** | **13.62** | **10.36** | **8.53** | **6.73** | **5.01** | **3.62** | **2.96** | **2.34** | **1.72** | **1.42** | **1.17** | **1.01** |
| Micro | 1.77 | 1.74 | 1.21 | 0.89 | 0.89 | 1.32 | 1.54 | 1.87 | 2.12 | 2.08 | 3.14 | 4.32 |
| Small | 43.57 | 40.54 | 38.60 | 36.51 | 35.68 | 37.00 | 37.28 | 36.86 | 35.65 | 37.65 | 38.28 | 40.09 |
| Medium | 16.41 | 15.78 | 15.51 | 15.09 | 15.60 | 15.27 | 15.25 | 16.35 | 17.15 | 16.79 | 16.43 | 15.62 |
| Large | 38.25 | 41.94 | 44.68 | 47.51 | 47.84 | 46.40 | 45.93 | 44.93 | 45.09 | 43.48 | 42.15 | 39.97 |
| **DPE** | **82.78** | **85.75** | **87.81** | **89.60** | **91.55** | **93.11** | **93.67** | **94.34** | **95.35** | **95.81** | **96.23** | **96.22** |
| Micro | 64.13 | 62.29 | 59.36 | 56.90 | 58.03 | 59.91 | 64.70 | 64.42 | 65.14 | 68.63 | 69.21 | 68.64 |
| Small | 31.56 | 33.45 | 36.24 | 38.51 | 37.73 | 35.99 | 31.42 | 31.66 | 31.47 | 28.25 | 27.61 | 28.09 |
| Medium | 2.01 | 1.99 | 2.13 | 2.25 | 2.17 | 2.10 | 1.97 | 2.04 | 1.76 | 1.65 | 1.65 | 1.78 |
| Large | 2.31 | 2.27 | 2.28 | 2.34 | 2.08 | 2.00 | 1.91 | 1.88 | 1.63 | 1.47 | 1.53 | 1.48 |
| **FIE** | **3.61** | **3.89** | **3.67** | **3.67** | **3.44** | **3.27** | **3.37** | **3.33** | **2.93** | **2.77** | **2.59** | **2.77** |
| Micro | 5.77 | 12.98 | 8.41 | 7.19 | 8.17 | 10.74 | 10.33 | 12.15 | 12.73 | 16.14 | 19.54 | 23.95 |
| Small | 55.08 | 52.66 | 53.86 | 54.75 | 54.31 | 53.53 | 54.08 | 52.95 | 53.79 | 53.15 | 49.82 | 47.45 |
| Medium | 13.25 | 12.08 | 12.05 | 11.36 | 11.22 | 9.85 | 9.86 | 9.88 | 9.99 | 8.90 | 8.82 | 8.56 |
| Large | 25.90 | 22.28 | 25.69 | 26.69 | 26.30 | 25.89 | 25.73 | 25.02 | 23.50 | 21.81 | 21.83 | 20.04 |

Source: GSO
Note: Enterprises as a whole are in numbers, enterprises by size or ownership are in percentage.

The number of SOEs decreased over time due to the equitization policy, but with a much lower rate than the reduction of its share in total enterprises. Over 11 years, SOEs' proportion fell dramatically from 14% to 1%. In contrast, there was significant growth of the domestic private sector in number of firms and proportion. In spite of that fact, enterprises in Vietnam remain small in size. Micro and small firms account around 88%-96% of total firms, and more than 95% of DPEs are at micro and small size. Moreover, micro firms' proportion recorded an increasing trend, in contrast to the decreasing trend of medium and large enterprises' proportion.[13] The bigger share of micro enterprises combined with the smaller share of small and medium enterprises as a whole and especially in DPEs confirms the lack of medium enterprises. The "missing middle" may

[13] Micro firms, which is defined with 10 persons or fewer following Decree 56/2009/ND-CP, usually are household firms tending to maintain or survive rather than having productivity or growth (Truong, 2013).

cause difficulties for DPEs and Vietnamese enterprises on the way to becoming larger corporations or multinational companies (World Bank, 2005; Truong, 2013).

The SOEs, albeit decreasing in number, still play a big role in the economy. The privatization process started in the 1990s was recorded little achievement, but it remains far from the expectations (Pham et al., 2013). Most equitized enterprises are local SOEs and small, while the number of central and big SOEs being equitized is much smaller. Hence, over the period 2000-2011, on average, the number of local SOEs reduced 8% annually, while central SOEs reduced only 1.3%. Being considered as the leading economic sector, the state sector and SOEs have enjoyed preferential treatment in obtaining credits, land, market information and policy facilitation (Pham et al., 2013; Truong, 2013). For example, SOEs can easily gain access to land in convenient locations with low cost even if not needed. Moreover, SOEs can receive "cheap loans" from state credits, commercial credits. According to CIEM (2011, as cited in Pham et al., 2013), debts of SOEs in 2009 made up 60% of total debt of the whole economy. Nevertheless, SOEs do not need to worry about paying loans as DPEs. If they default, they are allowed to make late payment or are even excused from paying entirely. Despite of the bias treatment and favor, SOEs have played an inequivalent role in business performance, and social aspect. Recently, SOEs are moving from the labor-intensive sector to investment-intensive sector. Nevertheless, SOEs working in high technology sectors, i.e. manufacturing of machinery and equipments, manufacturing medical instruments or precise engineering have not operated well and showed little contribution to sector restructuring (Pham et al., 2013).

The domestic private sector make impressive with respect to numbers of enterprises and job creation. DPEs have accounted for 82-97% of total number of enterprises and 30-61% of total employees in the enterprises sector. However, almost all DPEs are of small scale and their performance lags behind SOEs and FIEs. Most DPEs are of simple corporative form, i.e. private companies, limited companies (World Bank, 2005). Meanwhile, DPEs in a more complicated form, i.e. joint stock companies, is still small, although number of these enterprises are increasing, indicating weak governance ability of

DPEs. This fact was confirmed in a report by Nguyen & Luu (2010), which found some main points on competitiveness of the Vietnamese private sector. First, rapid growth of DPEs has contributed to GDP growth rate, industrial output, job creation when share of SOEs and FIEs reduced due to privatization or stagnancy as the consequence of financial crisis. Second, most DPEs are young and small. They usually operate in labor-intensive area and have lower economic competitivenesss, i.e. low labor productivity and lower profitability than SOEs and FIEs. Third, their performance weakness links to their constraints and obstacles, i.e. weak corporate governance, obstacles in accessing land, finance and technology, facing administrative barriers, informal charges.

The foreign invested sector has registered the highest growth of value added. FDI is an important investment, especially for the first steps toward industrialization. In contrast to the expectation, spillovers from FDI remains limited (Nguyen, Vu, Tran, & Nguyen, 2006; GSO, 2014a). It is because FDI mostly is in import-substitution sectors, outsourcing or assembling activities using mostly imported inputs and generating low value added. In fact, commodity imports of FDI sector keeps increasing continuously and constituted over half of total commodity imports since 2012 (Figure 2-8). Organizational structure of FIEs is another barrier of spillovers. Most FIEs are enterprises with 100% foreign capital, accounting for 79.2% and 83.4% of total FIEs in 2006 and 2011, respectively (GSO, 2014a), and these enterprises have few interactions with domestic firms. A study of Newman, Narciso, Tarp, & Vu (2009) confirmed that joint venture companies create more productivity spillovers than wholly foreign owned enterprises. The moderate spillovers also stem from the domestic side with low absorptive capacity (illustrated through low proportion of skilled laborers) and technology gap (low capital intensity and low R&D investment) (Nguyen et al., 2006). Moreover, most domestic enterprises cannot meet MNC affiliates' condition on inputs or intermediate goods and hardly become their suppliers. The trend of FDI spillovers can be illustrated through the indicator of FDI and technology transfer by the World Economic Forum. For Vietnam, the indicator has continuously reduced from 5.048 in 2006-2007 to 4.234 in 2014-2015, in which higher value indicates better FDI and technology transfer (World Economic Forum, 2014).

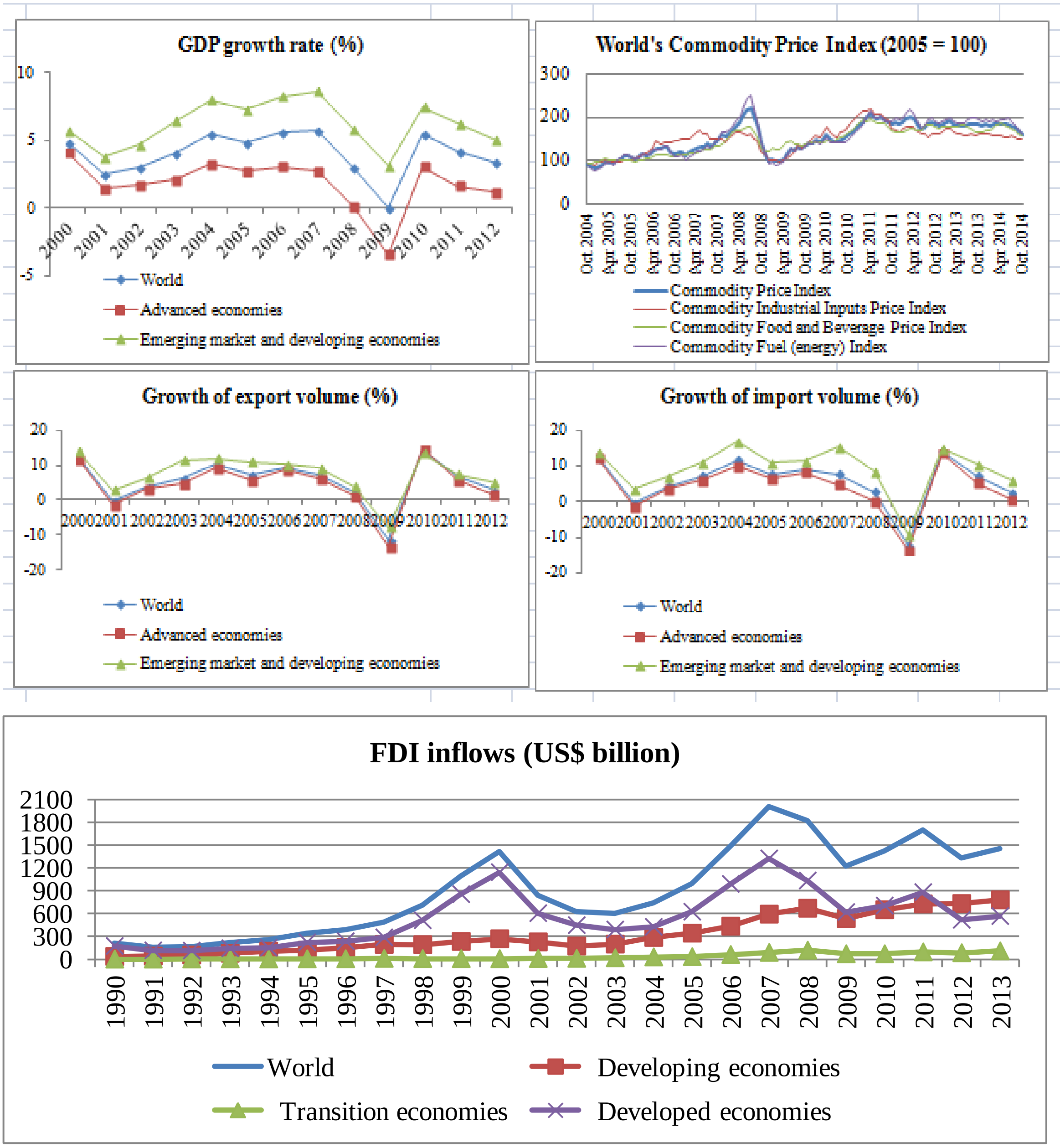
## 2.3. Impacts of the Global Financial Crisis on the Economy of Vietnam

### 2.3.1. Overview of the Global Financial Crisis

The global financial crisis that originated directly from the American housing bubble and subprime loans is supposed to connect with world macroeconomic causes, financial market problems, policy implementation and regulatory failures (Merrouche & Nier, 2010; Norgren, 2010). The crisis started in the United States, spread to advanced economies, and then induced the global recession. Figure 2-7 shows that GDP growth of the world economy as well as advanced economies and emerging markets and developing economies diminished from 5.7% in 2007 to 3.04% in 2008 and to a bottom of nearly 0% for the whole world in 2009. Advanced economies have been recorded with lower GDP growth rates, and were more seriously affected than developing and emerging economies. In particular, advanced economies suffered wider depression in GDP growth rate than developing and emerging economies, -3.6 percentage points (from 0.142% to -3.409%) compared to -2.7 percentage points (from 5.802% to 3.084%) in 2009. The economic growth rate of the world and two groups increased in 2010, but decreased again in 2011. Up to 2013, the tendency continued for emerging markets and developing economies as well as the world economy as a whole, with smaller reduction, while a modest recovery of advanced economies was registered (from 1.26% in 2012 to 1.39% in 2013).

In the same tendency with GDP growth rate, world trade volume fell again in 2011 after going up from the bottom in 2009. In particular, the world export volume of goods reduced from 7.1% in 2007 to 2.27% in 2008 and dropped to -11.4% in 2009. After rising back to 14.1% in 2010, a diminishing trend of global export volume was recorded, but with lower reduction. Advanced economies registered more severe recessions of both export and import volume compared to developing economies, but their trade volume regained in 2013. Combined with an improvement in growth of trade volume of advanced economies, a modest recovery in world import volume in 2013 suggests a recovery for the world economy. Yet, the recovery was not presented for emerging markets and developing economies.

**Figure 2-7. Some Indicators of the World Economy**




Source: IMF (GDP, export volume, import volume), www.indexmundi.com (Commodity Price Index), UNCTAD (FDI inflow)

FDI inflow was in the same vein with GDP growth rate, as in 2008 FDI inflow went down for developed economies and the world. The world's FDI inward drop from US$2002 billion in 2007 to US$1819 billion in 2008, while developed economies recorded bigger loses, from US$1323 billion to US$1023 billion. In 2009, the reduction trend happened to all groups of economies, i.e. developed economies, developing economies and transition economies. While FDI inflows of transition and developing economies repossessed in 2010 and kept an increasing trend, FDI inflows of developed economies reduced and in 2012, and for the first time since 1970, it was lower than that of developing economies.

With regard to world prices, strong global growth, especially high economic growth rate of emerging and developing economies during 2003-2007 raised their income and demand for food and fuel. In contrast, supply of these commodities seemed not to meet growing demand. For food, climate problems and agricultural materials for bio-fuel eased down the supply. For oil, limited spare capacity in combination with inelastic demand, US dollar depreciation and backdrop of real policy interest promoted increase of oil price (IMF, 2008). The surge of food price and fuel price caused price index's climb. In the first half of year 2008, the world's Commodity Price Index increased and peaked at 219.74 in July 2008 as a result of a surge of the commodity of food and beverage price index, especially an upsurge of the fuel price index. The economic recession lowered the commodity price index and the indices in the first quarter of 2009 were the same as those in the first half of 2005. Commodity price indices inflated again in the second quarter of 2009 and have ranged around 180-200 since 2011.

### 2.3.2. Impacts on the Macroeconomy of Vietnam

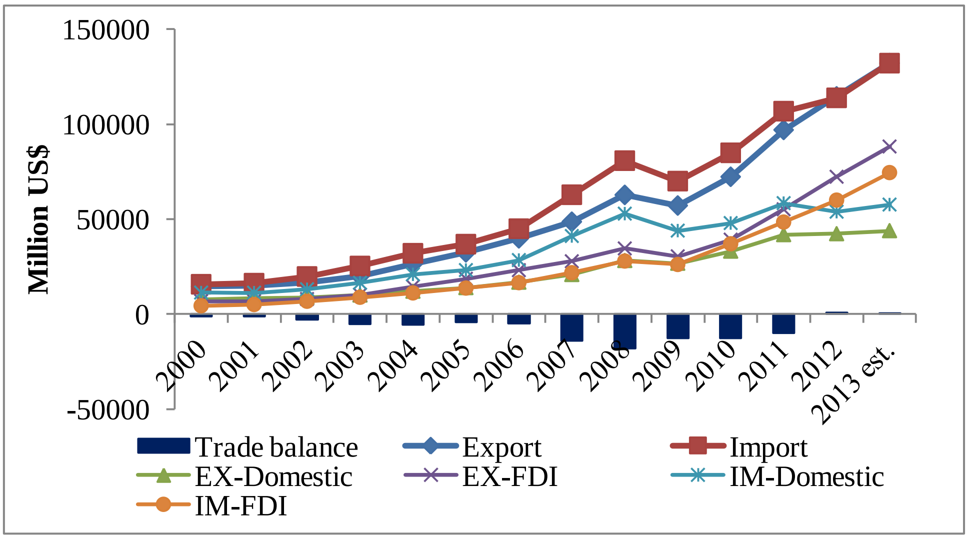
The world economy reported difficulties since the second half of 2007 with slower growth of advanced economies, higher prices and instable financial markets (World Bank, 2008). In 2008, the crisis directly influenced the Vietnam's economy in terms of export, price, capital inflow (FDI and FII), remittances and labor export. More importantly, the global economic depression indirectly promoted a clear exposition of national macroeconomic instabilities. The direct and indirect impacts of the crisis and problems of the Vietnamese economy are introduced in the following section.

#### *2.3.2.1. Exports and Imports*

Serious effects of the crisis on developed countries, who are the main trade partners of Vietnam, i.e. the United States, the EU, and Japan, influenced the country's trade performance. In 2009, commodity export and import lost 8.9% and 13.3% of their value, plummeting to US$57.1 billion and nearly US$70 billion, respectively. Trade performance has registered resurgence since 2010 in both trade value and volume. In particular, export and import value soared to US$72.2 billion, and US$84.8 billion, respectively. Meanwhile, export volume increased from 7.05% to 11.4% and import volume increased from -3.2% to 7.9%. In 2011, trade in commodity registered higher paces in both value and volume.

The slower growth rate of commodity trade value in 2012 was, in part, caused by a slight reduction of the world price index. Those figures imply that Vietnam has obtained more integration and more impact from the world economy since joining the WTO. In terms of weaker demand from export markets, the crisis seems to have not greatly impacted on Vietnam's exports as its exports structure is biased to light manufacturing products and agricultural-based products that were less affected than raw materials and heavy manufacturing products. Since 2000, imports had reported higher growth rate than exports and induced continuously increased deficit. Trade deficit peaked at US$-18 billion in 2008, has narrowed since 2009 as a result of the lower imports growth compared to exports growth. In terms of import structure, import value of production means (machinery, equipment and parts; materials and fuel), which accounts for 85%-92% of total import value, has reported a lower growth rate since 2009 compared to those until 2008. This implies domestic production's stagnation, which is explicitly exhibited in GDP growth rate.

**Figure 2-8. Vietnam's Commodity Exports and Imports**




Source: GSO

In terms of trade performance, the domestic sector seems to be more heavily affected by lower external demand than the foreign investment sector. The two sectors registered lower growth in commodity export and import value in 2009, but since 2010 the foreign investment sector has steadily grown in both export and import value of commodity. Meanwhile, the domestic sector recorded a lower and fluctuated growth rate.[14] As a result, the domestic sector has contributed to the narrower trade deficit, while the foreign investment sector has generated larger trade deficit. It means that the global crisis involved production deceleration of the domestic sector.

#### *2.3.2.2. GDP Growth Rate, Production and Demand*

GDP growth rate is observed with a reduction in 2008-2009, going up in 2010, and then diminishing again in 2011-2012. Annum average growth rate of GDP in 2008-2013 is 5.73%, lower than that of 6.47% in the period 1997-2001 corresponding to the Asian financial crisis. Figure 2-9 illustrates economic growth since 1987, and the 27-year period is divided into three periods marked by the Asian financial crisis 1997 and the global crisis 2008. After the Renovation in 1986, the economy had a high economic growth, and GDP growth in the period 1987-1997 averaged at 6.95% annum. The Asian financial crisis slowed down the economy's growth in 1998-1999. After hitting a bottom of 4.77% in 1999, GDP registered a steady growth and peaked at 8.46% in 2007. On average, annum GDP growth in period 1998-2007 is 7.24%. However, such a high economic growth rate has not been maintained after the global crisis in 2008. Average GDP growth rate over the period 2008-2013 is 5.73% annum. The economy's lower growth and slower recovery after the global financial crisis compared to a quick and strong recovery after the Asian financial crisis imply that: first, it reflects greater international integration of the country; second, it is appeared that the factor-driven growth model can no longer induce high growth, but increase the economy's vulnerability.

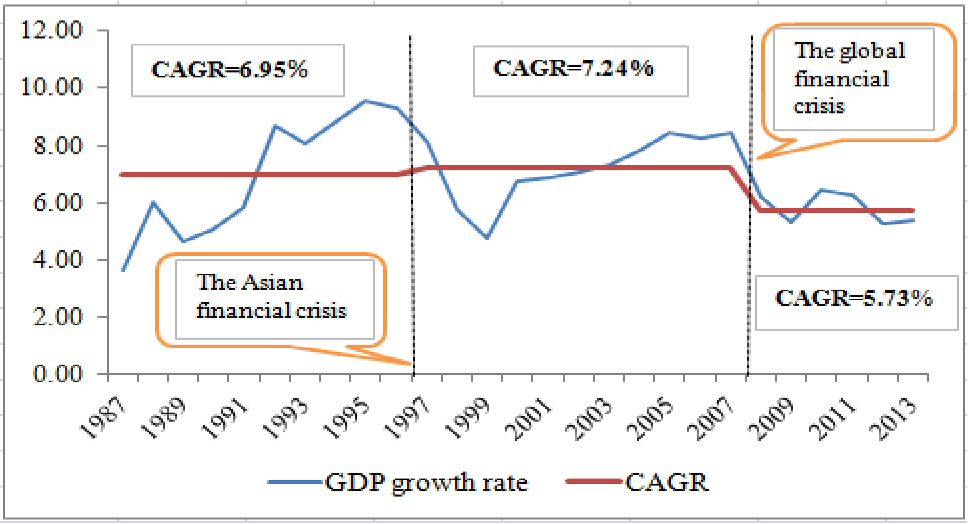
Weak demand is the main reason for slower economic growth during 2008-2013. As illustrated in Table 289, private consumption growth descended to 3.13% in 2009; and it

[14] Export value of foreign invested sector increased 28.9%; 40.8%; 31.1%, and 22% in 2010-2013, while domestic sector's export value grew 23,8%; 26.3%; 1.2%, and 3.8% in the same period.

remained unrecovered to the level before the crisis in spite of higher growth since 2011. Meanwhile, government consumption also registered a lower growth rate of 7.12%-7.59% (except year 2012) compared to 8.20%-8.90% during the period 2005-2007. Retail sales of goods and services, a proxy for domestic demand, was observed a slowdown.

The weak demand directly affected production presenting in deceleration of value added of industry and construction, and services. Especially, gross output of industry as a whole, for the non-state sector and foreign invested sector recorded a slower pace in 2009. The Index of Industrial Production (IIP), accordingly, was lower than the Index of Manufacturing Stocks, representing the stagnation in production and consumption of industrial products.[15] In December 2010, manufacturing products in stocks increased nearly 28%, three times higher than 8.8% growth of the industrial production. Up to 2012, manufacturing stocks simultaneously dropped with the decline of IIP, indicating that industrial enterprises cut down their production to release stocks. High manufacturing stocks and low industrial production combined with lower imports growth imply production stagnation that has negatively affected enterprises. This content will be introduced in the next section.

**Figure 2-9. GDP Growth Rate (1987-2013)**




Source: Author's calculation based on GSO's data.
Note: 1. CAGR: Constant Annual Growth Rate. 2. GDP growth rate from 2000-2007 is based on GDP constant 1994 price, since 2008 GDP was on 2010 price.

[15] The IIP and Index of Manufacturing Consumption, Index of Manufacturing Stocks were measured by GSO since 2008. Data are on corresponding months in 2005.

**Table 2-8. Growth Rate of Some Macroeconomic Indicators (%)**

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|
| **GDP by industry (*)** | **8.44** | **8.23** | **8.46** | **6.18** | **5.32** | **6.42** | **6.24** | **5.25** | **5.42** |
| Agriculture | 4.02 | 3.69 | 3.76 | 4.07 | 1.83 | 3.29 | 4.02 | 2.68 | 2.64 |
| Industry | 10.69 | 10.38 | 10.22 | 6.11 | 5.52 | 7.17 | 6.68 | 5.75 | 5.43 |
| Services | 8.48 | 8.29 | 8.85 | 7.18 | 6.63 | 7.19 | 6.83 | 5.90 | 6.57 |
| **GDP by economic sector (*)** | **8.44** | **8.23** | **8.46** | **6.31** | **5.32** | **6.42** | **6.24** | **5.25** | **5.42** |
| State | 7.37 | 6.17 | 5.91 | 4.36 | 3.99 | 4.64 | 4.46 | 5.68 | 4.84 |
| Non-state | 8.21 | 8.44 | 9.37 | 7.47 | 6.52 | 7.08 | 7.44 | 4.91 | 5.35 |
| Foreign invested sector | 13.22 | 14.33 | 13.04 | 7.85 | 4.81 | 8.07 | 6.30 | 5.38 | 6.70 |
| **Expenditure on GDP (*)** | | | | | | | | | |
| Private consumption | 7.26 | 8.35 | 10.80 | 9.34 | 3.13 | 8.19 | 4.10 | 4.88 | 5.18 |
| Government consumption | 8.20 | 8.50 | 8.90 | 7.52 | 7.59 | 12.28 | 7.12 | 7.19 | 7.26 |
| Gross domestic capital formation | 11.15 | 11.83 | 26.80 | 6.28 | 4.31 | 10.41 | -6.84 | 2.37 | 5.45 |
| Exports of goods and services | 7.76 | 14.21 | 11.30 | 5.07 | 11.10 | 14.64 | 10.78 | 15.71 | 17.22 |
| Imports of goods and services | 5.86 | 15.17 | 27.62 | 7.62 | 6.66 | 13.73 | 4.10 | 9.09 | 17.34 |
| **Gross output of industry (*)** | **10.5** | **16.8** | **16.8** | **13.9** | **8.5** | **10.5** | **9.1** | **8.8** | **9.2** |
| State | 10.1 | 5.8 | 5.2 | 2.5 | 4.5 | 10.1 | 10.8 | 8.9 | 8.7 |
| Non-state | 9.6 | 25.7 | 24.6 | 19.8 | 10.2 | 9.6 | 7.6 | 7.3 | 7.8 |
| Foreign invested sector | 11.5 | 19.9 | 19.6 | 16.9 | 9.4 | 11.5 | 9.7 | 10.0 | 10.7 |
| -Index of Industrial Production | | | | 8.7 | 7.8 | 8.8 | 7.3 | 4.7 | 5.9 |
| -Index of Manufacturing Consumption (**) | | | | | | 12.3 | 15.8 | 3.7 | 11.2 |
| -Index of Manufacturing Stocks (**) | | | | | | 27.9 | 23.0 | 21.5 | 10.2 |
| -Retail sales of goods and services | | | | 6.5 | 11.0 | 14.0 | 4.4 | 6.5 | 5.6 |
| -Commodity exports [a] | 22.5 | 22.7 | 21.9 | 29.1 | -8.9 | 26.5 | 34.2 | 18.2 | 15.4 |
| -Commodity imports [a] | 15.0 | 22.1 | 39.8 | 28.6 | -13.3 | 21.3 | 25.8 | 6.6 | 16.1 |
| -CPI | | 7.4 | 8.4 | 23.1 | 6.7 | 9.2 | 18.6 | 9.2 | 6.6 |
| -PPI | | 4.2 | 6.8 | 21.8 | 7.4 | 12.6 | 18.4 | 3.4 | 5.3 |
| -GDP deflator | | 8.6 | 9.6 | 22.7 | 6.2 | 12.1 | 21.3 | 10.9 | 4.8 |
| -Export price index | | 107.3 | 107.2 | 124.8 | 88.1 | 110.7 | 119.6 | 99.5 | 97.6 |
| -Import price index | | 103.8 | 105.1 | 118.2 | 88.4 | 105.6 | 120.2 | 99.7 | 97.6 |
| -M2 growth[b] | | 33.6 | 46.1 | 20.3 | 29.0 | 33.3 | 12.1 | 34.9 | 4.4 |
| FDI commitment (mill. USD) | | 12005 | 21349 | 71727 | 23108 | 19887 | 15619 | 16348 | 22352 |

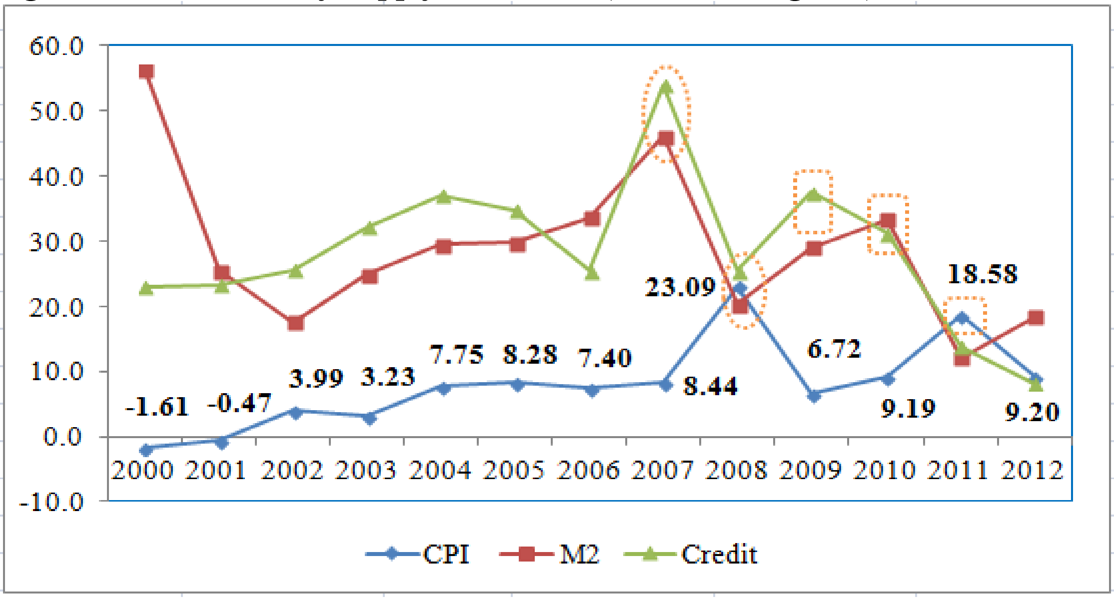
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| FDI implement (mill. USD) | 4100 | 8034 | 11500 | 10001 | 11000 | 11000 | 10047 | 11500 |

Source: GSO, Vietnam Customs (a), SBV (b)
Note: (*) Data by 2009 are on 1994 price, data from 2010 are on 2010 price, (**) This December to previous December.

### *2.3.2.3. Inflation and Monetary Policy*

The macroeconomy in 2008 was marked by a high inflation rate, which was, in part, caused by high world prices. As indicated previously, world commodity prices significantly went up 56.29% since the third quarter of 2007 and peaked in July 2008, attributed to the 77.57% increase of the Commodity Fuel (energy) Index and 33.55% increase of the Commodity Food and Beverage Price Index. Those highly increasing price indices contributed to a 28.32% increase of the year-on-year Consumer Price Index (CPI) in August 2008. Average CPI in 2008, subsequently, was 23.09% higher than that in the previous year.

**Figure 2-10. CPI, Money Supply and Credit (Annual change, %)**




Source: GSO, SBV

The high world price was not the sole source of high inflation in 2008. The expanding monetary policy contributed to high GDP growth in the period 2003-2007 and the growth of the stock market, accordingly. After accessing the WTO, a large capital inflow, i.e. direct investment, portfolio investment and private transfers, flooded in the stock market and real estate market and caused a boom in the end of 2007. [16] Such huge capital flow placed pressure on the monetary policy. Net foreign assets went up 42.54% and induced an increase 14.02% of money supply, while net domestic assets surged 47.75% and resulted in an increase of 32.08% of money supply (SBV, 2008). As a result, money supply (M2) and credit boosted 46.12% and 53.89%, respectively, in 2007. Their lagged effects diffused in 2008 and led to the highest inflation rate since the Doimoi (Figure 2-10).

Since 2008, the monetary policy, again, largely contributed to the movement in inflation rate. In the first eight months of 2008, the contracting monetary policy was implemented to constrain inflation in the context of high world price through raising the yearly base interest rate to 12% per annum in May 2008 and to 14% per annum in June 2008, along with raising other operation rates in February 2008. A higher lending interest rate, as a result of the increased yearly base interest rate, consequently lowered growth of credit and money supply and resulted in CPI slumping to 6.72% in 2009. However, in the last quarter of 2008, the monetary policy was expanded in response to the global crisis and domestic economic slowdown. Particularly, the yearly base interest rate, refinancing rate and rediscount rate were lowered since October 2008 parallel with the lowered reserve requirement ratio. The expanding monetary policy was continued in 2009 with lower operation rates and the reserve requirement ratio, and induced higher credit and money supply growth that led to increased CPI in 2010. In December 2009, all operation rates were inflated 1 percentage point and the base interest rate was increased 1 more percentage point in February 2010. In August 2010, some expanding activities were carried out to react low GDP growth, i.e. lessening the yearly lending interest rate, refinancing. In return, money supply quickly expanded and raised the CPI. The inflation rate in 2011 is 18.58%. In order to restrain inflation when its signal was observed, operation rates were increased 1 percentage point more in November 2010. The yearly deposit and lending interest rate, subsequently, increased as a result of raising the yearly base interest rate. In December

[16] According to ADB (2014), in 2007, private transfers were US$6.18 billion double that in the previous year; direct investment and portfolio investment were US$6.52 billion and US$6.24 billion, three-fold and five-fold higher than those in 2006, respectively. The overall balance of payment was in surplus of more than US$10 billion, 2.5 times higher than BoP surplus in 2006.

2010, the yearly lending interest rate averaged 15.27%. Nevertheless, raising operation rates at the end of the year, when enterprises' money demand for transactions, payments tops, created pressure for their operation. During 2011, the contracting monetary policy was continued to implement Resolution 11 issued in February 2011 on inflation constraint and macroeconomic stabilization. Operation rates were raised during February to April and in November. Consequently, the average lending rate was 18.65% per annum in the first half and the lending rate for production and business was about 17%-20% in the second half (SBV, 2012). In addition, the domestic currency, VND, depreciated 9.3% in February.

The tightening monetary policy in 2011 lowered inflation in 2012 to be half of the inflation rate in 2011. Nevertheless, the policy generated more pressure on enterprises in terms of the high lending interest rate and high input prices. Particularly, VND depreciation of 9.3% boosted imported price and indirectly raised production cost.[17] Meanwhile, the high lending interest rate directly caused higher product prices. Also, weak demand and high inventory lowered enterprise's credit demand. Hence, even though the lending interest rate was lowered in 2012, total credit only grew 8.19%.

In sum, the monetary policy has biased towards growth promotion, rather than economic stability. The growth-inflation trade off, therefore, tightly connects with frequently changed monetary policy. Subsequently, the lack of a long-term view and an inconsistent monetary policy are the main causes of the high inflation rate in 2008 and 2011. Specifically, during the period 2008-2012 contracting-expanding cycle based on money supply growth was repeated five times (Ha & Pham, 2013).[18] Since a money supply and credit widening lasts 5 to 12 months, such shortly repeated changes in monetary policy lessened the policy effect and caused more difficulties for banks, financial institutions and enterprises.[19]

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[17] Import value of production means accounts for 85%-92% commodity import value (GSO, 2015).

[18] During 2003-2007, an expanded monetary policy was implemented. The cycle of the monetary policy since 2008 was repeated as follows: 2008Q1-2008Q4 (contracted), 2009Q1-2009Q4 (expanded), 2010M1-2010M6 (contracted), 2010M6-2011M2 (expanded), 2011M2-2012M5 (contracted).

[19] IMF (2006) revealed the relation between credit, money supply and inflation with 12-month lagged effects. Nguyen et al. (2012) found that during the period 2006-2011, the lagged effect of credit and money supply growth to inflation lasts 5-12 months.

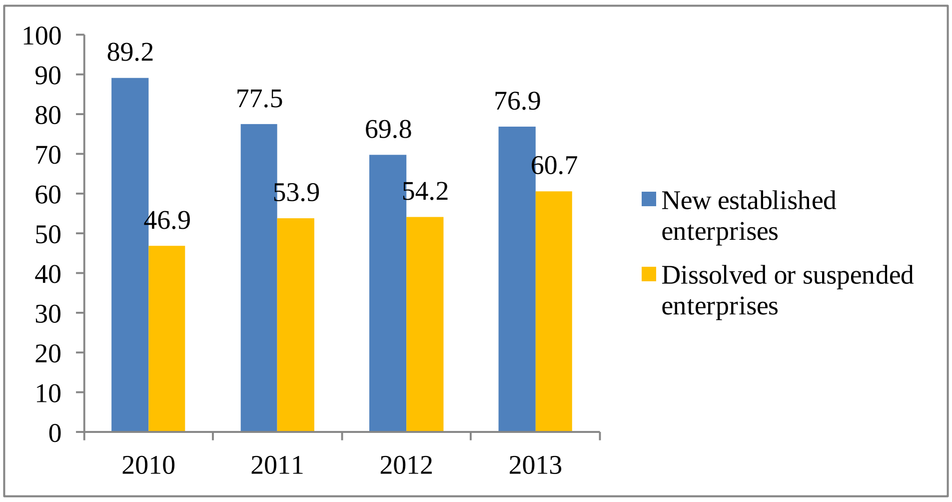
### *2.3.2.4. FDI Inflow*

A clear effect of the global economic crisis on the Vietnamese economy can be seen through a significant reduction of FDI commitment. FDI commitment reduced nearly 70% in 2009, from nearly US$72 billion to US$23 billion and the downward trend continued until 2011. In contrast, FDI implementation was nearly unchanged during the period 2009-2012, annually around US$10 billion to US$11 billion of FDI was disbursed. In 2013, accompanied with the increase of world FDI inflow, FDI registration and implementation reported a slight increase to US$22 billion and US$11.5 billion, respectively.

### 2.3.3. Impacts on Enterprises in Vietnam

The global financial crisis's effects combined with economic recession, high input prices and high interest rate negatively impacted performance of Vietnamese enterprises. Following the SME survey by CIEM, DoE, & ILSSA (2014), 68.3% of respondents were negatively affected by the crisis in 2013, followed by 61.9% in 2011. More importantly, enterprises facing lower demand for their products increased from less than one fifth to one quarter in two years. In the context of weak demand, competition became more severe, according to 20% of enterprises in 2013, double that in 2011.

**Figure 2-11. Number of Established, Dissolved or Suspended Enterprises (in thousands)**




Source: Department of Business Registration Management, Ministry of Planning and Investment.

Enterprise difficulties can be illustrated through the increasing number of dissolved or suspended enterprises. According to the Ministry of Planning and Investment, the number of dissolved or suspended enterprises increased continuously from 46.9 thousand in 2010 to 60.7 thousand in 2013. Meanwhile, the number of newly established enterprises diminished from 89.2 thousand in 2010 to 69.8 thousand in 2012. In the period 2010-2013, newly established enterprises decreased 13.8% in number, while dissolved or suspended enterprises increased 29.4% in number.

Enterprises have coped with difficulties in both supply and demand aspects. On the demand side, lower demand caused a high inventory rate, and lower production. On the supply side, very high input prices, including material and fuel prices since 2008 have been a burden to enterprises. Enterprises, moreover, confronted high interest rates as a result of the contracting monetary policy. The lending interest rate and deposit rate were very high since 2008. Especially, the yearly lending rate was over 20% in the three first quarters in 2008. It decreased in the fourth quarter of 2008 and varied around 10% in 2009 before going up again to nearly 20% in the second half of 2011 and the first half of 2012. The high interest rate prevented enterprises from obtaining bank loans, while weak demand and high inventory precluded them from enlarging operations. Weak credit demand, therefore, could not improve credit growth despite the interest rate reduction since 2012.

Examining the effects by type of ownership, the non-state sector sustained the biggest loss of industrial production presented by an industrial gross output growth 17.9% in 2009-2011, half that in 2007-2009 (32.0%). Meanwhile, the foreign-invested sector recorded a lower reduction in industrial gross output growth, from 27.9% to 22.3%, implying that the foreign-invested sector suffered less impact than the domestic sector. This finding is consistent with trade performance of foreign and domestic sector represented in part 5.2.1. The state sector was observed an inverse trend of industrial gross output to those of the non-state and foreign-invested sectors.

Difficulties of the macroeconomy, production and business have increased pessimism for enterprises. According to VCCI and USAID/VNCI, the percentage of DPEs and FIEs planning to expand their business within two years has continuously reduced in parallel with the declining proportion of firms increasing investment or adding workers (Table 2-9). Right before the crisis, over 70% of interviewed DPEs intended to expand their business within 2 years, but in 2009, only 59.7% of DPEs planned expansion.[20] Less than half of DPEs and FIEs being optimist with the economic prospect in 2011, and these figures continued decreasing to 32.5% and 28.2% of DPEs and FIEs in 2013, respectively. The increasing pessimism may connect with increasing rate of lost enterprises for both DPEs and FIES. In terms of actual performance, 6.4% of DPEs increased investment in 2012 and 2013, a quarter of that in 2007; and only 5.1% of FIEs expanded business in the two years compared to 37.3% in 2010.

**Table 2-9. Enterprise Performance and Outlook**

| DPEs | Expanding business (*) | Increasing investment | Adding employees | Got profit | Loss |
|---|---|---|---|---|---|
| 2006 | 74.6 | 27.6 | 22.0 | 77.5 | 10.8 |
| 2007 | 72.5 | 27.1 | 20.9 | 81.1 | 9.3 |
| 2008 | 71.0 | 29.3 | 21.6 | 82.3 | 8.7 |
| 2009 | 59.7 | 15.4 | 12.3 | 69.2 | 19.9 |
| 2010 | 61.7 | 22.1 | 17.1 | 74.9 | 16.0 |
| 2011 | 47.4 | 14.1 | 11.2 | 72.9 | 14.4 |
| 2012 | 34.0 | 6.4 | 6.0 | 58.9 | 21.9 |
| 2013 | 32.5 | 6.4 | 6.2 | 64.3 | 20.8 |
| **FIEs** | **Expanding business (*)** | **Increasing investment** | **Adding employees** | **Got profit** | **Loss** |
| 2010 | 68.5 | 37.3 | 54.0 | 70.1 | 24.6 |
| 2011 | 45.5 | 27.8 | 47.1 | 73.9 | 20.5 |
| 2012 | 32.7 | 5.1 | 32.2 | 60.0 | 28.0 |
| 2013 | 28.2 | 5.1 | 33.4 | 64.1 | 23.8 |

Source: VCCI and USAID/VNCI
Note: 1. The survey module for FIEs began in 2010. 2. (*) Two-year planned expanding business. 3. Other indicators are actual performance result.

Generally, FIEs have suffered less negative impacts than their domestic counterparts since almost all of their products are for exports. Following Figure 2-8 and previous analyses, FIEs export value has kept increasing steadily since 2010, while domestic enterprises' export growth was significantly slower in 2012 and 2013. In the domestic market, foreign invested firms can respond better because of their financial ability, managerial skills and experience. Meanwhile, most domestic firms are private enterprises and SMEs that are vulnerable due to their scale, modest ability of finance, and so on. Moreover, the majority of domestic firms is inward-oriented and have seriously sustained declining domestic demand.

[20] In the PCI survey only operating enterprises interviewed. Dissolved and closed enterprises or enterprises finished tax code closure are not included in the sample.

# CHAPTER 3

# TERMINOLOGIES AND METHODOLOGIES

## 3.1. Conceptual Framework

This chapter introduces methodologies to measure technical efficiency, cost efficiency, and allocative efficiency as well as productivity change in order to fulfill the research objectives. Prior to the methodology section, the conceptual framework and terminologies are represented in Section 3.1 and 3.2. The content of the two sections are heavily dependent on Kumbhakar & Lovell (2003) and Coelli et al. (2005).

### 3.1.1. Production Technology

A feasible production activity can be presented by three characteristics, i.e. the graph of production technology, the input sets and the output sets.

#### *3.1.1.1. The Graph of Production Technology*

Suppose that there is a non-negative input vector **x** and a non-negative output vector **y**. The graph of production technology (GR), referred to as the name production possibilities set, is the input-output combination, which is defined as:

$$GR = \{(\boldsymbol{y}, \boldsymbol{x}): \boldsymbol{x}\ can\ produce\ \boldsymbol{y}\} \qquad (3.1.1)$$

GR is assumed to be a non-empty, close, bounded, convex set, and satisfies some properties to ensure the radial expansions of feasible inputs and the radial contractions of feasible outputs, and to ensure any increase in feasible inputs and any decrease in feasible outputs (Kumbhakar & Lovell, 2003, pp. 19-20).

#### *3.1.1.2. The Input Sets*

The input sets of production technology, denoted by $L(\boldsymbol{y})$, presents feasible input vectors set, $\boldsymbol{x}$, to produce each output vector, $\boldsymbol{y}$.

$$L(\boldsymbol{y}) = [\boldsymbol{x}: (\boldsymbol{y}, \boldsymbol{x}) \in GR] \qquad (3.1.2)$$

$L(\boldsymbol{y})$ is assumed to be a non-empty, closed, bounded, convex set for $\boldsymbol{y}$, radial expansions of feasible inputs and radial contractions of feasible outputs, and strongly/freely disposable inputs and outputs (Kumbhakar & Lovell, 2003, p. 21).

### *3.1.1.3. The Output Sets*

The output set of production technology, denoted by *P(x)*, present feasible output vector sets, $\boldsymbol{y}$, produced from each input vector, $\boldsymbol{x}$.

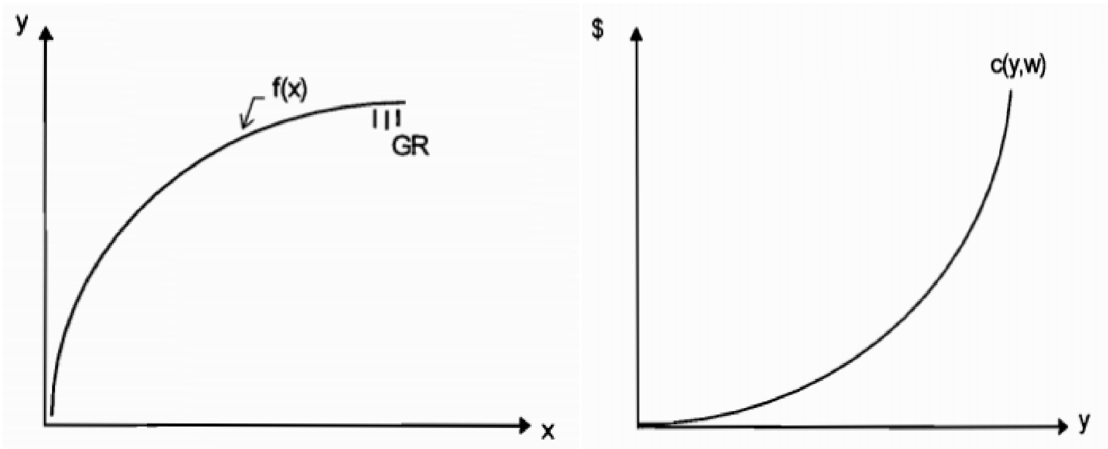
$$P(\boldsymbol{x}) = [\boldsymbol{y}: (\boldsymbol{y}, \boldsymbol{x}) \in GR] \quad (3.1.3)$$

*P(x)* is closed, bounded, convex set, zero inputs surely produce zero output, radial expansions of feasible inputs and radial contractions of feasible outputs, strongly/freely disposable inputs and outputs (Kumbhakar & Lovell, 2003, pp. 22-23).

### *3.1.1.4. Production Frontier*

Figure 3-1 illustrates the production possibilities set with single-input and single-output, *GR*. The production frontier-*f(x)*, which bounds the production possibility set from above, represents the maximum output that can be produced with a given input vector. The input-output combination of each producer, therefore, locates on or below the frontier *f(x)*.

**Figure 3-1. A Production Frontier and Cost Frontier**




*(a) The Production Possibilities Set and Production Frontier*

*(b) A Cost Frontier*

Source: Adapted from Kumbhakar and Lovell (2003, p. 27 and p. 33)

A production frontier, according to Kumbhakar & Lovell (2003, pp. 27-28), is a function with regard to the output sets P(**x**) and the input sets L(**y**).

$$f(\boldsymbol{x}) = max\{\boldsymbol{y}: \boldsymbol{y} \in P(\boldsymbol{x})\} = max\{\boldsymbol{y}: \boldsymbol{x} \in L(\boldsymbol{y})\} \quad (3.1.4)$$

Therefore, the production frontier can satisfy the properties of the output sets P(**x**) and the input sets L(**y**) (Kumbhakar & Lovell, 2003, pp. 27-28).

### 3.1.2. Distance Functions

In the case of multiple inputs and multiple outputs, the distance functions describe functional characteristics of the structure of production technology and relate to technical efficiency measurements (Kumbhakar & Lovell, 2003, p. 28). There are two kinds of distance functions: input distance functions and output distance functions. Input distance functions describe input sets, while output distance functions describe output sets.

#### *3.1.2.1. Input Distance Functions*

An input distance function, referring to the input-conserving approach, measures the distance from a producer's location to the boundary of the production possibilities and introduces the maximum amount of input that can be reduced radically to produce a given amount of output (Kumbhakar & Lovell, 2003, p. 28).

$$D_I(\boldsymbol{y}, \boldsymbol{x}) = max\{\lambda : \boldsymbol{x}/\lambda \in L(\boldsymbol{y})\} \tag{3.1.5}$$

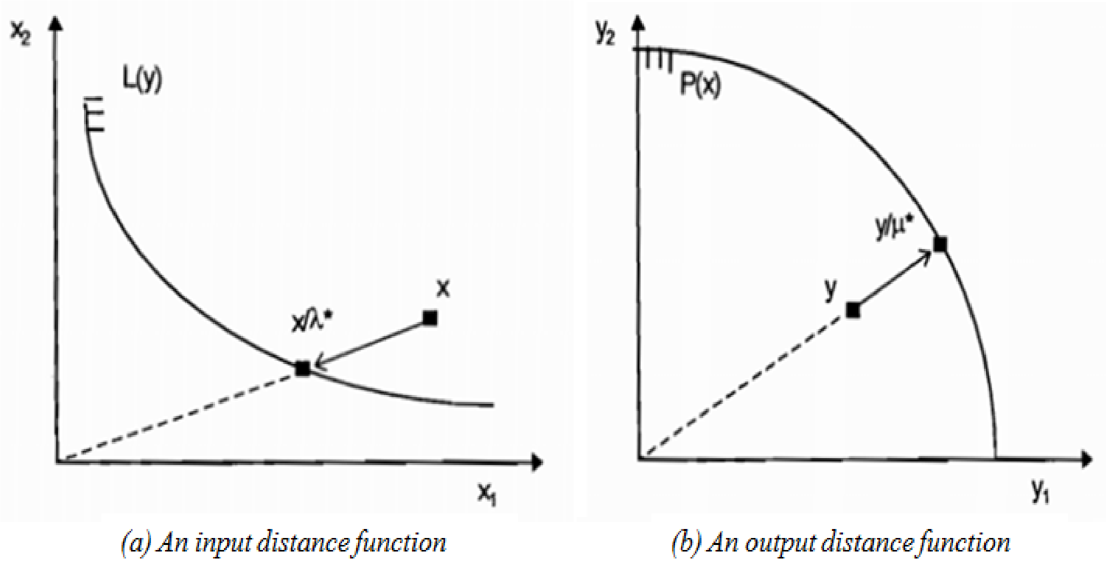
The graph of an input distance function with two inputs is denoted on the left of Figure 3-2. A producer with the input set $\boldsymbol{x}$ can reduce inputs up to $\boldsymbol{x}/\lambda^*$, with no change in output level. It means that after reducing the input set from $\boldsymbol{x}$ to $\boldsymbol{x}/\lambda^*$, the producer will move from the current position to the lower boundary of the input sets and obtain the minimum amount of inputs. Notably, the movement from $\boldsymbol{x}$ to $\boldsymbol{x}/\lambda^*$ means that all inputs are reduced rationally.

#### *3.1.2.2. Output Distance Functions*

An output distance function, referring to the output-expanding approach, measures the distance from a producer's location to the boundary of the production possibilities, and represents the minimum amount of an output vector can be reduced with a given input vector, or the maximum amount of outputs that can be produced with a given amount of inputs (Kumbhakar & Lovell, 2003, p. 30).

$$D_o(\mathbf{x}, \mathbf{y}) = min\{\mu : \mathbf{y}/\mu \in P(\mathbf{x})\} \tag{3.1.6}$$

**Figure 3-2. An Input Distance Function and an Output Distance Function**




Source: Adapted from Kumbhakar & Lovell (2003, p.29 and p.31)

The graph on the right of Figure 3-2 introduces the output distance function with two outputs. A producer with the output set $\boldsymbol{y}$ can increase output set up to $\boldsymbol{y}/\mu^{*}$ without emloying more inputs. And, the producer will move upward from the current position to the boundary of the output sets, which all outputs are increased rationally, and obtain the maximum amount of output.

### 3.1.3. Cost Frontier

The structure of production technology is described through the production frontier by using input and output quantities. Meanwhile, production technology is illustrated through the cost frontier by utilizing input and output quantities and input prices (Kumbhakar & Lovell, 2003, pp. 32-33). Suppose that producers face input prices $\boldsymbol{w} = (w_1, w_2, \ldots, w_n) \in R^N_{++}$ and try to minimize the production cost to produce the ouput vector $\boldsymbol{y}$, $\boldsymbol{w}^T\boldsymbol{x} = \sum_i w_i x_i$. A cost frontier, following Kumbhakar & Lovell (2003, p. 33) is defined as a function $c(\boldsymbol{y},\boldsymbol{w})$ that employs the input sets and the input distance function.

$$c(\boldsymbol{y}, \boldsymbol{w}) = min_x\{\boldsymbol{w}^T\boldsymbol{x}: \boldsymbol{x} \in L(\boldsymbol{y})\} = min_x\{w^T\boldsymbol{x}: D_I(\boldsymbol{y}, \boldsymbol{x}) \geq 1\} \qquad (3.1.7)$$

The cost frontier shown in Figure 3-1 introduces the minimum cost to produce any output with given input prices. A producer can be located on or above the cost frontier, meaning that the real production cost can be equal to or greater than the minimum cost.

### 3.1.4. The Metafrontier

Based on the assumption that producers in different groups can use alternative production technology, the metafrontier method was introduced. This part represents the conceptual framework of the metafrontier method, following O'Donnell et al. (2008).

#### *3.1.4.1. The Metafrontier*

The input-output combinations of a sample as a whole are called the metatechnology set. And the input/output metafrontier is the boundary of the input/output set.

$$T = \{(\mathbf{y}, \mathbf{x}): \mathbf{x}\ can\ produce\ \mathbf{y}\} \tag{3.1.8}$$

$$L(\mathbf{y}) = [\mathbf{x}: (\mathbf{y}, \mathbf{x}) \in T] \tag{3.1.9}$$

$$P(\mathbf{x}) = [\mathbf{y}: (\mathbf{y}, \mathbf{x}) \in T] \tag{3.1.10}$$

The input meta-distance function measures the distance from a producer's location to the metafrontier and the maximum amount of input that can be reduced radically to produce a given amount of output. While, the output meta-distance function measures the distance from a producer's location to the metafrontier, and represents the minimum amount an output vector can be deflated with a given input vector.

$$D_I(\mathbf{y}, \mathbf{x}) = max\{\lambda: \mathbf{x}/\lambda \in L(\mathbf{y})\} \tag{3.1.11}$$

$$D_o(\mathbf{x}, \mathbf{y}) = min\{\mu: \mathbf{y}/\mu \in P(\mathbf{x})\} \tag{3.1.12}$$

#### *3.1.4.2. Group Frontiers*

Assuming that the whole data set consists of $K$ groups ($K > 1$), $K$ groups differ in feasible input-output combinations and each group has its own technology set. The group-specific technology set of group $k$, according to O'Donnell, Rao, & Battese (2008) is defined as:

$$T^k = \{(\mathbf{y}, \mathbf{x}): \mathbf{x}\ can\ be\ used\ by\ firms\ in\ group\ k\ to\ produce\ \mathbf{y}\} \tag{3.1.13}$$

$$k = 1, 2, \ldots, K$$

Also, the group-specific input sets and output sets as well as the group-specific input distance function and output distance function of group $k$ are defined as follows:

$$L^k(\mathbf{y}) = [\mathbf{x}: (\mathbf{y}, \mathbf{x}) \in T^k] \tag{3.1.14}$$

$$P^k(\mathbf{x}) = [\mathbf{y}: (\mathbf{y}, \mathbf{x}) \in T^k] \tag{3.1.15}$$

$$D_I^k(\mathbf{y}, \mathbf{x}) = max\{\lambda: \mathbf{x}/\lambda \in L^k(\mathbf{y})\} \quad (3.1.16)$$

$$D_O^k(\mathbf{x}, \mathbf{y}) = min\{\mu: \mathbf{y}/\mu \in P^k(\mathbf{x})\} \quad (3.1.17)$$

$$k = 1, 2, \ldots, K$$

Group-specific input/output sets are sub-sets of the meta-technology input/output set, and the metatechnology set $T$ bounds group-specific technology sets $T^k$ (O'Donnell et al., 2008).

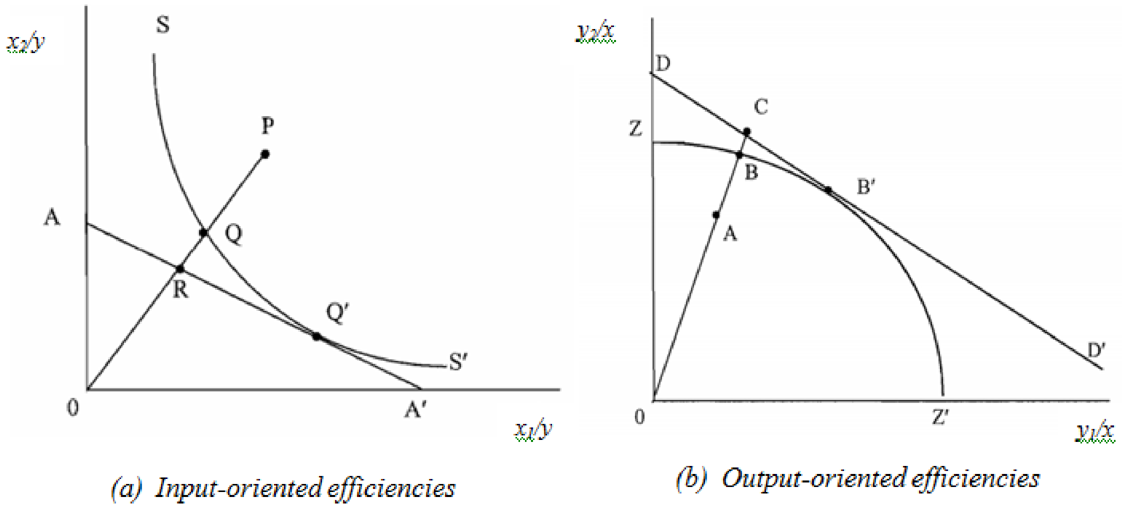
## 3.2. Efficiency and Productivity Terminologies

### 3.2.1. Efficiency Measurement with Distance and Cost Functions

#### *3.2.1.1. Input-oriented Measures*

The input-oriented measure was introduced by Farrell (1957) in a simple example, which utilizes two inputs (*x1*, *x2*) to produce one output *y*, under the assumption of constant return to scale (CRS). This measure is illustrated in Figure 3-3(a).

**Figure 3-3. Input-oriented and Output-oriented Efficiencies**




*(a) Input-oriented efficiencies*

*(b) Output-oriented efficiencies*

Source: Adapted from Coelli et al. (2005, p.52 and p.54)

The iso-quant SS' introduces combinations of 2 inputs that efficient producers use to produce a unit of output. The iso-quant is the set of technically efficient firms. A firm using input combination in P can reduce its inputs proportionally into point Q and does not alter the output. Thus, the distance QP represents the technical inefficiency of the firm and the input-oriented measure of technical efficiency in percentage is defined as (Coelli et al., 2005, pp. 52-53):

$$TE_I = 1/D_I(\boldsymbol{x}, \boldsymbol{y}) = OQ/OP = 1 - QP/OP \qquad (3.2.1)$$

where $D_I(\boldsymbol{x}, \boldsymbol{y})$ is the input-distance function. Because the distance QP is equal or greater than zero, technical efficiency varies from zero to unity.

If information of input prices is available, cost efficiency would be calculated. Let **w** and **x** be vectors of input prices and inputs used associated with point P; $\widehat{\boldsymbol{x}}$ and **x*** are input vectors associated with the technically efficient point Q and cost-minimization point Q', respectively. Every point on the iso-cost line AA' has the same cost, and if AA' has a slope equal to the ratio of the prices of two inputs, Q' is the optimal method of production. Since both Q and Q' are technically efficient, the ratio OR/OQ represents allocative efficiency (Farrell, 1957).

$$AE_I = {}^{OR}/_{OQ} \qquad (3.2.2)$$

The cost efficiency of the firm is determined by input price and inputs associated with two points P and Q'. Cost efficiency measures a firm's ability to minimize its cost with given output and input prices (Coelli et al., 2005, p. 53).

$$CE = \frac{\boldsymbol{w}'\boldsymbol{x}^*}{\boldsymbol{w}'\boldsymbol{x}} = OR/OP \qquad (3.2.3)$$

The input-oriented measure of technical efficiency is defined as a firm's ability to minimize its inputs used without changing outputs. And, input mix allocative efficiency measures a firm's ability to select the optimal mix of input quantities with the given input prices. The optimal mix of input quantities can be defined when the input price ratios equal the marginal product ratios (Coelli et al., 2003, p. 11). The allocative efficiency and technical efficiency are determined as follows (Coelli et al., 2005, p. 53).

$$AE_I = \frac{\boldsymbol{w}'\boldsymbol{x}^*}{\boldsymbol{w}'\widehat{\boldsymbol{x}}} = OR/OQ \qquad (3.2.4)$$

$$TE_I = \frac{\boldsymbol{w}'\widehat{\boldsymbol{x}}}{\boldsymbol{w}'\boldsymbol{x}} = OQ/OP \qquad (3.2.5)$$

Obviously, cost efficiency is the product of input-oriented measure of technical efficiency and input mix allocative efficiency.

$$CE = \frac{OR}{OP} = \frac{OQ}{OP} \times \frac{OR}{OQ} = TE_I \times AE_I \qquad (3.2.6)$$

#### *3.2.1.2. Output-oriented Measures*

Since the input-oriented measure of technical efficiency connects to the input distance function, it reflects the volume of input quantities can be proportionally reduced to produce given output quantities. Whereas, the output-oriented measure of technical efficiency connects to the output distance function and it measures the volume of outputs can be proportionally expanded with given input quantities (Coelli et al., 2005, p. 54). Moreover, the input-oriented measure employs information of input prices and calculates cost efficiency and input mix allocative efficiency, while the output-oriented measure uses information of output prices and calculates revenue efficiency and output mix allocative efficiency.

Figure 3-3(b) represents output-oriented efficiencies with two output (*y1, y2*) and input *x* under the assumption of CRS. The ZZ' curve introduces the upper bound of the production possibilities and any firm that lies on ZZ' is technically efficient. Firm A lies below the ZZ' curve and its technical efficiency is defined as the ratio:

$$TE_o(\boldsymbol{x}, \boldsymbol{y}) = D_o(\boldsymbol{x}, \boldsymbol{y}) = OA/OB \tag{3.2.7}$$

where $D_o(\boldsymbol{x}, \boldsymbol{y})$ is the output distance function. If the information of output prices **p** is available, revenue efficiency can be calculated as follows (Coelli et al., 2005, p. 56).

$$RE = \frac{\boldsymbol{p}'\boldsymbol{y}}{\boldsymbol{p}'\boldsymbol{y}^*} = OA/OC \tag{3.2.8}$$

With the existence of the iso-revenue DD', output allocative and technical efficiency can be measured (Coelli et al., 2005, p. 56).

$$AE_o = \frac{\boldsymbol{p}'\widehat{\boldsymbol{q}}}{\boldsymbol{p}'\boldsymbol{q}^*} = OB/OC \tag{3.2.9}$$

$$TE_o = \frac{\boldsymbol{p}'\boldsymbol{q}}{\boldsymbol{p}'\widehat{\boldsymbol{q}}} = OA/OB \tag{3.2.10}$$

### 3.2.2. Productivity Terminologies

Productivity is an important measure of performance of a country, an industry, and an enterprise. For the country-level, as emphasized by APO (2014), productivity is important for economic prospects and is the sole way to maintain economic growth in the long term. Productivity is defined by the ratio of output(s) to input(s) and can be measured partially or totally (Coelli, Estache, Perelman, & Trujillo, 2003, p. 10; Coelli et al., 2005, pp. 2 and p. 62). Partial productivity, or single factor productivity, equals output(s) divided by a specific input, i.e. labor, capital. A frequently-used single factor productivity, namely labor productivity, is a sign of efficiency level of labor in conjunction with other factors by quantifying how much outputs are produced by a unit of labor input (OECD, 2001).[21]

Calculation and explanation of a partial productivity is relatively straightforward, but this concept has some limitations. Particularly, this measure does not absolutely reflect firm performance since a product is produced from a bunch of inputs and each input has its own contribution to the product. So, reliance on a single factor productivity makes performance interpretation misleading and subjective (Arunsawadiwong, 2007). A more suitable measure is total factor productivity (TFP) or multifactor productivity (MFP), which covers all inputs used in production.[22] TFP is described as the change in output that cannot account for changes in inputs, including labor, capital and materials (Newman et al., 2009; Thangavelu & Chongvilaivan, 2013).

TFP, according to Coelli et al. (2005, p. 3), is a productivity measure that involves all production factors (including all inputs for multiple inputs cases and all outputs for multiple outputs cases). Since all inputs and outputs are recruited, efficiency and effectiveness of production is reflected more accurately through TFP (Arunsawadiwong, 2007). On the basis of productivity's definition, productivity change occurs when the output growth rate differs from the input growth rate. Following Jorgenson & Griliches (1967), the Total Factor Productivity growth rate "is the difference between the rate of growth of real product and the rate of growth of real factor input". In the case of single

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[21] Labor input, here, can be number of workers or number of working hours.

[22] Coelli, Rao, O'Donnell, & Battese (2005, p. 64) emphasized that the difference between the two terminologies is delicate, but, in fact, they are usually used interchangeably. The distinction, according to Arunsawadiwong (2007), is only concerned by who is interested in the accuracy of the concept. For instance, according to (Ahmed & Wilder, 2001), the U.S. Bureau Labor Statistic measures MFP "as output per unit of combined input". Also, the authors stated that MFP "is calculated as a residual that measures the change in an industry output that is not measured changes in labor, capital or intermediate purchased inputs".
For more detail, MFP is defined as MFP = Output(s)/ Inputs. Following this equation, the growth of MFP equals growth of Output(s) subtracting growth of Inputs. TFP growth, which is defined as the change of output that cannot be explained by changes of inputs, is formularized by equation (3.2.11). In this manner, there is no difference between MFP growth and TFP growth. However, T. J. Coelli et al. (2005, p. 64) stated that MFP is more appropriate when all factors driving outputs are taken into account.

output and multiple inputs, the rate of growth of inputs is the weighted sum of the growth of single inputs. The weights are the share of each input cost to total input costs. Therefore, the TFP growth is exhibited by the conventional Divisia index as (Kumbhakar & Lovell, 2003, p. 283):[23]

$$T\dot{F}P = \dot{y} - \sum_i \frac{w_i x_i}{C} \dot{x}_i \tag{3.2.11}$$

where $T\dot{F}P$ is the growth rate of TFP, $\dot{y}$ is the growth rate of output, $x_i$ is the observed quantity of the i-th input used to produce output, $w_i$ is the price of the i-th input, $\dot{x}_i$ is the growth rate of $x_i$, and $C$ is the observed cost.

### 3.3. Efficiency Measurement Methodologies

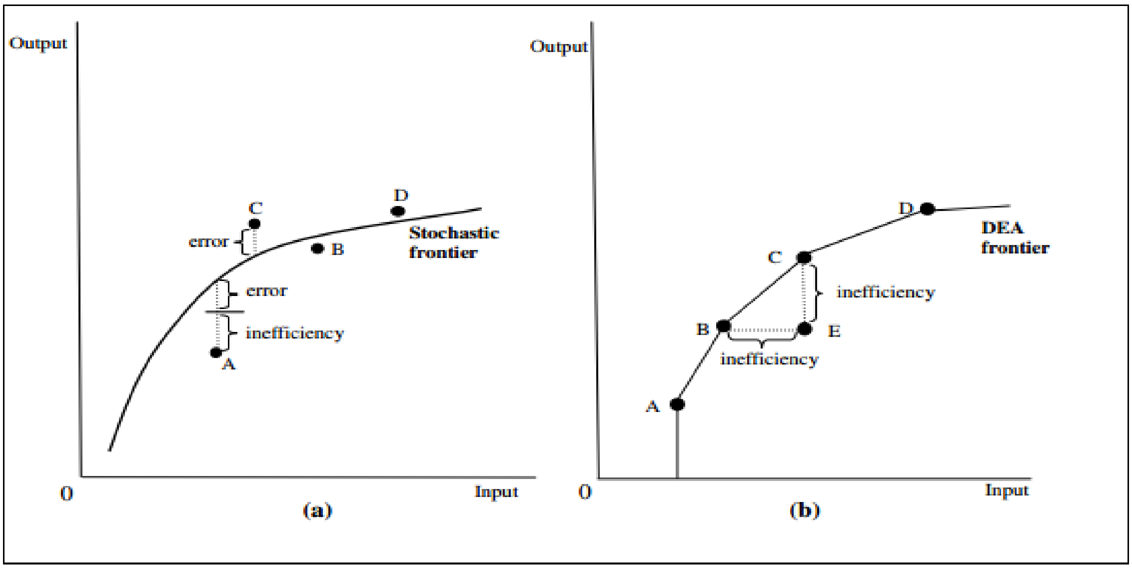
Efficiency measurement is based on comparison between actual value and optimal value that lies on the frontier. Because the frontier or "best-practice" frontier is unknown, it must be estimated. There are two main methods to define the "best-practice" frontier, i.e. the parametric approach and the non-parametric approach. The non-parametric frontier technique was developed by Farrell (1957), and uses the production possibilities set as a frontier unit-isoquant. In particular, the non-parametric approach, whose representative is the Data Envelopment Analysis (DEA) method, defines frontiers envelopment surface for all observations by connecting "benchmark" observations and then uses the distance function technique to measure efficiency of individual observations. The distance from an observation to the frontier is called inefficiency and this approach does not distinguish between inefficiency and statistical noise effects (Murillo-Zamorano & Cervera, 2000). Since the non-parametric method has the deterministic nature, it would be recognized as a non statistical technique "where the inefficiency scores and the envelopment surface are calculated rather than estimated" (Murillo-Zamorano, 2004).

In contrast, the parametric approach is a statistically-based method that estimates the inefficiency rather than calculating it. Two branches of the parametric approach are deterministic and stochastic models. The deterministic model uses the technological

[23] The Divisia index, according to Hulten (1973), is the weighted sum of growth rates, and the weights are the shares of components in aggregate value.

framework represented by mathematical programming approaches, but parameters of the frontier functions are estimated rather than calculated. However, the deterministic models differ from the mathematical programming approaches that the deterministic models include random shocks (Murillo-Zamorano, 2004). Yet, the deterministic models assume that all firms have the same technology and production frontiers, so that all divergences are due to business mismanagement or inappropriate technology (Nguyen et al., 2007). To overcome those limitations of the deterministic models, the stochastic models, namely the Stochastic Frontier Models (SFM), were introduced. The SFM separates the random error into inefficiency and statistical noise, and it requires a specific functional form for the production function or cost function and statistical distribution for the inefficiency error term (Murillo-Zamorano & Cervera, 2000; Murillo-Zamorano, 2004). The result, therefore, is decided by the accuracy of model specification and distribution form of inefficiency.

**Figure 3-4. The Stochastic Frontier and DEA Frontier**




Source: Adapted from C. L. V. Le (2010)

Figure 3-4 denotes the stochastic frontier and the DEA frontier. The SFM divides the random error into inefficiency and statistical noise. The statistical noise captures all factors that are out of a firm’s control, for instance, regulatory-competitive environments, socio-economic factors, uncertainty, etc. (Murillo-Zamorano, 2004). The DEA method considers all deviations from the frontier as inefficient terms. Also, the stochastic frontier and DEA frontier differ in their natures. On the one hand, the DEA frontier, with its deterministic nature, has the piece-wise linear form that connects all extreme/best-practice values. Thus, the DEA method's results are sensitive with outliers. On the other hand, the stochastic frontier is smooth since it is estimated based on observations. The main limitation of the SFM is that it requires functional form and statistical distribution of the inefficient element, and hence, functional specification and distribution of inefficiency should be considered carefully.

### 3.3.1. Metafrontier Frameworks

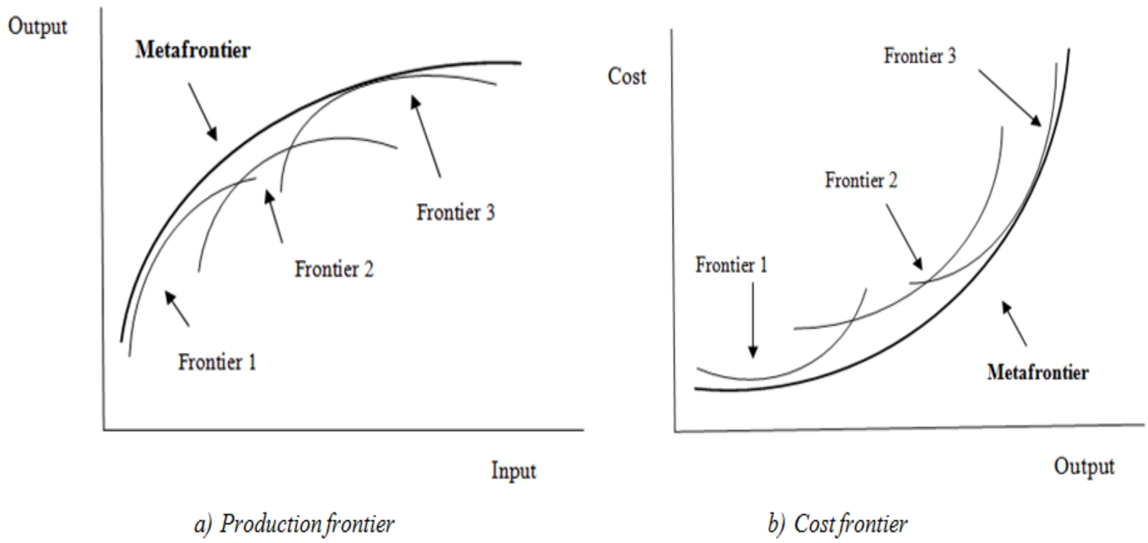
The metafrontier model, which was introduced by Battese & Rao (2002) based on the works of Hayami (1969) and Hayami & Ruttan (1970), originates from the fact that firms in different groups, i.e. industries, regions, countries, etc, may differ from available inputs or economic infrastructure, resource endowments or physical, social and economic environment (O'Donnell et al., 2008). Different groups, hence, may choose different input-output combination sets or use different technology (Battese, Rao, & O'Donnell, 2004; O'Donnell et al., 2008) and subsequently, have separated frontiers though they share a common frontier for the aggregate data. After Battese and Rao (2002), Battese et al. (2004) introduced a modified model of the stochastic metafrontier production function to estimate technical efficiencies and technology gap. Then, O'Donnell et al. (2008) presented the metafrontier frameworks using non-parametric and parametric methods. The metafrontier framework is not only applied for the production function to obtain the technical efficiency and technology gap, but also applied for the cost function to measure the cost efficiency level and the gap between the metafrontier cost efficiency and cost efficiencies with respect to group-based frontiers.

Based on data of all observations, the boundary of input or output set is built and named the metafrontier. Referring to the metafrontier and each decision making unit (DMU),[24] the technical efficiency or cost efficiency levels of each observation in the whole sample are determined. Group frontiers are defined for group-specific data and they are enveloped by the

[24] The term DMU was introduced by Charnes, Cooper and Rhodes (1978) to distinguish between other concepts, i.e. "firm", "plant", being considered as "organization entities concerned with input and output decisions".

metafrontier. The distances between each group frontier and observations inside the group determine group-specific efficiency levels. For each observation, the gap between the technical/cost efficiency levels defined by the metafrontier and the group frontier is called the technical/cost gap ratio. Hence, the metafrontier efficiencies contain group efficiencies and the technical/cost gap ratios. According to O'Donnell et al. (2008), the gap between the metafrontier and group frontiers might be the reference for performance enhancement engaging production environment.

**Figure 3-5. Metafrontier and Group-specific Frontiers**




Source: Adapted from Battese et al. (2004), Huang & Chiang (2007)

The order to measure metafrontier related efficiency and group efficiencies are as follows. First, the group-specific efficiencies ($TE^k$, $CE^k$) for data groups are measured by the parametric or non-parametric method. Then, the efficiency of the whole sample (TE, CE) is defined to ensure that the metafrontier bounds group frontiers. If the non-parametric method is applied in the first step, this method is also used in the second step for determining efficiency relating to the metafrontier. In another case, if group efficiencies are measured by occupying the parametric method in the first step, in the second step, an alternative method is employed to ensure that group frontiers are bounded by the metafrontier. Particularly, an optimization problem is solved by the simulation or bootstrapping methods to minimize the sum of absolute deviations or minimize the sum of squares of deviations of the metafrontier values from those of group frontiers (Battese et al., 2004). The next section describes how to calculate efficiency of all observations and group efficiencies and technology gap ratios, cost gap ratios in detail by using the non-parametric method.

Firstly, the DEA models are applied to each group of DMUs to calculate group-specific technical efficiency ($TE^k$) and group-specific cost efficiency ($CE^k$). Then the same models are employed to all DMUs to measure metafrontier technical efficiency (TE) and metafrontier cost efficiency (CE). Finally, the technology gap ratio of group *k* ($TGR^k$) is defined as the ratio of the metafrontier technical efficiency to the *k-th* group technical efficiency.[25] Meanwhile, the cost gap ratio of group k ($CGR^k$) is the ratio of the metafrontier cost efficiency to the *k-th* group cost efficiency:

$$TGR^k = \frac{TE}{TE^k} \qquad (3.2.12)$$

$$CGR^k = \frac{CE}{CE^k} \qquad (3.2.13)$$

Since the metafrontier bounds the group-specific frontiers, the metafrontier efficiency is smaller than group-specific efficiencies. Therefore, the technology/cost gap ratio varies from zero to unity. The $TGR^k$ or $CGR^k$ quantifies how close the production or cost frontier of the *k-th* group to the corresponding metafrontier. In particular, the $TGR^k$ or $CGR^k$ reflects the gap between the current technology used by firms in the *k-th* group according the technology available in the whole sample (Battese & Rao, 2002). If the *k-th* group has higher value of $TGR^k$ or $CGR^k$, the group use more advanced technology than others (Huang & Chiang, 2007)

The non-parametric method (DEA) is applied to measure efficiency performance for Vietnamese manufacturing firms due to the following reasons: First, the input orientation is employed to measure cost efficiency or the ability to cut down production cost with a given output. To insure unification of results, especially allocative efficiency result, technical efficiency must be measured by the input-oriented approach. Yet, estimating the input-oriented model in the SFA is complicated, and therefore, the SFA is rarely used to define input-oriented technical efficiency (Alvarez & Arias, 2014). For the DEA,

[25] The technology gap ratio is named by Battese & Rao (2002) and Battese, Rao, & O'Donnell (2004), while O'Donnell, Rao, & Battese (2008) call it is the metatechnology ratio.

measurement of input-oriented technical efficiency is straightforward. Second, the study uses the metafrontier approach to compare individual efficiency levels of different groups and of the whole sample. The DEA method facilitates the metafrontier generation and ensures that the metafrontier envelops estimated group frontiers. Meanwhile if individual frontiers are estimated by the SFA method, a different technique is needed to estimate the metafrontier, i.e. the constrained mathematical programming algorithm (Battese & Rao, 2002).

### 3.3.2. Data Envelopment Analysis

The term Data Envelopment Analysis, a well-known name of the non-parametric approach, was proposed by the Charnes, Cooper and Rhodes (1978) (Cooper et al., 2007). The DEA uses mathematical programming for each DMU in order to maximize the ratio of sum weighted outputs to sum weighted inputs.

Assuming that there are *n* DMUs and each DMU acquires *m* inputs $(x_1, x_2, \dots, x_m)$ to produce $s$ outputs $(y_1, y_2, \dots, y_s)$, the sum of weighted input (virtual input) and the sum of weighted output (virtual output) of $DMU_o$ are defined as follows:

Virtual input = $v_1 x_{10} + v_2 x_{20} + \dots + v_m x_{m0} = \sum_{i=1}^{m} v_i x_{i0} = \boldsymbol{v}'\boldsymbol{x}_o$ (3.3.1)

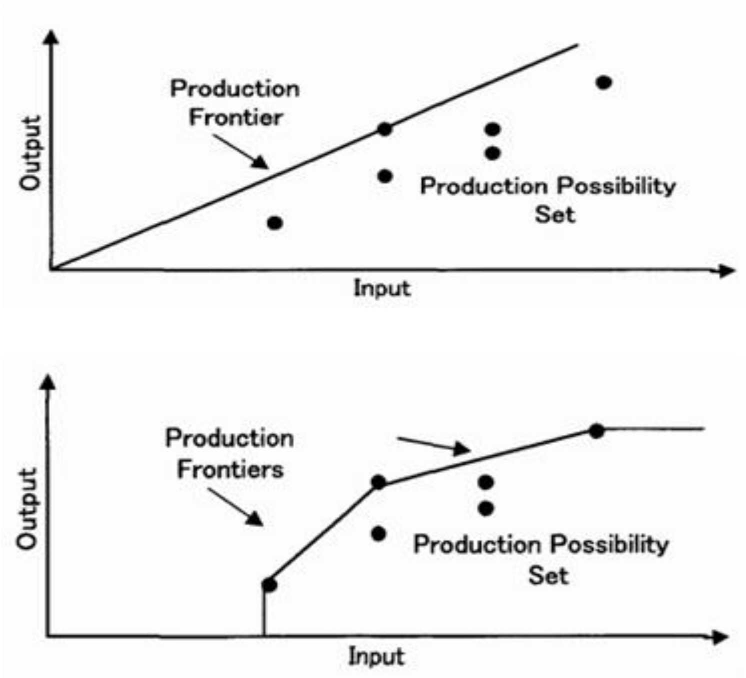
Virtual output = $u_1 y_{10} + u_2 y_{20} + \dots + u_s y_{s0} = \sum_{r=1}^{s} u_r y_{r0} = \boldsymbol{u}'\boldsymbol{y}_o$ (3.3.2)

#### *3.3.2.1. Models to Determine Technical Efficiency*

There are two main models to measure technical efficiency level, namely the Charnes, Cooper and Rhodes (1978) model (CCR model), and the Banker, Charnes and Cooper (1984) (BCC model). The two models can measure technical efficiency by the input approach and the output approach. However, within the study scope of this paper, only input-orientation is employed and represented.

The two models differ from characteristic of the hull of existing DMUs. It is nonconvex in the CCR model and convex in the BCC model. Therefore, the production frontier of the CCR model is linear, while the production frontier of the BCC model is piece-wise linear and concave. The CCR model, hence, relates to the Constant Returns to Scale (CRS) characteristic, meaning that input(s) and output(s) increase at the same rates, and a DMU can obtain CRS when it operates at an optimal scale. Actually, DMUs might not perform at optimal scale due to various factors, i.e. incomplete competition, regulation, etc. (Coelli et al., 2005, p. 172), but they operate under Increase/Decrease/Variable Returns to Scale. Therefore, Banker, Charnes and Cooper (1984) developed the CCR model by adding a convexity condition and the BCC model's assumption is Variable Returns to Scale (VRS).

**Figure 3-6. Production Frontiers of the CCR and BCC model**




*a. CCR model*

*b. BCC model*

Source: Adapted from Cooper et al. (2007, p. 88)

*a. The CCR model*

The CCR model was introduced by Charnes, Cooper and Rhodes (1978) in an attempt to build "a new definition of efficiency" to evaluate non-profit organizations' performance. The CCR model uses the production possibility set with input vector $\boldsymbol{x}$ and output vector $\boldsymbol{y}$ and a nonnegative vector $\boldsymbol{\lambda}$.

$$P = \{(\boldsymbol{x}, \boldsymbol{y}) | \boldsymbol{x} \geq X\boldsymbol{\lambda}, \boldsymbol{y} \leq Y\boldsymbol{\lambda}, \boldsymbol{\lambda} \geq \mathbf{0}\} \qquad (3.3.3)$$

The input-oriented CCR model, the fractional programming problem, tries to find vectors of weights $\boldsymbol{u}$,$\boldsymbol{v}$ to maximize the ratio of virtual output to virtual input.

$$(CCR - FP_o) \qquad \text{Max}_{\boldsymbol{u},\boldsymbol{v}} \left( \frac{\boldsymbol{u}'\boldsymbol{y}_o}{\boldsymbol{v}'\boldsymbol{x}_o} \right) \qquad (3.3.4)$$

Subject to $$\frac{\boldsymbol{u}'\boldsymbol{y}_j}{\boldsymbol{v}'\boldsymbol{x}_j} \leq 1 \;\; (j = 1,2,\ldots,n)$$

$$\boldsymbol{u},\boldsymbol{v} \geq 0$$

The programming is run for each DMU, called DMU$_o$ ($o$ = *1, 2,…, n*). Other DMUs are considered as the reference set and follow the constraint that the ratio of the virtual output to the virtual input must be less than or equal to unity. Also, the weight vectors $\boldsymbol{u}$,$\boldsymbol{v}$ must be nonnegative.

The fractional programming leads to an infinitive number of solutions as if $(\boldsymbol{u}^*, \boldsymbol{v}^*)$ is a solution, $(\alpha\boldsymbol{u}^*, \alpha\boldsymbol{v}^*)$ is also a solution. Therefore, the fractional program $(FP_o)$ is replaced by the linear program $(LP_o)$.

$$(CCR - LP_o) \qquad \text{Max}_{\mu,v} \;\; (\boldsymbol{\mu}'\boldsymbol{y}_o) \qquad (3.3.5)$$

Subject to $$\boldsymbol{v}'\boldsymbol{x}_o = 1$$

$$-\boldsymbol{v}X + \boldsymbol{\mu}Y \leq 0$$

$$\boldsymbol{\mu},\boldsymbol{v} \geq 0$$

where the constraint $\boldsymbol{v}'\boldsymbol{x}_o = 1$ is added to guarantee the equivalence of linear program to the fractional programming. The constraint $-\boldsymbol{v}X + \boldsymbol{\mu}Y \leq 0$ means that the virtual output must not exceed the virtual input.

The linear programming problem is in multiple form, while its dual problem is in envelopment form, as follows:

$$(CCR - I_o) \qquad \text{Min}_{\theta,\lambda} \;\; \theta \qquad (3.3.6)$$

Subject to $$\theta x_o - X\boldsymbol{\lambda} \geq 0$$

$$Y\boldsymbol{\lambda} \geq y_0$$

$$\boldsymbol{\lambda} \geq 0$$

where $\theta$ is a scalar and $\boldsymbol{\lambda}$ is a column vector of constants with all non-negative elements. The envelopment form is preferred since it requires fewer constraints than the multiple form (Coelli et al., 2005, p. 163).

*b. The BCC model*

The CCR model, due to its nonconvex hull of DMUs, has CRS characteristics and combines both technical and scale inefficiency. Banker et al. (1984) developed the CCR model by adding a constraint of convexity condition that differentiates technical inefficiency and scale inefficiency. The production possibility set used in the BCC model is described as follows:

$$P_B = \{(\boldsymbol{x}, \boldsymbol{y}) | \boldsymbol{x} \geq X\boldsymbol{\lambda}, \boldsymbol{y} \leq Y\boldsymbol{\lambda}, e\boldsymbol{\lambda} = 1, \boldsymbol{\lambda} \geq \boldsymbol{0}\} \qquad (3.3.7)$$

where $\boldsymbol{e}$ is a row vector with all unity elements. The added condition $e\boldsymbol{\lambda} = 1$ combines with $\boldsymbol{\lambda} \geq 0$ to ensure the convexity of production frontiers.

The BCC input-oriented model is presented in the envelopment form as follows:

$(BCC - I_o)$ $\quad \text{Min}_{\theta,\lambda}\ \theta_B$ (3.3.8)

Subject to $\quad \theta x_o - X\boldsymbol{\lambda} \geq 0$

$Y\boldsymbol{\lambda} \geq y_0$

$e\boldsymbol{\lambda} = 1$

$\boldsymbol{\lambda} \geq 0$

where $\theta_B$ is a scalar, $\lambda$ is a column vector of constants with all non-negative elements. The constraint $e\lambda = 1$ insures the VRS. Obviously, the production possibility set of the BCC model is the sub-set of the production possibility set of the CCR model.

### *3.3.2.2. Models to determine cost efficiency*

When the information of unit cost is available, cost efficiency of DMUs can be calculated. In the case that all DMUs have common unit input-price $c = (\boldsymbol{c}_1, \boldsymbol{c}_2, \dots, \boldsymbol{c}_m) \in R^{mxn}$, cost efficiency is determined by solving the following programming problem on the production possibility set P (Cooper et al., 2007, p. 259).

$(Cost_o)$ $\quad \boldsymbol{cx}^* = Min_{x,\lambda}\boldsymbol{cx}$ (3.3.9)

Subject to $\quad \boldsymbol{x} \geq X\boldsymbol{\lambda}$

$Y\boldsymbol{\lambda} \geq y_0$

$\boldsymbol{\lambda} \geq 0$

The problem tries to find optimal input $\boldsymbol{x^*}$ and non-negative scalar $\boldsymbol{\lambda}$ to minimize the production cost under the constraint of input used and output produced and define the cost efficiency.

$$CE = \frac{\boldsymbol{cx}^*}{\boldsymbol{cx}_o} \tag{3.3.10}$$

Model (3.3.10) is valid when all DMUs use common unit price and cost. Actually, such a situation is rare and it induces the irrational cost efficiency measure (Tone, 2002; Cooper et al., 2007). In case of different unit price and cost, the cost-based production possibility set is introduced (Tone, 2002; Cooper et al., 2007, p. 263).

$$P_c = \{(\overline{\boldsymbol{x}}, \boldsymbol{y}) | \overline{\boldsymbol{x}} \geq \bar{X}\boldsymbol{\lambda}, \boldsymbol{y} \leq Y\boldsymbol{\lambda}, \boldsymbol{\lambda} \geq \boldsymbol{0}\} \tag{3.3.11}$$

where $\bar{X} = (\overline{\boldsymbol{x}}_1, \overline{\boldsymbol{x}}_2, \dots, \overline{\boldsymbol{x}}_n)$ and $\overline{\boldsymbol{x}}_j = (c_{1j}x_{1j}, c_{2j}x_{2j}, \dots, c_{mj})$. Matrixes $X = (\boldsymbol{x}_1, \boldsymbol{x}_2, \dots, \boldsymbol{x}_m) \in R^{mxn}$; $Y = (\boldsymbol{y}_1, \boldsymbol{y}_2, \dots, \boldsymbol{y}_s) \in R^{sxn}$ and $C = (\boldsymbol{c}_1, \boldsymbol{c}_2, \dots, \boldsymbol{c}_m) \in R^{mxn}$ are input quantity, output and input unit price matrixes, respectively.

Applying the BCC-I model for the cost-based production possibility set $P_c$, we obtain technical efficiency with VRS assumption and different unit prices (Tone, 2002; Cooper et al., 2007, p. 263).

$(NTech_o)$ $\quad \text{Min}_{\bar{\theta},\lambda}\ \bar{\theta}_B$ $\quad$ (3.3.12)

Subject to $\quad \bar{\theta}\bar{x}_o - \bar{X}\boldsymbol{\lambda} \geq 0$

$Y\boldsymbol{\lambda} \geq y_0$

$e\boldsymbol{\lambda} = \boldsymbol{1}$

$\boldsymbol{\lambda} \geq 0$

Furthermore, the new cost model is applied on the production possibility set $P_c$ (Tone, 2002; Cooper et al., 2007, p. 263).

$(NCost_o)$ $\quad \boldsymbol{e}\overline{\boldsymbol{x}}^* = Min_{x,\lambda}\boldsymbol{e}\overline{\boldsymbol{x}}$ $\quad$ (3.3.13)

Subject to $\quad \overline{\boldsymbol{x}} \geq \bar{X}\boldsymbol{\lambda}$

$Y\boldsymbol{\lambda} \geq y_0$

$\boldsymbol{\lambda} \geq 0$

where $\boldsymbol{e}$ is a row matrix with all unity elements. The new cost efficiency is the ratio of optimal cost to real cost (Tone, 2002; Cooper et al., 2007, p. 263).

$$CE_N = \frac{\boldsymbol{e\bar{x}}^*}{\boldsymbol{e\bar{x}_o}} \tag{3.3.14}$$

Allocative efficiency is achieved by dividing the new cost efficiency by the new technical efficiency.

$$AE = {CE_N}/{TE_N} \tag{3.3.15}$$

### 3.4. Methodology and Model to Determine Sources of the Efficiency

#### 3.4.1. Methodology

Since the efficiency levels are gauged by the DEA model, the two-stage DEA method is applied to investigate the sources of efficiency performance. This method encompasses two stages. In the first stage, the calculation of efficiency measures (technical efficiency, cost efficiency) is implemented by the DEA method. In the second stage, determinants of efficiency measurements (technical efficiency, allocative efficiency, and cost efficiency) are revealed by regressions.[26]

There are two possible regression models that can be applied in the second stage, i.e. Ordinary Least Square (OLS) regression and the Tobit model. To date, the Tobit model has been used to examine the determinants of efficiency in some studies including Nguyen and Truong (2007), Amornkitvikai (2011), Charoenrat (2012). According to Coelli et al. (2005, p. 194), OLS can apply for dependent variables greater than one. Since efficiency measures vary within 0 and 1, the OLS estimation seems inappropriate, and may induce biased and inconsistent estimators (Amornkitvikai, 2011; Charoenrat, 2012). Therefore, the Tobit model is applied to examine possible factors contributing to inefficiency of Vietnamese manufacturing enterprises. The Tobit model can be represented in a latent variable model as follows (Hoff, 2007; Wooldridge, 2003, p. 540):

$$y = \begin{cases} y^*; & 0 \le y \le 1 \\ 0; & y < 0 \\ 1; & y > 1 \end{cases} \; ; \; y^* = \sum \beta_k x_k + u \tag{3.4.1}$$

[26] The DEA-Solver software is used in the first step, and the Tobit model is carried out by the STATA software in the second step.

### 3.4.2. Model Specification

The models to investigate possible factors of efficiency measures, i.e. technical efficiency, allocative efficiency, and cost efficiency are in the following forms.

$$\mathbf{EFF} = f\,(\mathbf{X}^{\mathbf{firm}}, \mathbf{X}^{\mathbf{lev}}, \mathbf{X}^{\mathbf{hhi}}, \mathbf{X}^{\mathbf{fdi}}, \mathbf{X}^{\mathbf{pci}}, \mathbf{X}^{\mathbf{subpci}}, \mathbf{D}^{\mathbf{sector}}, \mathbf{D}^{\mathbf{year}}) \qquad (3.4.2)$$

where:

$\mathbf{EFF} = (TE_{ij}, AE_{ij}, CE_{ij})$: vector of efficiencies

$\mathbf{X}^{\mathbf{firm}} = (lnAge_{ij}, LE_{ij}, DPE_{ij}, FIE_{ij}, Urban_{ij}, lnCAPIN_{ij}, Vocatn_{ij}, Univpost_{ij}$ : vector of firm characteristics

$\mathbf{X}^{\mathbf{lev}} = (Leverage_{ij})$: vector of financial constraint

$\mathbf{X}^{\mathbf{hhi}} = (HHI_{ij})$: vector of Herfindahl-Hirschman index

$\mathbf{X}^{\mathbf{fdi}} = (HZ\_GO_{ij}, HZ\_L_{ij}, FW_{ij}, BW_{ij})$: vector of FDI spillover effects

$\mathbf{X}^{\mathbf{pci}} = (PCI_{ij})$: vector of PCI

$\mathbf{X}^{\mathbf{subpci}} = (Entrycost_{ij}, Land_{ij}, Transprn_{ij}, Timecost_{ij}, Informal_{ij}, Proact_{ij}, Support_{ij}, Laborpolicy_{ij}, Institution_{ij})$: vector of sub-indices of PCI

$\mathbf{D}^{\mathbf{sector}} = (FBT_j, GT_j, FWL_j, WP_j, PP_j, CP_j, RP_j, NM_j, FM_j, ME_j, EE_j, TE_j, FN_j)$: vector of dummy variables for sectors.

$\mathbf{D}^{\mathbf{year}} = (Y09_i, Y11_i)$: vector of dummy variables for years

List and description of the variables are in Chapter 4, section 4.3.2 and data description is in section 4.4.2. The name of sectors and enterprise classification are in Table 4A-1 and 4A-2.

### 3.5. Methodologies to Measure Productivity Change

Total Factor Productivity change between two periods *t* and *t+1* can be measured by some methods, i.e. (i) TFP index number, (ii) Growth accounting, (iii) Conventional econometric models, (iv) Data Envelopment Analysis (DEA), and (v) Stochastic Frontier Analysis (SFA) (Diewert, 1981, pp. 18-28; Coelli et al., 2005, pp. 64-65; Arunsawadiwong, 2007). These methods are grouped in two ways. In the first way, these methods are aggregated into the non-parametric approach (method (i), (ii), and (iv)) and the parametric approach (method (iii) and (v)). In the second way, they belong to the non-frontier and frontier approach. The non-frontier approach, including methods (i), (ii), and (iii) assumes that all firms are efficient. However, the frontier approach, including methods (iv) and (v) is preferable because their assumption on the existence of inefficiency is true in reality.[27] Moreover, non-frontier methods only measure TFP growth, while frontier methods go further by decomposing sources of TFP change. Components of TFP growth vary from the frontier, i.e. production frontier and cost frontier.

**Table 3-1. Classification of Productivity Growth Measure Methods**

| | **Non-frontier** | **Frontier** |
|---|---|---|
| **Parametric** | Conventional econometric models | Stochastic Frontier Approach |
| | i.e. Production function, Cost function | i.e. Production frontier approach, Dual approach (Cost frontier approach) |
| **Non-parametric** | TFP index number<br>Growth accounting | Data Envelopment Approach |
| | i.e. Törnqvist index | i.e. Malmquist productivity index, Cost Malmquist productivity index Hick-Moorteen TFP index (Malmquist TFP index) |

Source: Author's compilation

### 3.5.1. Non-frontier Approach

Three popular models in the non-frontier approach are the conventional econometric models, the TFP index number, and the growth accounting approach. While the first model is parametric, the two others are non-parametric. Overview of these models is described below.

#### *3.5.1.1. The Growth Accounting Approach*

The growth accounting approach was famous with the Solow (1957)'s residual characterized as a simple, elegant and theoretical link between the production function and the index number approach (Hulten, 2001). This section is following (Solow, 1957; Hulten, 2001, pp. 7-9). The growth accounting approach starts by an aggregate production function

[27] If inefficiency is not taken into account, TFP measure is likely to be biased (Kerstens & Van de Woestyne, 2014)

with the assumption of neutral technical change, CRS and factors are paid their marginal products.

$$Q = A(t)f(K,L) \tag{3.5.1}$$

where $Q$ is output, $L$ and $K$ are labor and capital quantities, $A(t)$ measures accumulated effects of shifts over time. Taking total differentiation for (3.5.1) and divided by Q, we obtain:

$$\frac{Q^{\cdot}}{Q} = \frac{A^{\cdot}}{A} + A\frac{\partial f}{\partial K}\frac{K^{\cdot}}{Q} + A\frac{\partial f}{\partial L}\frac{L^{\cdot}}{Q} \tag{3.5.2}$$

or

$$\frac{Q^{\cdot}}{Q} = \frac{A^{\cdot}}{A} + w_K\frac{K^{\cdot}}{Q} + w_L\frac{L^{\cdot}}{Q} \tag{3.5.3}$$

and become

$$\Re = \frac{A^{\cdot}}{A} = \frac{Q^{\cdot}}{Q} - w_K\frac{K^{\cdot}}{Q} - w_L\frac{L^{\cdot}}{Q} \tag{3.5.4}$$

Since the output elasticity $A\frac{\partial f}{\partial K}\frac{K^{\cdot}}{Q}$ and $A\frac{\partial f}{\partial L}\frac{L^{\cdot}}{Q}$ are not observed, we assume that each input equals its value of marginal product $\frac{\partial Q}{\partial K} = \frac{\mathrm{r}}{\mathrm{p}}$ and $\frac{\partial Q}{\partial L} = \frac{\mathrm{w}}{\mathrm{p}}$ or marginal product of each input is subtituted by its relative price. Then, we obtain $w_K = \frac{\partial Q}{\partial K}\frac{K^{\cdot}}{Q} = A\frac{\partial f}{\partial K}\frac{K^{\cdot}}{Q}$ and $w_L = \frac{\partial Q}{\partial L}\frac{L^{\cdot}}{Q} = A\frac{\partial f}{\partial L}\frac{L^{\cdot}}{Q}$ , which are relative share of capital and labor, respectively.

Equation (3.5.2) shows that output growth is made by growth of capital and labor that are weighted by their output elasticity, and growth of the Hicksian efficiency index. In Equation (3.5.4), $\Re$ is the Solow residual or the residual growth of output that is not explained by growth of inputs. $\Re$, following Hulten (2001), is an index number as it can be calculated from quantities and prices. So, Solow turned time-series or discrete analogs of $\frac{Q^{\cdot}}{Q}$ , $\frac{K^{\cdot}}{Q}, \frac{L^{\cdot}}{Q}, w_K, w_L$ into an index number.

The growth accounting approach provides a simple way to measure the residual of output growth, which is not explained by input growths. However, it comes with some limitations. First, the residual $\Re$ refers to technical change or any kind of shift in the production function. In reality, productivity change can be attributed not only by technical change, but also by efficiency change, returns to scale, reallocation of resources, and other factors (Oum, Waters II, & Yu, 1999; Meyer & Harper, 2005). Second, the Solow model is associated with the assumption of CRS that is only necessary for estimating returns to capital. Third, under the assumption of marginal cost pricing, price of an input rising greater than its marginal cost causes a biased estimate of A (Hulten, 2001).

#### *3.5.1.2. TFP Index Number*

TFP index number is in the same class of non-parametric and non-frontier approach with the growth accounting approach. TFP index number is determined as output index divided to input index (Coelli et al., 2003, p. 18 and p. 26).

$$TFP\ index = \frac{Output\ index}{Input\ index} = \frac{\sum_{m=1}^{M} a_m Y_m}{\sum_{k=1}^{K} b_k X_k} \tag{3.5.5}$$

A popular TFP index number is the Törnqvist index. From Equation (3.5.5), TFP change from period *t* to period (*t+1*) is defined in (3.5.6) and the logarithm form of the TFP change index between two periods of the *n-th* DMU is defined in (3.5.7) (Coelli et al., 2003a, pp. 27-28):

$$\frac{TFP_{t+1}}{TFP_t} = \frac{\sum_{m=1}^{M} a_m Y_m^{t+1} \Big/ \sum_{k=1}^{K} b_k X_k^{t+1}}{\sum_{m=1}^{M} a_m Y_m^{t} \Big/ \sum_{k=1}^{K} b_k X_k^{t}} \tag{3.5.6}$$

$$\ln\left( TFP_{n,t+1} \Big/ TFP_{n,t} \right) = \frac{1}{2}\sum_{j=1}^{M} \left[ \left( r_{jn,t+1} + r_{jn,t} \right) . \left( y_{jn,t+1} - y_{jn,t} \right) \right] - \frac{1}{2}\sum_{j=1}^{K} \left[ \left( s_{jn,t+1} + s_{jn,t} \right) . \left( x_{jn,t+1} - x_{jn,t} \right) \right] \tag{3.5.7}$$

where: $x_{jn,t}, y_{jn,t}$ are logarithm of *j-th* input and output of n-th DMU at time *t*, and $s_{jn,t}, r_{jn,t}$ are cost share and revenue share of the *j-th* input and output of n-th DMU at time *t*.

The Törnqvist TFP index is equal to the Malmquist productivity index, proposed by Caves, Christensen, & Diewert (1982) and mentioned later, under translog production structures. The Törnqvist TFP index is a simple measure of TFP index with discrete data, but it is a composed index that cannot be factored.

### *3.5.1.3. Conventional Econometric Methods*

Different from the growth accounting approach, parameters of productivity change or productive efficiency are estimated by the conventional econometric method. A production function, based on the Solow model, which is estimated by a conventional econometric method, is in the form:

$$y_t = f(x_t, t) + \mathcal{E} \qquad (3.5.8)$$

Where $\mathcal{E}$ is a random statistical error term with zero mean, and $t = 1,2,\ldots,T$. The function $f$ can take many forms, i.e. Cobb-Douglas, translog. By taking logarithmical differentiation of the production function by time t, we have.

$$\frac{\partial lny}{\partial t} = \sum_{i=1}^{N} \frac{\partial lnf}{\partial lnx_i}\frac{\partial lnx_i}{\partial t} + \frac{\partial lnf}{\partial t} \qquad (3.5.9)$$

The second element on the right of Equation (3.5.9) is technical progress that reflects the shift in the production function as mentioned by Solow (1957).

The conventional econometric method, according to Arunsawadiwong (2007), yields the following merits. First, apart from productivity, other parameters of the production technology are estimated. Second, this method reduces fixed conditions that are set in the non-parametric approach, i.e. technical change rather than Hick-neutral technology. In addition, other conditions can be tested in the conventional econometric method, i.e. non-constant returns to scale, non-competitive pricing behavior, factor-augmenting technical change. Nevertheless, this method comes with a cost: the complex econometric function appears with a caution of robustness, degree of freedom with small-sized data, and statistical test for the complicated function form.

### 3.5.2. Frontier Approaches

As mentioned earlier, for the frontier methods, both parametric and non-parametric approaches, productivity change and its components are calculated with the existence of inefficiency. The non-parametric frontier technique is data-based and non-statistical that uses production possibilities set as a frontier unit-isoquant; and this technique does not require functional forms. Meanwhile, the parametric approach is a statistically-based method that requires specific functional form for the production function or cost function and statistical distribution for the inefficiency error term (Murillo-Zamorano & Cervera, 2000; Murillo-Zamorano, 2004). The technical background supporting for the two approaches are the same as in section 3.2.1.

#### *3.5.2.1. The Parametric Frontier Approach*

The measurement of productivity change based on the parametric frontier approach stems from the works of the deterministic production frontier by Aigner & Chu (1968), and the stochastic production frontier by Aigner, Lovell, & Schmidt (1977), Meeusen & van Den Broeck (1977), and Battese & Corra (1977). The first effort in measuring TFP growth using the parametric frontier approach, according to Shen (2009), is dedicated to Førsund & Hjalmarsson (1979). The two authors solved the deterministic frontier production function with variable scale elasticity to determine technical change for Swedish dairy plants. Later, Nishimizu & Page (1982) pointed out that technical change and efficiency change had not been differentiated in previous studies on productivity for both the non-parametric index number approach and the parametric approach. Providing a clear distinction that technological progress refers to the change in the production frontier and technical efficiency change covers all other productivity changes, including learning by doing, technological diffusion, managerial practice, external shocks, they proposed a method that decomposed TFP change into the two above components.

Denny, Fuss, & Leonard (1981) might be the first who used information from the cost function to measure and decompose TFP change. With the assumption of cost minimizing behavior, the duality between cost and production holds. And, TFP change, for the case of single output, consists of the shift in the cost function (technical change) and scale component. In the case of CRS, TFP change equals technical change. Inspired by Denny et al. (1981), Bauer (1990) goes further by presenting a frontier stochastic method to decompose TFP growth with the existence of cost inefficiency and Non-Constant Returns to Scale for both the production function approach and cost function approach. TFP growth's decomposition is more apparent for the cost function approach that includes technological progress, scale effect, overall efficiency change (encompassing changes in technical efficiency and allocative efficiency), and price effect term. TFP growth's decomposition by Bauer (1990) for production function is quite similar to that by Nishimizu & Page (1982), but the two studies differ in the presence of inefficiency. While Nishimizu & Page (1982) allow efficiency and inefficiency, Bauer (1990) deals with inefficiency. Bauer (1990)'s study is the first in the frontier parametric approach that considers the existence of cost inefficiency. The two approaches mentioned by Bauer (1990), i.e. primal approach and dual approach, are introduced as follows.

*a. Primal Approach (Production Function Approach)*

According to Bauer (1990), for the production frontier *f*, the maximum output can be produced with a bundle of *m* input $x = (x_{1,}x_2, \dots, x_m)$ at time *t*:[28]

$$y^* = f(x,t) \tag{3.5.10}$$

The output-based technical efficiency ($TE$ ) is defined as a ratio of the actual output to the optimal output.

$$TE \quad = \frac{y}{f(x,t)}, \qquad 0 < TE \quad \leq 1 \tag{3.5.11}$$

Taking the natural logarithm of (3.5.11), and then taking total differentiation with respect to time *t*, we obtain technical efficiency growth.

$$\frac{dlnTE}{dt} = \frac{dlny}{dt} - \sum_i \frac{\partial lnf(x,t)}{\partial x_i}\frac{dx_i}{dt} - \frac{\partial lnf(x,t)}{\partial t} \tag{3.5.12}$$

or
$$\dot{TE} = \dot{y} - \dot{f}(x,t) - \sum_i \frac{\partial f(x,t)}{\partial x_i}\frac{x_i}{f(x,t)}\dot{x}_i \tag{3.5.13}$$

where $\dot{TE}$ is the time rate of change of technical efficiency, $\dot{y}$ is the time rate of change of output, $\dot{f}(x,t)$ is the time rate of change of the technological progress, $\dot{x}_i$ is the time rate of change of *i-th* input.

Rearrange (3.5.13) into

$$\dot{TE} - \dot{y} + \dot{f}(x,t) + \sum_i \frac{\partial f(x,t)}{\partial x_i}\frac{x_i}{f(x,t)}\dot{x}_i = 0 \tag{3.5.14}$$

[28] The deterministic production frontier is in the form $y = f(x,t).\exp(-u)$, where $\exp(-u)$ is technical efficiency level. After taking logarithm for both sides, the production frontier is in the new form $\ln y = lnf(x,t) - u$. Since $u$ is non-negative, the actual output level is $\ln y \leq lnf(x,t)$. So, the maximum output level is defined as (3.5.10).

Add (3.5.14) into (3.2.11), we obtain a new formulation of TFP growth

$$\dot{TFP} = \dot{TE} + \dot{f}(x,t) + \sum_{\iota} \frac{\partial f(x,t)}{\partial x_\iota} \frac{x_\iota}{f(x,t)} \dot{x}_\iota - \sum_{i} \frac{w_i x_i}{C} \dot{x}_\iota \tag{3.5.15}$$

or

$$\dot{TFP} = \dot{TE} + \dot{f}(\dot{x},t) + \sum_{i} \left( \frac{\partial f(x,t)}{\partial x_i} * \frac{x_i}{f(x,t)} - \frac{w_i x_i}{C} \right) \dot{x}_\iota \tag{3.5.16}$$

Set $\mathcal{E}_i(x,t) = \frac{\partial f(x,t)}{\partial x_i} \times \frac{x_i}{f(x,t)}$ is the output elasticity of the *i-th* input, and $s_i = \frac{w_i x_i}{C}$ is the observed share of the *i-th* input. Equation (3.5.16) can be rewritten as

$$\dot{TFP} = \dot{TE} + \dot{f}(x,t) + \sum_{i} (\mathcal{E}_i(x,t) - s_i)\dot{x}_\iota \tag{3.5.17}$$

From equation (3.5.17), it is stated that TFP growth decomposes technical efficiency change ($\dot{TE}$), technical change ($\dot{f}(x,t)$) and the last component consists of returns to scale and cost efficiency effect. The term technical change (frontier-shift effect) refers to a shift in the production frontier over time (Coelli et al., 2003, p. 48) or “the change in the efficiency frontiers between two time periods” (Cooper et al., 2007, p. 328), or “a short hand expression for any kind of shift in the production function” (Solow, 1957). Technical efficiency change (catch-up effect) refers to “the degree to which a DMU improves or worsens its efficiency” (Cooper et al., 2007, p. 328).

*b. Dual Approach (Cost Function Approach)*[29]

Following Bauer (1990), at time *t* the minimum cost $C^*$ with a given combination of input and output $(y, w, t)$ is:[30]

$$C^* = C(y,w,t) \tag{3.5.18}$$

According to Farrell (1957), cost efficiency is identified as the ratio of the optimal cost to the observed cost.

$$CE = \frac{C(y,w,t)}{C} \tag{3.5.19}$$

[29] The duality between production function and cost function was mentioned by Shephard (1953), Uzawa (1964). McFadden (1978, p. 19) stated that the duality is means a cost function contains necessary information to rebuild production possibilities, a sense of a “sufficient statistic” for the technology.

[30] The deterministic cost frontier is defined as $C = C(y,w,t).\exp(u)$ or $lnC = lnC(y,w,t) + u$, where $\exp(u)$ is the cost efficiency level. Due to the non-negative characteristic of u, the actual cost is equal to or greater than the minimum cost $C \geq C(y,w,t)$. Thus, the optimum cost level is in the form of (3.5.27).

Taking the natural logarithm of (3.5.19), and then taking total differentiation with respect to time t, we obtain overall efficiency growth.

$$\frac{dlnCE}{dt} = \frac{\partial lnC(y,w,t)}{\partial y} \times \frac{dy}{dt} + \sum_i \frac{\partial lnC(y,w,t)}{\partial w_i} \times \frac{w_i}{C(y,w,t)} \times \frac{dw_i}{dt} + \frac{\partial lnC(y,w,t)}{\partial t} - \frac{dlnC}{dt} \quad (3.5.20)$$

Or $$\dot{CE} = \mathcal{E}_{cy}(y,w,t)\dot{y} + \sum_i \frac{\partial C(y,w,t)}{\partial w_i} \times \frac{w_i}{C(y,w,t)} \times w_\iota^{\cdot} + \dot{C}(y,w,t) - \dot{C} \quad (3.5.21)$$

Where $\mathcal{E}_{cy}(y,w,t)$ is cost elasticity of output. Rearrange (3.5.21):

$$\dot{CE} - \mathcal{E}_{cy}(y,w,t)\dot{y} - \sum_i \frac{\partial C(y,w,t)}{\partial w_i} \times \frac{w_i}{C(y,w,t)} \times w_\iota^{\cdot} - \dot{C}(y,w,t) + \dot{C} = 0 \quad (3.5.22)$$

Substitute (3.5.22) into (3.2.11):

$$T\dot{F}P = [1 - \varepsilon_{cy}(y,w,t)]\dot{y} + \dot{CE} - \dot{C}(y,w,t) - \sum_i \frac{\partial C(y,w,t)}{\partial w_i} \times \frac{w_i}{C(y,w,t)} \times \dot{w}_\iota + \dot{C} - \sum_i \frac{w_i x_i}{C}\dot{x}_\iota \quad (3.5.23)$$

Since $C = \sum_i w_i x_i$, taking deferentiation of C with respect to time t, we get:

$$\frac{dC}{dt} = \sum_i w_i \frac{dx_i}{dt} + \sum_i x_i \frac{dw_i}{dt} \quad (3.5.24)$$

Note that:

$$\dot{C} = \frac{dlnC}{dt} = \frac{dC}{dt} \times \frac{1}{C} \rightarrow \frac{dC}{dt} = \dot{C} \times C \quad (3.5.25)$$

$$x_\iota^{\cdot} = \frac{dlnx_i}{dt} = \frac{dx_i}{dt} \times \frac{1}{x_i} \rightarrow \frac{dx_i}{dt} = \dot{x}_\iota \times x_i \quad (3.5.26)$$

$$w_\iota^{\cdot} = \frac{dlnw_i}{dt} = \frac{dw_i}{dt} \times \frac{1}{w_i} \rightarrow \frac{dw_i}{dt} = \dot{w}_\iota \times w_i \quad (3.5.27)$$

Substituting (3.5.25), (3.5.26), and (3.5.27) into (3.5.24):

$$\dot{C} \times C = \sum_i w_i x_i \times \dot{x}_\iota + \sum_i w_i x_i \times \dot{w}_\iota$$

$$\leftrightarrow \dot{C} = \sum_i \frac{w_i x_i}{C} \times \dot{x}_\iota + \sum_i \frac{w_i x_i}{C} \times \dot{w}_\iota$$

$$\leftrightarrow C - \sum_\iota \frac{\dot{w}_\iota x_\iota}{C} \times \dot{x}_\iota = \sum_i \frac{w_i x_i}{C} \times \dot{w}_\iota \quad (3.5.28)$$

Replacing (3.5.28) into (3.5.24):

$$T\dot{F}P = \left[1 - \varepsilon_{cy}(y, w, t)\right]\dot{y} + \dot{CE} - \dot{C}(y, w, t) \tag{3.5.29}$$
$$+ \sum_i \left[\frac{w_i x_i}{C} - \frac{w_i x_i(y, w, t)}{C(y, w, t)}\right] \dot{w_\iota}$$

or $$T\dot{F}P = \left[1 - \varepsilon_{cy}(y, w, t)\right]\dot{y} + \dot{CE} - \dot{C}(y, w, t) + \sum_i [s_i - s_i(y, w, t)]\dot{w_\iota} \tag{3.5.30}$$

Equation (3.5.30) expresses components of productivity change in the context of multiple inputs and single output with respect to the cost frontier. $\left[1 - \varepsilon_{cy}(y, w, t)\right]\dot{y}$ is the scale effect. $\dot{CE}$ is cost efficiency change. Its positive sign suggests that improvement of cost efficiency over time contributes to productivity's increase. $-\dot{C}(y, w, t)$ is technical change, which reflects the shift of cost frontier. If the cost frontier shifts down, technical change is progressive and vice versa. $\sum_i [s_i - s_i(y, w, t)]\dot{w_\iota}$ is the price effect term, which captures differentiation between actual cost share and efficient cost share of all inputs in the relation with input prices. The price effect term only equals zero if a firm is allocatively efficient--$s_i = s_i(y, w, t)$ or input price changes at the same rate-- $\sum_i [s_i - s_i(y, w, t)] = 0$. Bauer (1990) further explains the existence of the price effect term associated with the observable quantity of TFP growth that the price effect is biased by relying on observed input usage as a result of cost inefficiency.

### *3.5.2.3. The Non-parametric Frontier Approach*

The non-parametric frontier approach for decomposition of TFP growth is famous with the Malmquist productivity index. The productivity index originates from the work of Malmquist (1953) on index numbers and indifference surface in which index numbers between two points of time were shown with information of income, price, quantity and consumption. Malmquist did not deal with a productivity index, but he is named for a productivity index because of his idea that a price and quantity index between two points of time are the ratio of distance function and that an index number equals the geometric mean of two indices is the main idea of the productivity index.

After that, based on Malmquist's idea, Caves, Christensen & Diewert (1982) developed index number procedures for input, output index, Malmquist input based productivity index and Malmquist output based productivity index for two firms with the conditions of translog structure of production and technical efficiency and allocative efficiency. The Malmquist productivity index is defined as a ratio of two distance functions. The type of distance function, i.e. input distance function, output distance function, decides the orientation of the Malmquist productivity index. Their work is the milestone of the Malmquist productivity index and has been inherited and developed by many authors.

Färe, Grosskopf, Lindgren, & Roos (1992) combined the ideas of Farrell (1957) and Caves et al. (1982) and proposed an input-based Malmquist index of productivity that represents the distinction between change in efficiency and change in production function. This study differs from that of Caves et al. (1982) in the existence of technical inefficiency. The application of Farrell technical efficiency allows the decomposition of TFP growth into efficiency change and technical change under the assumption of CRS. In the same vein, Färe, Grosskopf, Norris, & Zhang (1994) decompose the output-based Malmquist productivity index for 17 industrialized countries. Going further than Färe et al. (1992), Färe et al. (1994) consider VRS and, therefore, decompose technical efficiency change into change in pure technical efficiency and change in scale efficiency.

Maniadakis & Thanassoulis (2004) developed a productivity index based on the Malmquist index, namely the Cost Malmquist productivity index (CM), capturing technical efficiency change and allocative efficiency change. Under the assumption CRS, scale effect is not included in the Cost Malmquist productivity index. According to Yang, Sheng, & Huang (2009), a model that measures CM under VRS was proposed by Yang and Huang (2009).

*a. The Malmquist Productivity Index*

Suppose that at two time periods *t* and *t+1*, there are corresponding input set and output set for each period, $(y^t, x^t)$ and $(y^{t+1}, x^{t+1})$ as well as two seperated input isoquant curves, $\text{Isoq}L^t(y^t)$ and $\text{Isoq}L^{t+1}(y^{t+1})$. The input-oriented Malmquist index

(MI) at each period with the CRS production technology relates to the Shephard distance function assuming CRS.

$$MI_{CRS}^{t} = \frac{D_{IC}^{t}(y^{t+1}, x^{t+1})}{D_{IC}^{t}(y^{t}, x^{t})} \tag{3.5.31}$$

$$MI_{CRS}^{t+1} = \frac{D_{IC}^{t+1}(y^{t+1}, x^{t+1})}{D_{IC}^{t+1}(y^{t}, x^{t})} \tag{3.5.32}$$

The subscript "IC" of the distance functions means that they are input-oriented distance functions being subject to CRS. According to Maniadakis & Thanassoulis (2004), $MI_{CRS}^{t}$ and $MI_{CRS}^{t+1}$ compare the distance of $(y^{t+1}, x^{t+1})$ and $(y^{t}, x^{t})$ from the CRS production boundary of period *t* and *t+1*, respectively. The Malmquist productivity index is the geometric mean of two Malmquist indices at two periods.

$$MI_{CRS} = (MI_{CRS}^{t} \times MI_{CRS}^{t+1})^{1/2} = \left[\frac{D_{IC}^{t}(y^{t+1}, x^{t+1})}{D_{IC}^{t}(y^{t}, x^{t})} \times \frac{D_{IC}^{t+1}(y^{t+1}, x^{t+1})}{D_{IC}^{t+1}(y^{t}, x^{t})}\right]^{1/2} \tag{3.5.33}$$

TFP change records an improvement if the index is less than unity and vice versa. MI equals one, suggesting that productivity remains unchanged.

To illustrate the Malmquist productivity index suppose that two inputs $(x_1, x_2)$ generate one output y. Figure 3-7 describes that production takes place at point G$(y^{t}, x^{t})$ in period *t* and moves to point B$(y^{t+1}, x^{t+1})$ in period (*t+1*). The distances of input and output sets in each period with corresponding production boundary $D_{IC}^{t}(y^{t}, x^{t})$ is OG/OE and $D_{IC}^{t+1}(y^{t+1}, x^{t+1})$ is OB/OA. The Malmquist indices are illustrated as:

$MI_{CRS}^{t} = \frac{OB/OC}{OG/OE}$ and $MI_{CRS}^{t+1} = \frac{OB/OA}{OG/OF}$

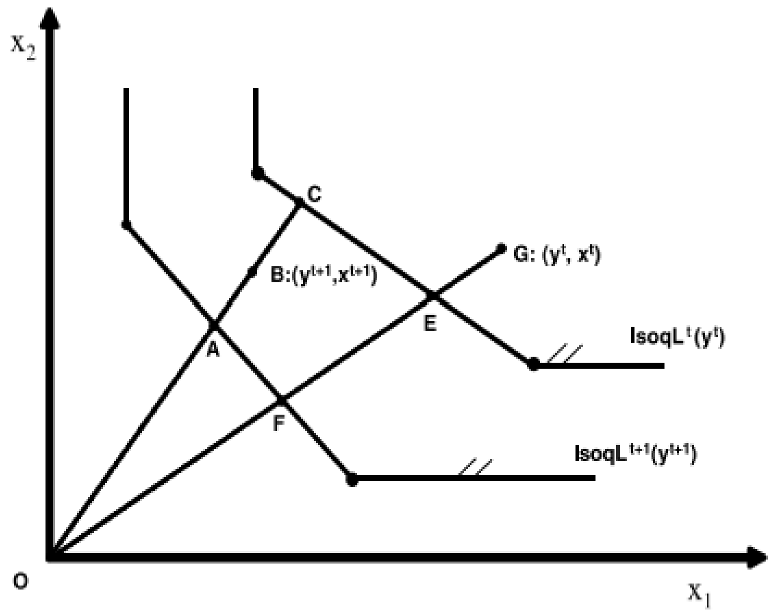
Hence, $MI_{CRS} = \left[\frac{OB/OC}{OG/OE} \times \frac{OB/OA}{OG/OF}\right]^{1/2}$

TFP growth, under CRS, is caused by two effects, i.e. catch-up effect and frontier-shift effect. The catch-up effect, or efficiency change, examines efficiency change of a DMU in two periods, to capture whether the efficiency increases or reduces. This term is defined by the ratio of efficiency of $(y^{t+1}, x^{t+1})$ with regard to the frontier of period (*t+1*) divided by efficiency of $(y^{t}, x^{t})$ with regard to the frontier of period t. In this case, only technical affiance is measured, so efficiency change is technical efficiency change (TEC).

$$TEC = \frac{D_{IC}^{t+1}(y^{t+1}, x^{t+1})}{D_{IC}^{t}(y^{t}, x^{t})} = \frac{OB/_{OA}}{OG/_{OE}} \quad (3.5.34)$$

*TEC* is less (greater) than one, registering technical efficiency improvement (deterioration), or a DMU is getting closer (farther) to its efficiency frontier over time. *TEC* equals unity, suggesting no change in technical efficiency.

**Figure 3-7. The Input-oriented Malmquist Productivity Index**




Source: Adapted from Maniadakis & Thanassoulis (2004)

The second component of TFP growth is the frontier-shift effect, or innovation, or technical change, or technological progress, denoted by *TC*.

$$\mathrm{TC} = (\phi_t \times \phi_{t+1})^{1/2} \quad (3.5.35)$$

$$TC = \left[\frac{D_{IC}^{t}(y^{t+1}, x^{t+1})}{D_{IC}^{t+1}(y^{t+1}, x^{t+1})} \times \frac{D_{IC}^{t}(y^{t}, x^{t})}{D_{IC}^{t+1}(y^{t}, x^{t})}\right]^{1/2} = \left[\frac{OB/OC}{OB/OA} \times \frac{OG/OE}{OG/OF}\right]^{1/2}$$

where: $\phi_t$ is the frontier-shift effect at $(y^t, x^t)$, and $\phi_{t+1}$ is the frontier-shift effect at $(y^{t+1}, x^{t+1})$. Under the assumption of CRS, the Malmquist productivity index is the product of efficiency change and technical change.

$$MI_{CRS} = TEC \times TC \tag{3.5.36}$$

$$= \frac{D_{IC}^{t+1}(y^{t+1}, x^{t+1})}{D_{IC}^{t}(y^{t}, x^{t})} \times \left[\frac{D_{IC}^{t}(y^{t+1}, x^{t+1})}{D_{IC}^{t+1}(y^{t+1}, x^{t+1})} \times \frac{D_{IC}^{t}(y^{t}, x^{t})}{D_{IC}^{t+1}(y^{t}, x^{t})}\right]^{1/2}$$

If the production technology is VRS, the technical efficiency change is divided into pure technical efficiency change (PTEC) and scale efficiency change (SEC). Therefore, the input-oriented Malmquist productivity index with VRS encompasses three components:

$$MI_{VRS} = TEC \times TC = PTEC \times SEC \times TC \tag{3.5.37}$$

where: $PTEC = \frac{D_{IV}^{t+1}(y^{t+1},x^{t+1})}{D_{IV}^{t}(y^{t},x^{t})}$ measures the change in technical efficiency over time;

$SEC = \left[\frac{\frac{D_{IC}^{t+1}(y^{t+1},x^{t+1})}{D_{IV}^{t+1}(y^{t+1},x^{t+1})}}{\frac{D_{IC}^{t+1}(y^{t},x^{t})}{D_{IV}^{t+1}(y^{t},x^{t})}} \times \frac{\frac{D_{IC}^{t}(y^{t+1},x^{t+1})}{D_{IV}^{t}(y^{t+1},x^{t+1})}}{\frac{D_{IC}^{t}(y^{t},x^{t})}{D_{IV}^{t}(y^{t},x^{t})}}\right]^{\frac{1}{2}}$ measures the change in scale efficiency over time; and

$TC = \left[\frac{D_{IV}^{t}(y^{t+1},x^{t+1})}{D_{IV}^{t+1}(y^{t+1},x^{t+1})} \times \frac{D_{IV}^{t}(y^{t},x^{t})}{D_{IV}^{t+1}(y^{t},x^{t})}\right]^{1/2}$ is the change in technology over time.

The subscript "IV" indicates the input distance functions under the VRS technology.

*b. The Cost Malmquist Productivity Index*

When input prices are available, the iso-cost can be determined and cost efficiency can be measured. Cost efficiency (or overall efficiency) consists of technical efficiency and allocative efficiency. While change in technical efficiency is involved in TFP growth, change in allocative efficiency and therefore change in overall efficiency was not mentioned until Bauer (1990), who used a parametric method to decompose productivity change from a cost function. The parametric method requires assumptions on function's form, inefficiency's distribution and it is only applicable for continuous data (Maniadakis & Thanassoulis, 2004). In an effort to apply Bauer's approach for discrete data, Balk (1997, as cited in Maniadakis & Thanassoulis, 2004) proposed an index numbers method and added assumptions that technology in each period is in the form of a translog cost function with time-invariant second order coefficients, and shadow prices are employed instead of observed input prices. Realizing the shortcomings of these studies, Maniadakis & Thanassoulis (2004) developed the non-parametric Malmquist productivity index to be the cost Malmquist productivity index, which is applicable for discrete data and uses actual input prices.

In the same style with the Malmquist productivity index, the cost Malmquist productivity index is the geometric mean of two cost Malmquist indices in periods *t* and *t+1*.

$$CM = (CM^t \times CM^{t+1})^{1/2} = \left[\frac{w^t x^{t+1}/C^t(y^{t+1}, w^t)}{w^t x^t/C^t(y^t, w^t)} \times \frac{w^{t+1} x^{t+1}/C^{t+1}(y^{t+1}, w^{t+1})}{w^{t+1} x^t/C^{t+1}(y^t, w^{t+1})}\right]^{1/2} \quad (3.5.38)$$

where $CM^t = \frac{w^t x^{t+1}/C^t(y^{t+1}, w^t)}{w^t x^t/C^t(y^t, w^t)}$ is the cost Malmquist index in period *t*.

$CM^{t+1} = \frac{w^{t+1} x^{t+1}/C^{t+1}(y^{t+1}, w^{t+1})}{w^{t+1} x^t/C^{t+1}(y^t, w^{t+1})}$ is the cost Malmquist index in period *t+1*.

The cost Malmquist productivity index can be factored into change in overall efficiency (OEC) and cost-technical change (CTC). Being similar to the Malmquist productivity index, the OEC term captures the catch-up effect that measures firm-specific changes in cost efficiency in association with input bundle. Meanwhile, the CTC term captures the frontier-shift effect that measures the shift in the cost frontier over time.

$$CM = OEC \times CTC \quad (3.5.39)$$

$$CM = \frac{w^{t+1} x^{t+1}/C^{t+1}(y^{t+1}, w^{t+1})}{w^t x^t/C^t(y^t, w^t)} \times \left[\frac{w^t x^{t+1}/C^t(y^{t+1}, w^t)}{w^{t+1} x^{t+1}/C^t(y^{t+1}, w^t)} \times \frac{w^t x^t/C^t(y^t, w^t)}{w^{t+1} x^t/C^{t+1}(y^t, w^{t+1})}\right]^{1/2} \quad (3.5.40)$$

Overall efficiency change, in turn, can be divided into technical efficiency change (*TEC*) and allocative efficiency change (*AEC*). *TEC* is the catch-up term in the Malmquist productivity index that examines the change in input-oriented technical efficiency over time. AEC implies the catch-up ability of a DMU to an optimal input bundle with respect to input prices during two periods.

$$\text{OEC} = \text{TEC} \times \text{AEC} \quad (3.5.41)$$

$$OEC = \frac{D_{IV}^{t+1}(y^{t+1}, x^{t+1})}{D_{IV}^t(y^t, x^t)} \times \frac{w^{t+1} x^{t+1}/(C^{t+1}(y^{t+1}, w^{t+1}) \times D_{IV}^{t+1}(y^{t+1}, x^{t+1}))}{w^t x^t/(C^t(y^t, w^t) \times D_{IV}^{t+1}(y^{t+1}, x^{t+1}))} \quad (3.5.42)$$

In the same fashion with the Malmquist productivity index, the technical efficiency change subjecting to VRS includes pure technical efficiency change (PTEC) and cost-scale efficiency change (CSEC).

$$CSEC = \left[\frac{C_V^{t+1}(y^{t+1}, w^{t+1})/C_C^{t+1}(y^{t+1}, w^{t+1})}{C_V^{t+1}(y^{t}, w^{t+1})/C_C^{t+1}(y^{t}, w^{t+1})} \times \frac{C_V^{t}(y^{t+1}, w^{t})/C_C^{t}(y^{t+1}, w^{t})}{C_V^{t}(y^{t}, w^{t})/C_C^{t}(y^{t}, w^{t})}\right]^{1/2} \qquad (3.5.43)$$

The cost-technical change (CTC) that measures the shift in the cost boundary is the combination of shifts of the production boundary (technical change, TC) and/or shifts in relative input prices (price effect change, PEC). Technical change is described in equation (3.5.35). While TC quantifies the input needed to produce certain output attributed to innovation and technological improvement, PEC measures the input needed to produce certain output attributed to changes in input prices. The first element inside the brackets of PEC determines the shift of minimum cost frontier in producing $(y^t, x^t)$ due to changes of input prices, the second one assesses the shift in producing $(y^{t+1}, w^{t+1})$.

$$PEC = \left[\frac{\dfrac{w^t x^{t+1}}{(C_V^t(y^{t+1}, w^t) \times D_{IV}^t(y^{t+1}, x^{t+1})}}{\dfrac{w^{t+1} x^{t+1}}{(C_V^{t+1}(y^{t+1}, w^{t+1}) \times D_{IV}^{t+1}(y^{t+1}, x^{t+1})}} \times \frac{\dfrac{w^t x^t}{(C_V^t(y^t, w^t) \times D_{IV}^t(y^t, x^t)}}{\dfrac{w^{t+1} x^t}{(C_V^{t+1}(y^t, w^{t+1}) \times D_{IV}^{t+1}(y^t, x^t)}}\right]^{1/2} \qquad (3.5.44)$$

In sum, the cost Malmquist productivity index with VRS production technology consists of five components.

$$\begin{aligned} CM &= OEC \times CTC = (TEC \times AEC) \times (TC \times PEC) \\ &= PTEC \times CSEC \times AEC \times TC \times PEC \end{aligned} \qquad (3.5.45)$$

Figure 3-8 depicts the cost Malmquist productivity index under CRS technology for DMUs in periods *t* and (*t+1*) with two inputs and one output. With information of input prices the iso-cost lines are determined. Graphically, the cost Malmquist productivity index and its components are defined as:

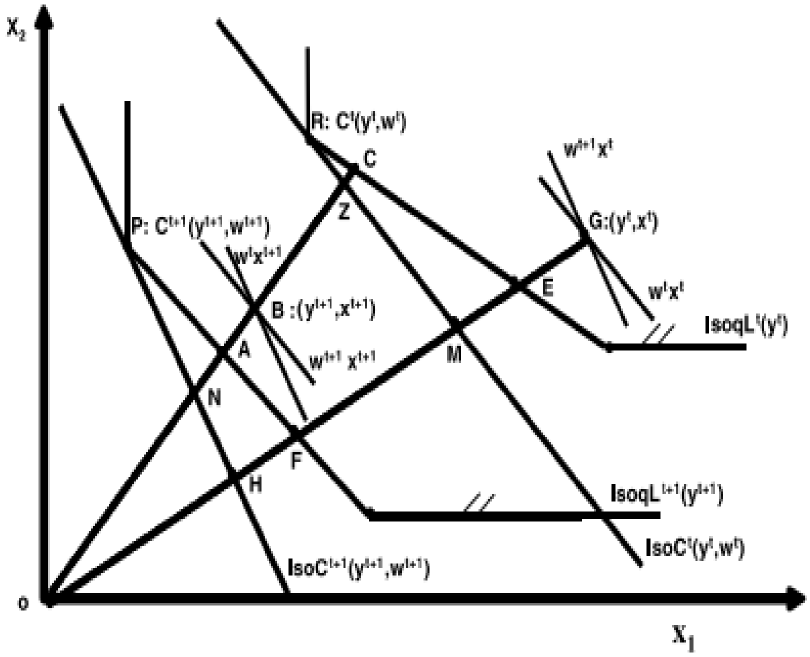
$$CM = \left[\frac{OB/OZ}{OG/OM} \times \frac{OB/ON}{OG/OH}\right]^{1/2}$$

$$OEC = \frac{OB/ON}{OG/OM} \text{ and } CTC = \left[\frac{OB/OZ}{OB/ON} \times \frac{OG/OM}{OG/OH}\right]^{1/2} = \left[\frac{ON/OZ}{OH/OM}\right]^{1/2}$$

$$TEC = \frac{OB/OA}{OG/OE} \text{ and } AEC = \frac{OA/ON}{OE/OM}$$

$$TC = \left[\frac{OA}{OC} \times \frac{OF}{OE}\right]^{1/2} \text{ and } PEC = \left[\frac{OC/OZ}{OA/ON} \times \frac{OE/OM}{OF/OH}\right]^{1/2}$$

**Figure 3-8. The Cost Malmquist Productivity Index**




Source: Adapted from Maniadakis & Thanassoulis (2004)

In sum, components of the input-oriented Malmquist productivity index and the cost Malmquist productivity index are summarized in the following table.

**Table 3-2. Summary of TFP Index and Components**

| Index | Meaning |
|---|---|
| CM: Cost Malmquist productivity index | Measures TFP change connecting to cost efficiency when input quantities and input prices are available. $CM_{VRS} = OEC \times CTC = PTEC \times CSEC \times AEC \times TC \times PEC$ |
| MI: Malmquist productivity index | Measures TFP change connecting to technical efficiency when input quantities are available. $MI_{VRS} = PTEC \times SEC \times TC$ |
| OEC: Overall efficiency change | "Catch-up" effect: Firm-specific changes in cost efficiency related to input combination. $OEC = TEC \times AEC = PTEC \times CSEC \times AEC$ |
| AEC: Allocative efficiency change | "Catch-up" effect with the optimal input combination with input prices. |
| TEC: Technical efficiency change | $TEC = PTEC \times CSEC$ |
| PTEC: Pure technical efficiency change | Whether the firm getting closer to its efficiency frontier over time. |
| CSEC: Scale efficiency change | Whether the firm getting closer to (farther away) its optimal scale in minimizing the production cost. |

| | |
|---|---|
| SEC | Whether the firm getting closer to (farther away) its technically optimal scale. |
| CTC: Cost-technical change | "Frontier-shift" effect: the distance between cost boundaries. |
| TC: Technical change (innovation) | Whether the cost boundary over time due to innovation and technological improvements.<br>*CTC = TC × PEC* |
| PEC: Price effect change<br>*(AEC at industry level)* | Residual impact of relative input price changes on the shift of the cost boundary. |

Source: Author's summarization

*c. The Hicks-Moorsteen TFP index*

The Hicks-Moorsteen TFP index or the Malmquist TFP index was developed by Bjurek (1996) using the concept of the Malmquist productivity index.[31] The two indices differ in orientation. While the Malmquist productivity index utilizes partial orientation, i.e. input-oriented and output-oriented, the Hicks-Moorsteen TFP index employs simultaneous orientation that equals Malmquist output quantity index divided by Malmquist input quantity index. The original idea of the Hicks-Moorsteen TFP index is the ratio of output quantity index to input quantity index that is equivalent to the ratio of output growth to input growth.

$$\text{HM TFP index} = \frac{\text{Growth in output}}{\text{Growth in input}} = \frac{\text{Output quantity index}}{\text{Input quantity index}} \quad (3.5.46)$$

The Hicks-Moorsteen productivity index at time *t* is the ratio of output-oriented Malmquist productivity index ($M_O^t$) and input-oriented Malmquist productivity index ($M_I^t$) at the corresponding period.

$$HM^t(x^t, y^t, x^{t+1}, y^{t+1}) = \frac{M_O^t}{M_I^t} = \frac{D_O^t(x^t, y^t)/D_O^t(x^t, y^{t+1})}{D_I^t(x^t, y^t)/D_I^t(x^t, y^{t+1})} \quad (3.5.47)$$

Similarly, the Hicks-Moorsteen productivity index at time $(t+1)$ is defined as:

$$HM^{t+1}(x^t, y^t, x^{t+1}, y^{t+1}) = \frac{M_O^{t+1}}{M_I^{t+1}} = \frac{D_O^{t+1}(x^{t+1}, y^t)/D_O^{t+1}(x^{t+1}, y^{t+1})}{D_I^{t+1}(x^{t+1}, y^t)/D_I^{t+1}(x^{t+1}, y^{t+1})} \quad (3.5.48)$$

[31] The Hicks-Moorsteen TFP index is dedicated to Hicks (1961) and Moorsteen (1961) by Diewert (1992).

The Hicks-Moorsteen TFP index, similarly to the Malmquist productivity index, is the geometric mean of the Hicks-Moorsteen productivity index at two periods *t* and *t+1*.

$$HM(x^t, y^t, x^{t+1}, y^{t+1}) = (HM^t \times HM^{t+1})^{1/2} \quad (3.5.49)$$

Decomposition of the Hicks-Moorsteen productivity index was developed by Lovell (2003) in a similar way as the Malmquist productivity index. Generally, the Hicks-Moorsteen productivity index at period *t* is factored into technical efficiency change, technical change, scale economies components, output mixed and input mixed effects.

$$\begin{aligned} HM \quad & (x^t, y^t, x^{t+1}, y^{t+1}) \\ & = \Delta TE_O(x^t, y^t, x^{t+1}, y^{t+1}) + \Delta T_O(x^t, y^t, x^{t+1}, y^{t+1}) \\ & + \Delta S^t(x^t, y^t, \lambda x^t, \mu y^t) + \Delta OM^t(x^t, y^{t+1}, \mu y^t) + \Delta IM^t(y^t, x^{t+1}, \lambda x^t) \end{aligned} \quad (3.5.50)$$

where $\Delta TE_O(x^t, y^t, x^{t+1}, y^{t+1})$ reflects technical efficiency change, and $\Delta T_O(x^t, y^t, x^{t+1}, y^{t+1})$ is technical change.

The three last components on the right of (3.5.50), i.e. scale economies component, output mixed effect and input mixed effect, are determined as follows (Baležentis, 2012a):

$$\Delta S^t(x^t, y^t, \lambda x^t, \mu y^t) = \frac{D_O^t(x^t, \mu y^t)/D_O^t(x^{t+1}, y^{t+1})}{D_I^t(\lambda x^t, y^t)/D_I^t(x^t, y^t)} \quad (3.5.51)$$

where: $\lambda = [D_I^t(x^t, y^{t+1}/D_I^t(x^{t+1}, y^{t+1}))]^{-1}$

and $\mu = [D_O^t(x^{t+1}/D_O^t(x^{t+1}, y^{t+1}), y^t/)]^{-1}$

$$\Delta OM^t(x^t, y^{t+1}, \mu y^t) = \frac{D_O^t(x^t, y^{t+1})}{D_O^t(x^t, \mu y^t)} \quad (3.5.52)$$

$$\Delta IM^t(y^t, x^{t+1}, \lambda x^t) = \frac{D_I^t(\lambda x^t, y^t)}{D_I^t(x^{t+1}, y^t)} \quad (3.5.53)$$

In sum, the Hicks-Moorsteen productivity index was developed based on the idea of the Malmquist productivity index, which is measured by a non-parametric approach and applicable for discrete data. The two indices return the same productivity result under the conditions of CRS and inverse homotheticity (Färe, Grosskopf, & Roos, 1996). However, the Hicks-Moorsteen productivity index measures productivity through hypothetical input-output combination or pseudo-observations rather than observed input-output combination used in the Malmquist productivity index (Färe et al., 1996; Kerstens & Van de Woestyne, 2014). The characteristic makes the Malmquist productivity index somewhat easier to interpret (Kerstens & Van de Woestyne, 2014). Therefore, the Hicks-Moorsteen TFP index is less popular than the Malmquist productivity index. Nevertheless, the Hicks-Moorsteen TFP index has some merits that the Malmquist productivity index does not.[32]

In this study, based on its objective to examine productivity change with the presence of cost inefficiency, the cost Malmquist productivity index, which is developed on the basis of the Malmquist productivity index is chosen for the following reasons. The first reason stems from data characteristic. This study employs discrete firm-level data in 2008, 2010 and 2012. As a DEA model is congruent with discrete data, while the parametric method proposed by Bauer (1990) is suitable for continuous data. Second, among methods for discrete data, the Malmquist productivity index and the Hicks-Moorsteen TFP index only involve change of technical efficiency, not the change of allocative efficiency and cost efficiency as a whole. This limitation is solved by the cost Malmquist productivity index that measures productivity change in the circumstance of cost inefficiency. The following part represents the computation of the cost Malmquist productivity index and its components.

### 3.5.3. Computation of Productivity Index and Components

The computation of productivity index is done by the non-parametric linear programming method (DEA). Assuming that there are $n$ DMUs using $m$ inputs $\boldsymbol{x} = (x_1, x_2, \dots, x_m)$ to produce $s$ outputs $\boldsymbol{y} = (y_1, y_2, \dots, y_{s)}$. Corresponding with inputs are input prices $\boldsymbol{w} = (w_1, w_2, \dots, w_m)$. Following Cooper et al. (2007), the production possibility set used is described as follows:

$$P_B = \{(\boldsymbol{x}, \boldsymbol{y}) | \boldsymbol{x} \geq X\boldsymbol{\lambda}, \boldsymbol{y} \leq Y\boldsymbol{\lambda}, e\boldsymbol{\lambda} = 1, \boldsymbol{\lambda} \geq \boldsymbol{0}\} \quad (3.5.54)$$

[32] See Kerstens & Van de Woestyne (2014) for more information.

The term $C^t(y^t, w^t)$ for k-*th* DMU under VRS is obtained by solving the cost minimization programming model.

$$C^t(y^t, w^t) = \min_{x,\lambda} w^t_{km} x_m \tag{3.5.55}$$

Subject to:

$$\sum_{j=1}^{n} \lambda_j y^t_{js} \geq y^t_{ks}$$
$$\sum_{j=1}^{n} \lambda_j x^t_{jm} \leq x_{km}$$
$$\lambda_j \geq 0, x_m \geq 0$$
$$\sum_{j=1}^{n} \lambda_j = 1$$

Where $\lambda_j$ (*j=1,…,J*) are intensity variables used to form a convex linear combination of observed inputs and outputs.

Similarly, the term $C^t(y^{t+1}, w^t)$ for the *k-th* DMU is computed as follows.

$$C^t(y^{t+1}, w^t) = \min_{x,\lambda} w^t_{km} x_m \tag{3.5.56}$$

Subject to:

$$\sum_{j=1}^{n} \lambda_j y^{t+1}_{js} \geq y^t_{ks}$$
$$\sum_{j=1}^{n} \lambda_j x^t_{jm} \leq x_{km}$$
$$\lambda_j \geq 0, x_m \geq 0$$
$$\sum_{j=1}^{n} \lambda_j = 1$$

The terms $C^{t+1}(y^{t+1}, w^{t+1})$ and $C^{t+1}(y^t, w^{t+1})$ are calculated similarly to $C^t(y^t, w^t)$ in model (3.5.55) and $C^t(y^{t+1}, w^t)$ in model (3.5.56) by using the appropriate time.

The input-oriented VRS distance function $D^t_{IV}(y^t, x^t)$ is computed as follows:

$$[D^t_{IV}(y^t, x^t)]^{-1} = \min_{\lambda,\theta} \theta \tag{3.5.57}$$

Subject to:

$$\sum_{j=1}^{n} \lambda_j y^t_{js} \geq y^t_{ks}$$
$$\sum_{j=1}^{n} \lambda_j x^t_{jm} \leq \theta x^t_{km}$$
$$\lambda_j \geq 0$$
$$\sum_{j=1}^{n} \lambda_j = 1$$

In the same way, $D_{IV}^{t}(y^{t+1}, x^{t+1})$ is computed as:

$$[D_{IV}^{t}(y^{t+1}, x^{t+1})]^{-1} = \min_{\lambda,\theta} \theta \qquad (3.5.58)$$

Subject to:

$$\sum_{j=1}^{n} \lambda_j y_{js}^{t} \geq y_{ks}^{t+1}$$

$$\sum_{j=1}^{n} \lambda_j x_{jm}^{t} \leq \theta x_{km}^{t+1}$$

$$\lambda_j \geq 0$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

The two remaining terms $D_{IV}^{t+1}(y^{t+1}, x^{t+1})$ and $D_{IV}^{t+1}(y^{t}, x^{t})$ are obtained by solving model (3.5.57) and (3.5.58), respectively, with appropriate time period.

# CHAPTER 4

# DATA AND VARIABLES

## 4.1. Data Sources

In order to evaluate efficiency performance and productivity performance of Vietnamese manufacturing enterprises and sources of efficiency, two data sets are employed: firm-level data from the Enterprises Survey, and the provincial-level data from the Provincial Competitiveness Index survey. Moreover, the Input-Output Table was utilized for calculating some variables. The following parts only introduce the two data sources and their characteristics.

### 4.1.1. The Firm-level Data

The firm-level data is extracted from the Enterprise Survey, which has been conducted annually by the General Statistics Office of Vietnam since 2000. Enterprises in this survey are independent bookkeeping economic units that have their own legal status and remain operating at the surveyed time and at the end of the previous year.[33] They operate in all economic sectors, such as agriculture, forestry and fishering, mining industry, manufacturing industry, construction and services[34] and belong to 3 main types of ownership, i.e. state owned enterprises (SOEs), non-state owned enterprises or domestic private enterprises (DPEs) and foreign invested enterprises (FIEs).[35] The surveys provide rich information, such as (i) identification indicators: location, established year, type of ownership, production and business activities, (ii) performance indicators: number of labor, compensation, assets and capital, investment, depreciation, turnover and profit, taxes and payment, etc., and (iii) related information for evaluating enterprise operation and conducting macroeconomic indicators. This is the most comprehensive survey on enterprises in Vietnam which covers all enterprises inside the country. Since 2012, GSO has implemented an Establishment Census with a broader scope than the Enterprise Survey.

[33] Enterprises, here, were established by Enterprise Law, State Enterprise Law, Foreign Investment Law or by agreements between the government of Vietnam and governments of foreign countries.
[34] Enterprises activities are classified by VSIC 2007.
[35] See Table 4A-2 for details.

The Census contains four groups: enterprises, administrative and non-profit establishments, non-farm individual business establishments and religious foundations. The enterprise group includes SOEs, DPEs, and FIEs with independent economic accounting, cooperative, and branch or representative of foreign enterprises located in Vietnam.

From the data source, a variety of variables are made to meet the study's objectives: First, to measure efficiency performance (Chapter 5) and productivity change (Chapter 7), data on gross output, production cost, inputs (number of employees, capital, materials and energy), factor costs (labor cost, cost of capital, cost of materials and energy) are utilized. Second, to reveal determinants of efficiency (Chapter 6), data on firm characteristics (firm age, firm size, location, capital intensity, the share of workers with vocational certificates, and the share of employees with undergraduate and graduate certificates, leverage) are also employed. Moreover, the dataset of the whole manufacturing sector and agriculture, construction, and services are used for measuring the Herfindahl-Hirschman index, horizontal spillover, forward effect and backward effect of each manufacturing sector.

In addition, the empirical impacts on firm's efficiency performance are confirmed by the results of our field study in August 2013. The field study was carried out by face-by-face interview of 15 metal mechanics of SMEs in Hanoi, Hung Yen and Vinh Phuc province in the north of Vietnam.

To meet the research objectives, the author employ enterprise data from the Enterprise Survey in 2008, 2010, and 2012 (data in 2007, 2009 and 2011). The three years were selected because of two reasons. First, the global crisis stated in 2008. Hence, data in year 2007 is selected to capture enterprises performance right before, while data in year 2009 and 2011 capture performance after the crisis. Second, as Vietnamese enterprises have suffered more serious impacts of the international and domestic economic situation since 2010, data in year 2011 is selected to reflect differences in enterprises performance between two years 2009 and 2011.

### 4.1.2. The Provincial Competitiveness Index (PCI)

The PCI has been generated annually since 2006 under the cooperation of the Vietnam Chamber of Commerce and Industry (VCCI) and Vietnam Competitiveness Initiative (VNCI) based on a mailing survey for domestic private enterprises and foreign owned enterprises in all cities and provinces nationwide.[36] The respondents are randomly selected based on the list of tax paid enterprises to ensure reliability of the sample.

The purpose of the PCI is to explain the differences in economic governance at the provincial level, especially differences in regulatory environment and policies that influence the performance of the private sector and foreign sector, and what the local government can do to improve the business environment for the private enterprises. In order to compare the PCI among provinces equally, all factors relating to provincial endowment, i.e. infrastructure, labor force, location advantage, are eliminated. The PCI is the weighted sum of sub-indices that are designed to evaluate the provincial regulatory environment and policies. Each sub-indices is aggregated from individual indicators, and an index is marked from 1 to 10, being consonant with better evaluation. These indicators are adjusted over time to reflect the reforms and challenges in the economy. In this study, the PCI and PCI sub-indices are used as the proxy for business environment to reveal sources of efficiency (Chapter 6). These indices are introduced in Table 4A-3 and 4A-4.

## 4.2. Data Mining

From the original data, some criteria are applied to obtain the appropriate data as the inputs for efficiency measurement models: firstly, firms in the manufacturing industry with full information of value added, value of fixed assets, depreciation, labor, compensation, age, types of ownership and regions; secondly, firms with at least 1 year in performance; thirdly, firms with positive gross output, total cost, total fixed assets; and fourthly, firms in micro scale are dropped to avoid imprecision.[37] Lastly, a balanced panel dataset was

[36] Since 2007, the survey's scope has covered all of 64 provinces and cities compared to 42 provinces and cities in 2006. The FIEs surveys was started in 2011 (data in 2010).
[37] Companies with less than 10 workers are seen as household businesses, which may not follow accounting standards, leading to the distortion in the accounting data (Article 49, Decree 43/2010/ND-CP on Enterprise Registration dated April 15, 2010).

generated to ensure consistency of the results over time. In particular, unexpected effects of firm entry or exit are mitigated in balanced panel data.

Only enterprises belonging to the manufacturing industry have been chosen. That means firms in the range C10-C33 in VSIC 2007 are employed. [38] The sectors are classified into 14 sector groups (Table 4A-1).

With respect to scale, there are four levels of scale including micro, small, medium and large. The classification is based on Decree no. 56/2009/ND-CP on June 30, 2009 where enterprise size is discriminated by sectors based on the number of workers or capital, and the classification varies by industry.[39] In this study, number of laborers is used to classify firm size. In terms of ownership, enterprises are arranged in three types of ownership, namely State Owned Enterprises (SOEs), Domestic Private Enterprises (DPEs) and Foreign Invest Enterprises (FIEs). The details are shown in Table 4A-2.

### 4.3. Description of Variables

#### 4.3.1. Variables for Measuring Efficiency and Productivity Performance

Balanced panel data consisting of 5034 observations is employed to measure efficiency and productivity performance of manufacturing enterprises. Gross output is used as output, and labor, capital and materials are inputs. Moreover, input price data, i.e. labor price, capital price and material price are needed for measuring cost efficiency and the cost Malmquist productivity index. These variables are explained below.

##### *4.3.1.1. Output*

*Gross output (GO):* Total revenue at the end of year acts as a proxy for gross output. The real total revenue is obtained by deflating the Production Price Index (PPI, base year 2000) for each sector.

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[38] VSIC 2007 enacted at the Decision 10/2007/ND-CP dated 23 January 2007 and issued in detail at the Decision 37/2007/QD-BKH on 10 Oct 2007 to replace VSIC 1993, was built on International Standard Industrial Classification Revision 4 (ISIC Rev.4) of the United Nation Statistics Division.

[39] Three primary industries are mentioned in the decree, i.e. agriculture, forestry and fishery; industry and construction; and trade and services. The first two industries share the same definition of firm size. Particularly, by number of employees, a firm size is micro, small, or medium if its employees are in the range of [1-10], [11-200], [201-300] persons, respectively. By the volume of capital, a firm is considered as small or medium scale if its capital ranges from (0-20], (20-100] billions VND. The decree does not set the volume of capital for micro enterprises.

*Production cost (COST):* The total cost of production is equal to gross output minus value added and it is also the sum of labor cost, capital cost and material and energy cost.[40] The nominal production cost is deflated by the Production Price Index (PPI, base year 2000) for each sector.

#### *4.3.1.2. Input quantity*

*Labor (L):* Quantity of labor is proxy by the number of working employees at the end of the year.

*Capital (K):* The total value of fixed assets is used as a proxy for capital stock and it is deflated by the PPI of machinery and equipment (base year 2000).

*Materials and energy (M)*: Materials and energy is equal to material and energy cost divided by material and energy price. Material and energy cost is equal to total cost minus labor cost and capital cost. Labor cost is the product of labor and labor price, and capital cost is the product of capital and capital price.

#### *4.3.1.3. Input price*

*Price of labor (pL):* Price of labor is the quotient of labor cost over the number of employees. Labor cost encompasses (i) wages, salaries, bonus; (ii) social security contributed to employees; and (iii) contributions to insurance and pension, health, trade-union. Labor cost is deflated by the Consumer Price Index (CPI, base year 2000).

*Price of capital (pK):* The price of capital equals the cost of capital divided by capital stock. The cost of capital or capital services includes depreciation and interest expenses (Coelli et al., 2003, p.113; Newman et al., 2009; Doan, 2012). Hence, the capital service of a given year equals depreciation plus interest expenses in that year. Depreciation in one year is equal to accumulated depreciation at the end of year distracting that at the beginning of year. Meanwhile, an interest expense is the product of capital stock and interest rate. Following Newman et al. (2009), the lending interest rate is employed for measuring interest payment. The annual lending interest rate is available from the World

[40] Value added is the sum of profit before taxes, labor compensation, and depreciation.

Bank database (WDI) and converted to the base year 2000.[41] With the preferential treatment of SOEs, i.e. SOEs can access bank loans more easily at a preferred interest rate (Odano & Nguyen, 2009), the author assumes that, on average, SOEs receive half of the lending interest rate compared to the full interest rate DPEs and FIEs receive.[42] The cost of capital is deflated by the PPI of machinery and equipment (base year 2000).

*Price of materials and energy (pM):* The material and energy price is not available and is calculated based on the PPI for all sectors and coefficients extracted from the Input-Output Table (Tripathy, 2006).

$$pM_j = \sum p_j \frac{a_{jk}}{\sum a_{jk}} \tag{4.1}$$

where $pM_j$ is the material and energy price of sector j, $p_j$ is the production price index (PPI) of sector *j*; $a_{jk}$ is input-output coefficient for input *k* in the *j-th* sector. The latest Input-Output Table in 2007 was employed to calculate $a_{jk}$.

Following these calculations, input prices vary by firm, meaning that enterprises do not bear the same prices of inputs. Hence, the New-Tech model for measuring technical efficiency and the New-Cost model for measuring cost efficiency introduced in Chapter 3 are suitable. The two models are applied for pooled data and individual groups to define the metafrontier and group frontiers.

### 4.3.2. Variables for Determining Sources of Efficiency Performance

#### *4.3.2.1. Dependent Variables*

Dependent variables embody efficiency measures, i.e. technical efficiency, allocative efficiency and cost efficiency. For the whole sample, the efficiency measures are determined from the metafrontier and called metafrontier technical efficiency (TE), metafrontier allocative efficiency (AE), and metafrontier cost efficiency (CE). For specific groups, dependent variables are group-specific efficiencies.

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[41] The lending rate used here is the short- and medium-term bank rate for the private sector.

[42] It is well known that SOEs enjoy cheaper credit but their lending rates are unknown. Several lending rates for SOEs are tested: 0%, 30%, 50%, 70% and 100% of the market rate but the results are similar. So the rate 50% is chosen here.

#### *4.3.2.2. Independent Variables*

Potential sources of efficiency can be divided into some groups, i.e. firm-specific factors, finance, concentration degree, FDI spillovers and business environment, and they are introduced in following sections.

*(i) Firm characteristics*

**Firm age:** Firm age is recognized as a potential factor that influences firm performance following the learning-by-doing theory. Referring to the number of years in operation of a firm, firm age equals the considered year minus the year that the firm was established.

**Firm size:** Firm scale measured by number of employees is classified into two groups: small and medium enterprises (SMEs) and large enterprises (LEs). The dummy variable *LE* is used as a proxy for firm size. If a firm is a large one, *LE* equals unity and zero otherwise.

**Ownership types:** As an enterprise in Vietnam belongs to one of three types of ownership, i.e. SOEs, DPEs, and FIEs, two dummy variables are introduced as the proxy for types of ownership. *DPE* refers to domestic private enterprises and equals one if a firm is *DPE* and zero otherwise. FIE refers to foreign invested enterprises and equals one if a firm is *FIE* and zero otherwise. The reference group is *SOE*.

**Firm location:** The variable for firm location is to examine the advantages of urban/ municipality area. The dummy variable *Urban* exhibits urban location if it equals one and zero otherwise.

**Capital to labor ratio:** Ratio of capital to labor represents the capital intensity level of a firm. Capital is proxied by the total value of fixed assets and deflated by PPI of machinery and equipment (base year 2000). Quantity of labor is the number of working employees at the end of a year.

**Human capital:** The two variables that represent human capital of manufacturing firms in Vietnam are (i) the share of employees with vocational certificates,[43] and (ii) the share of employees with undergraduate or graduate certificates in total employees.

*(ii) Finance leverage*

The financial leverage of a firm is determined by the ratio of total debt to total assets representing how firms can finance their operation by external funds.

*(iii) Market concentration/competition degree*

Market concentration is exhibited by the Herfindahl-Hirschman Index, or Herfindah Index, defined by the total of squared share of each firm in the market or in the industry. A higher value of the Herfindahl index means the higher monopoly a market or an industry has. A lower value of the Herfindahl index implies higher competitiveness and it may induce enterprises' incentive to perform better.

*(iv) FDI spillovers*

The FDI spillovers consist of horizontal effects and vertical effects. Horizontal effects capture FDI spillovers within an industry, while vertical effects capture FDI spillovers across industries in the suppliers-clients relationship. The vertical effects include forward linkage (upstream effects-MNCs' affiliates are suppliers) and backward linkage (downstream effects-MNCs' affiliates are customers).

**Horizontal effects:** The horizontal effect of an industry can be measured by the share of output of foreign firms in the industry to total output of the industry (*HZ_GO)*.

$$HZ\_GO_j = \frac{\sum_i GO_{ij}}{GO_j} \qquad (4.2)$$

where: $\sum_i GO_{ij}$ = Total gross output of foreign invested firm $i$ of sector $j$; $GO_j$ = Gross output of sector $j$.

[43] Vocational certificates include certificates obtained from lower vocational, upper vocational training programs or colleges and vocational colleges.

Apart from using output, number of employees is used to measure *HZ_L* as the proportion of number of employees in foreign firms in sector *j* to total number of employees in sector *j*, following Nguyen, Simpson, Saal, Nguyen, & Pham (2008) and Le & Pomfret (2011).

$$HZ\_L_j=\frac{\sum_i L_{ij}}{L_j} \tag{4.3}$$

where: $\sum_i L_{ij}$ = Total employees of foreign invested firm *i* of sector *j*; $L_j$ = Number of employees of sector *j*.

The separation of horizontal effect by output and by number of laborers is to capture specific effects. Particularly, *HZ_GO* captures the demonstration effect and the competition effect, while *HZ_L* captures the labor movement effect.

**Vertical effects:** Vertical effects consider the relationship between MNCs affiliates and local firms in different industries consisting of forward linkage and backward linkage. The measurements of forward linkage and backward linkage follow Merlevede and Schoors (2007).

In order to calculate backward linkage and forward linkage, the share of foreign firms' output to total sector's output and the coefficients obtained from the Input-Output table 2007 are utilized.

Forward linkage

$$FW_{jt} = \sum_{h \neq j} b_{jht} HZ\_GO_{kt} \tag{4.4}$$

Backward linkage

$$BW_{jt} = \sum_{k \neq j} a_{kjt} HZ\_GO_{kt} \tag{4.5}$$

where $b_{jht}$ represents the proportion of sector h's input provided by sector j at time t, and $a_{jkt}$ represents the proportion of sector k's output supplied to sector j at time t.

*(v) Provincial Competitiveness Index (PCI)*

The PCI was first implemented in 2005 in order to explain the differences across provinces in the dynamism of the private sector, economic growth and employment generation. In particular, the index reveals the differences in economic governance quality at provincial level instead of considering provincial initial endowments, i.e. infrastructure, human capital, location advantages. The PCI is calculated from sub-indices with each index marked from 1 to 10. A higher score means better regulatory and institutional implementation. Since minor adjustments have been made to the PCI every year to reflect changes of the economic situation, nine common sub-indices in three years, 2008, 2010 and 2012 were selected. They are represented as follows.[44]

**Market Entry Costs:** Recently, some policies have been issued to simplify administrative procedures in general and for the business sector. For instance, in an attempt at administrative reform, the one-stop shop procedures were designed and carried out. Nevertheless, the implementation of these policies varies by province. Hence, this indicator is to measure possible costs to start-up a business including the time needed for a business to register and re-register, for acquiring a Land Use Rights Certificate (LURC), number of licenses or permits needed for running a business, and the degree of difficulty in getting these documents and starting operation.

**Land Access and Security of Tenure** reflects two issues: access to land and land usage stability. Access to land measures the difficulties to access land and LURC that affects business operation and credit access of enterprises. Having no owned land prevents a firm from having a long-term investment, while having no LURC limits its credit access since LURCs are the most popular collateral for bank loans. Land usage stability evaluates the stability in land usage for land with LURC. Although, an enterprise with an LURC might face expropriation risks and compensation for land might not follow market prices, which is a threat to its long-term investment.

**Transparency and Access to Information** illustrates firms' access to proper planning and legal documents necessary for doing business, evaluates equality of access those documents. Lackluster information precludes firms from being aware of and implementing regulations as well as maximizing business opportunities or support. This indicator consists of four components: Access, Equity of information, Predictability and

[44] See Malesky et al. (2007, 2009, 2012) for more detail. The PCI's sub-indices and component indicators are in Table 4A-3 and Table 4A-4 in the Appendix.

Openness. The Access component evaluates the awareness and access of (i) planning documents and (ii) laws and regulations. The second component, Equity of information, evaluates the equality of information access by asking the importance of relationship with local government staffs to have the information. This component, moreover, assesses the consistency of tax rules implementation. The third component, Predictability, captures how predictable the implementation of central rules, laws, and regulations is. The last component, Openness, is to evaluate the availability of business information.

**Time Costs of Regulatory Compliance** measures the time spent meeting bureaucratic regulations and the frequency of inspections of enterprises in operation. Furthermore, since 2009, some indicators were added for enterprises' evaluation on effectiveness of government officials, paperwork and fee reductions.

**Informal Charges** evaluates the frequency, types and amount of extra payments. Informal charges include bribes requested from provincial authorities, extra payments to ease the regulatory compliance, commissions on government contracts and bribes during registration.

**Proactivity** measures the creativity and activeness of provincial officials in interpreting and implementing national laws to extricate difficulties for private firms as well as their attitude toward the private sector perceived by firms.

**Business Support Services:** The index *Business Support Services* was developed since 2009 based on the index Private Sector Development used from 2005-2008 with new added indicators. Thus, under the name *Business Support Services,* the data in 2007 is the Private Sector Development index. The Private Sector Development index concentrates on the quality of the services provided by provincial agencies, i.e. market information, matchmaking business partners, export promotion and trade fairs, Industrial zones and SME concentration, technology. Over time, private agencies have appeared as better providers of these services than provincial agencies. Hence, in the *Business Support Services* these indicators were removed. The new index evaluates the quality of business support services (business information search services, consulting on regulatory information, business match-making, trade promotion, technology information and training) through the usage, share of private participation in the services, and the ability to reuse the services.

**Labor Policy** assesses provincial efforts in provision of general education and vocational training, number of these schools, firms' participation in labor exchange services and expenses on labor training and labor.

**Legal Institutions** evaluates firm confidence on the supporting role of provincial legal institutions, corruption appeals, courts and their costs.

It is believed that a better business environment improves enterprise performance. Hence, business environment variables, i.e. PCI and PCI sub-indices, are expected to positively associate with firm efficiency performance.

*(vi). Control variables*

Two groups of variables are used as control variables, including time dummy and sectoral dummy.

**Time dummy**: Among the three years, i.e. 2007, 2009, 2011, year 2007 is selected to be the base year. Time dummy variables, *Y09* and *Y11,* which refer to years 2009, 2011, respectively, introduce the change of efficiency measurements over time.

**Sectoral dummy**: There are 13 sectoral dummy variables among 14 sectors. The list of these sectors is in Table 4A-1. Sector Manufacture of Basic Metals (BM) is the base sector.

Since the PCI and PCI sub-indices are classified by province, they themselves can be control variables of location by province. Thus, dummy variables for provincial location are not necessary. Table 4-1 below represents the list of dependent variables and explanatory variables using in regression.

**Table 4-1. Variables for Investigating Sources of Efficiency**

| Variables | Description | Expected sign |
|---|---|---|
| **Dependent variables** | | |
| TE | Technical efficiency | |
| AE | Allocative efficiency | |
| CE | Cost efficiency (or overall efficiency) | |
| **Independent variables** | | |
| ***Firm characteristics*** | | |
| *Age (lnAge)* | The number of operation years up to the survey (the logarithm form of Age) | +/- |
| *LE* | Dummy variable for large-scale enterprises (Reference group: SMEs) | + |
| *DPE* | Dummy variable for Domestic Private Enterprises (Reference group: SOEs) | + |
| *FIE* | Dummy variable for Foreign Invested Enterprises (Reference group: SOEs) | + |
| *Urban* | Dummy variable for urban areas (Reference group: Rural areas) | + |
| *lnCAPIN* | Capital to labor ratio (logarithm form) (Nominal capital value is deflated by PPI of machinery and equipment, base year 2000) | + |
| *Vocatn* | Percentage of employees with vocational certificates | + |
| *Univpost* | Percentage of employees with undergraduate and graduate degrees among total employees | + |
| ***Financial constraint*** | | |
| *Leverage* | Financial leverage equals total debt divided by total asset | +/- |
| ***Competition degree*** | | |
| *HHI* | Herfindahl index captures competition (or concentration) degree of each industry | - |
| ***FDI spillovers*** | | |
| *HZ_GO* | Horizontal effect calculated by output | + |
| *HZ_L* | Horizontal effect calculated by labor. | + |
| *FW* | Forward linkage | + |
| *BW* | Backward linkage | + |
| ***Business environment*** | | |
| *PCI* | Provincial Competiveness Index | + |
| *Entrycost* | Market Entry Costs | + |
| *Land* | Land Access and Tenure Security | + |
| *Transprn* | Transparency and Access to Information | + |
| *Timecost* | Time Costs of Regulatory Compliance | + |
| *Informal* | Informal Charges | + |
| *Proact* | Proactivity of Provincial Leadership | + |
| *Support* | Business Support Services | + |
| *Laborpolicy* | Labor Policies | + |
| *Institution* | Legal Institutions | + |

Source: Author's calculation

### 4.4. Data Description

#### 4.4.1. Variables for Measuring Efficiency and Productivity Performance

The balanced panel data consist of 5034 observations in three years 2008, 2010 and 2012, 1678 observations for each year. On average, each manufacturing firm employees 169 employees, VND20.369 billion of capital, VND17.270 billion of materials and energy and generates VND47.661 billion of gross output. The average number of worker per enterprise is less than 200, indicating that most firms are small-sized. Table 4-2 shows that manufacturing enterprises, over time, seem smaller in size with respect to average number of laborers. For instance, the average number of employees working in a firm in 2007 was 173 persons, followed by 170 and 167 persons in 2009 and 2011, respectively. The decreasing trend of labor, capital stock and materials and energy over time exhibit weakened manufacturing production and partly reflect the impacts of the global crisis and Vietnamese economic recession on enterprise performance. The increasing tendency of labor price and materials and energy price may relate to increasing the minimum salary continuously since 2008, and the sky-rocketing of the industrial input price index from the beginning of 2009.[45]

In terms of ownership types and scales, FIEs predominate in number of firms inside the large enterprise group (56.45%), while DPEs accounted for over two third in the SME group (Table 4-3). Totally, there are only 87 SOEs, making up 1.72% of total enterprises in this sample.

[45] Data of industrial input price index can be found at http://www.indexmundi.com/commodities/?commodity=industrial-inputs-price-index&months=120 (Source: International Monetary Fund).

**Table 4-2. Summary of Variables**

| | | N | Mean | S.D. | Min | Max |
|---|---|---|---|---|---|---|
| **2007** | GO (million VND) | 1678 | 48507.89 | 97732.93 | 222.88 | 1284425.90 |
| | COST (million VND) | | 41296.60 | 85970.03 | 130.76 | 1198474.76 |
| | L (persons) | | 172.53 | 264.86 | 11.00 | 2068.00 |
| | K (million VND) | | 20809.34 | 45830.93 | 21.85 | 624419.85 |
| | M (million VND) | | 24212.24 | 55841.90 | 27.35 | 853923.72 |
| | pL (million VND/person) | | 15.91 | 8.98 | 1.93 | 69.48 |
| | pK | | 0.19 | 0.04 | 0.10 | 0.38 |
| | pM | | 1.48 | 0.14 | 1.26 | 1.82 |
| **2009** | GO (million VND) | 1678 | 42447.40 | 86405.58 | 245.98 | 1157805.63 |
| | COST (million VND) | | 35239.17 | 72845.53 | 168.80 | 984686.81 |
| | L (persons) | | 166.93 | 248.89 | 11.00 | 1893.00 |
| | K (million VND) | | 20480.75 | 44756.64 | 29.41 | 600856.16 |
| | M (million VND) | | 14114.26 | 33217.45 | 12.98 | 470732.98 |
| | pL (million VND/person) | | 17.39 | 8.88 | 2.78 | 76.33 |
| | pK | | 0.18 | 0.04 | 0.08 | 0.39 |
| | pM | | 2.17 | 0.30 | 1.62 | 2.69 |
| **2011** | GO (million VND) | 1678 | 52027.99 | 101660.69 | 327.63 | 1009644.24 |
| | COST (million VND) | | 44298.49 | 87872.04 | 228.81 | 934531.36 |
| | L (persons) | | 166.48 | 252.50 | 11.00 | 2089.00 |
| | K (million VND) | | 19818.14 | 43474.35 | 26.19 | 528048.80 |
| | M (million VND) | | 13484.22 | 30469.52 | 14.59 | 307993.29 |
| | pL (million VND/person) | | 19.89 | 10.01 | 2.71 | 73.92 |
| | pK | | 0.24 | 0.04 | 0.10 | 0.56 |
| | pM | | 2.89 | 0.44 | 1.96 | 3.72 |
| **Pooled** | GO (million VND) | 5054 | 47661.10 | 95548.69 | 222.88 | 1284425.90 |
| | COST (million VND) | | 40278.09 | 82569.77 | 130.76 | 1198474.76 |
| | L (persons) | | 168.65 | 255.47 | 11.00 | 2089.00 |
| | K (million VND) | | 20369.41 | 44690.71 | 21.85 | 624419.85 |
| | M (million VND) | | 17270.24 | 41715.55 | 12.98 | 853923.72 |
| | pL (million VND/person) | | 17.73 | 9.45 | 1.93 | 76.33 |
| | pK | | 0.20 | 0.05 | 0.08 | 0.56 |
| | pM | | 2.18 | 0.66 | 1.26 | 3.72 |

Source: Author's calculations

**Table 4-3.Variables by Size and Ownership**

| | | N (% of N) | GO | L | K | M | pL | pK | pM |
|---|---|---|---|---|---|---|---|---|---|
| SOE | Mean | 39 | 214511.5 | 663.4 | 66879.2 | 82165.0 | 29.45 | 0.154 | 2.012 |
| | S.D. | (5.24%) | 156694.9 | 382.3 | 57833.2 | 90999.1 | 8.96 | 0.037 | 0.597 |
| DPE | Mean | 285 | 127695.6 | 628.2 | 48139.9 | 43838.5 | 19.99 | 0.198 | 2.163 |
| | S.D. | (38.31%) | 126038.5 | 298.3 | 59457.0 | 65458.5 | 10.69 | 0.043 | 0.657 |
| FIE | Mean | 420 | 195435.1 | 711.0 | 95933.7 | 68060.6 | 21.30 | 0.204 | 2.063 |
| | S.D. | (56.45%) | 193308.0 | 354.7 | 97758.2 | 88703.7 | 8.25 | 0.041 | 0.592 |
| **LE** | **Mean** | **744** | **170486.5** | **676.8** | **76102.5** | **59521.3** | **21.23** | **0.199** | **2.099** |
| | **S.D.** | **(100%)** | **171920.6** | **337.7** | **86245.6** | **81614.9** | **9.50** | **0.043** | **0.619** |
| SOE | Mean | 48 | 35172.7 | 158.5 | 14889.2 | 12349.7 | 22.50 | 0.141 | 2.110 |
| | S.D. | (1.12%) | 26953.9 | 70.8 | 14237.4 | 13544.4 | 6.40 | 0.052 | 0.623 |
| DPE | Mean | 3156 | 18625.8 | 71.1 | 6247.7 | 7283.6 | 14.83 | 0.206 | 2.225 |
| | S.D. | (73.57%) | 36453.1 | 60.5 | 11232.2 | 17396.2 | 7.65 | 0.052 | 0.676 |
| FIE | Mean | 1086 | 48446.3 | 104.5 | 23468.6 | 17564.2 | 23.54 | 0.209 | 2.111 |
| | S.D. | (25.31%) | 73547.1 | 70.4 | 32778.1 | 33279.6 | 10.60 | 0.042 | 0.620 |
| **SME** | **Mean** | **4290** | **26359.9** | **80.5** | **10703.8** | **9942.8** | **17.12** | **0.206** | **2.195** |
| | **S.D.** | **(100%)** | **50221.8** | **65.4** | **20564.2** | **22907.9** | **9.31** | **0.050** | **0.663** |
| SOE | Mean | 87 | 115566.0 | 384.8 | 38195.1 | 43646.2 | 25.62 | 0.147 | 2.066 |
| | S.D. | (1.73%) | 138900.0 | 362.0 | 47591.4 | 70560.3 | 8.36 | 0.046 | 0.610 |
| DPE | Mean | 3441 | 27659.5 | 117.2 | 9717.4 | 10311.2 | 15.26 | 0.205 | 2.220 |
| | S.D. | (68.36%) | 58602.0 | 185.2 | 23257.6 | 27071.0 | 8.07 | 0.051 | 0.674 |
| FIE | Mean | 1506 | 89439.2 | 273.6 | 43678.0 | 31646.9 | 22.92 | 0.207 | 2.097 |
| | S.D. | (29.92%) | 136568.8 | 335.6 | 67022.1 | 59179.2 | 10.05 | 0.042 | 0.613 |
| **Pooled** | **Mean** | **5034** | **47661.1** | **168.6** | **20369.4** | **17270.2** | **17.73** | **0.205** | **2.181** |
| | **S.D.** | **(100%)** | **95548.7** | **255.5** | **44690.7** | **41715.6** | **9.45** | **0.049** | **0.658** |

Source: Author's calculations

### 4.4.2. Variables for Determining Sources of Efficiency Performance

Table 4-4 represents the statistical description of data used for determining sources of efficiency of manufacturing firms in Vietnam. Dependent variables are technical efficiency, allocative efficiency and cost efficiency. The mean technical efficiency is 58.0%, while the average allocative efficiency is 69.9%. The overall efficiency is only 38.9%.

**Table 4-4. Statistical Description of Manufacturing Firms**

| Variable | Unit | Pooled | | LEs | | SMEs | | DPEs | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | S.D. | Mean | S.D. | Mean | S.D | Mean | S.D |
| ***Dependent variable*** | | | | | | | | | |
| CE | | 0.389 | 0.084 | 0.506 | 0.116 | 0.398 | 0.153 | 0.488 | 0.094 |
| TE | | 0.580 | 0.150 | 0.714 | 0.139 | 0.592 | 0.950 | 0.663 | 0.132 |
| AE | | 0.699 | 0.161 | 0.721 | 0.142 | 0.712 | 0.197 | 0.754 | 0.141 |
| ***Independent variables*** | | | | | | | | | |
| Age | Year | 7.54 | 5.74 | 9.956 | 7.867 | 7.12 | 5.19 | 7.24 | 5.53 |
| LEs | Dummy | 0.15 | 0.35 | 1.00 | 0.00 | 0.00 | 0.00 | 0.08 | 0.28 |
| DPE | Dummy | 0.68 | 0.47 | 0.38 | 0.49 | 0.74 | 0.44 | | |
| FIE | Dummy | 0.30 | 0.46 | 0.56 | 0.50 | 0.25 | 0.43 | | |
| Urban | Dummy | 0.55 | 0.50 | 0.54 | 0.50 | 0.55 | 0.50 | 0.51 | 0.50 |
| lnCAPIN | Natural logarithm | 4.19 | 1.15 | 4.32 | 1.01 | 4.16 | 1.18 | 3.88 | 1.09 |
| Vocatn | % | 37.43 | 35.61 | 37.23 | 38.61 | 0.51 | 0.26 | 38.05 | 35.19 |
| Univpost | % | 9.15 | 10.72 | 7.02 | 9.44 | 37.46 | 35.07 | 8.90 | 10.53 |
| Leverage | Ratio | 0.515 | 0.257 | 0.545 | 0.227 | 9.524 | 10.883 | 0.532 | 0.265 |
| HHI | Ratio | 0.029 | 0.036 | 0.027 | 0.033 | 0.029 | 0.037 | 0.028 | 0.037 |
| HZ_GO | Ratio | 0.402 | 0.156 | 0.461 | 0.151 | 0.392 | 0.154 | 0.375 | 0.143 |
| HZ_L | Ratio | 0.331 | 0.183 | 0.404 | 0.183 | 0.318 | 0.180 | 0.299 | 0.173 |
| FW | Ratio | 0.141 | 0.138 | 0.099 | 0.133 | 0.148 | 0.137 | 0.136 | 0.134 |
| BW | Ratio | 0.593 | 0.717 | 0.418 | 0.637 | 0.623 | 0.726 | 0.589 | 0.717 |
| PCI | Point | 63.12 | 6.64 | 64.45 | 6.31 | 62.88 | 6.67 | 62.13 | 6.42 |
| Entrycost | Point | 8.12 | 0.62 | 8.10 | 0.57 | 8.12 | 0.63 | 8.11 | 0.66 |
| Land | Point | 6.24 | 0.92 | 6.29 | 0.92 | 6.24 | 0.92 | 6.19 | 0.92 |
| Transprn | Point | 6.46 | 0.69 | 6.57 | 0.67 | 6.44 | 0.69 | 6.38 | 0.69 |
| Timecost | Point | 6.72 | 0.81 | 6.80 | 0.76 | 6.71 | 0.82 | 6.66 | 0.82 |
| Informal | Point | 6.57 | 0.92 | 6.66 | 0.89 | 6.55 | 0.93 | 6.47 | 0.93 |
| Proact | Point | 5.54 | 1.91 | 5.81 | 1.93 | 5.49 | 1.91 | 5.29 | 1.82 |
| Support | Point | 5.98 | 1.78 | 6.22 | 1.75 | 5.94 | 1.78 | 5.92 | 1.81 |
| Laborpolicy | Point | 5.77 | 0.97 | 5.94 | 0.94 | 5.74 | 0.98 | 5.65 | 0.95 |
| Institution | Point | 5.28 | 0.97 | 5.34 | 0.94 | 5.27 | 0.97 | 5.21 | 0.99 |
| **N** | | **5034** | | **744** | | **4290** | | **3441** | |

Source: Author's calculation

The large share of enterprises is small and medium, and only 14.9% of total enterprises is large firms. The majority of firms are DPEs, which account for 68.2% of total firms, followed by FIEs with a share of 30%. Most firms established during the booming period of private enterprises since 2000. Hence, the average year in operation is only 7.5 years. More than half of the enterprises are located in urban areas. Human capital of manufacturing firms is at a low skill level: only 37.4% of employees have vocational certificates and 9.15% has undergraduate or graduate degrees, implying that more than half of labor in manufacturing firms has never had a training program or been in a training program without a certificate. The leverage ratio (0.515) implies that half of total assets of manufacturing firms originate from external sources. The average Herfindahl-Hirschman index of manufacturing firms in Vietnam is 0.029, meaning that the manufacturing industry of Vietnam is unconcentrated, according to the US Horizontal Merge Guidelines.[46]

The PCI is adjusted time by time to keep trace with macroeconomic change, particularly, the PCI 2009 deserved some changes compared to prior PCI, and the PCI 2011 is the same with PCI 2009.[47] Because of these adjustments, it is not appropriate to compare PCI sub-indices. However, the lessons which can be learnt is narrowed gap between minimum and maximum values and lower variation of the PCI. The narrowing gap showing improvement of bottom-ranked provinces due to their efforts and successes in easy reformed fields that do not require institutional changes (Malesky et al., 2012).[48] It does not mean lesser efforts were made by top-ranked provinces, which marked the same significant improvements in previous years, but it implies that high-ranked provinces now cope with harder reformed fields, which needs to change institutions. These reforms are hard and time consuming. Moreover, mean and median value of PCI observed reductions.

[46] The three concentration degrees classified are: unconcentrated (HHI < 0.10), moderately concentrated (0.10 < HHI < 0.18), and highly concentrated (HHI > 0.18 and ΔHHI > 0.005).
47 For example, weights are changed and some new indicators are added every year. In the PCI 2009, the index SOEs bias was excluded.
48 To test the “catching-up effect” of low-ranked provinces, the authors regressed the annual change in the weighted PCI on the lagged value of PCI. The coefficient is called Convergence Coefficient. The negative convergence coefficient indicates that lower-ranked provinces obtained larger improvement in governance than higher-ranked provinces did. The convergence coefficient from 2007 to 2011 are -0.131, -0.145, -0.339, -0.391, -.0428, respectively. The higher magnitude of the coefficient over time suggests a larger improvement pace of lower-ranking provinces in governance (Malesky et al., 2012).

## Appendix of Chapter 4

**Table 4A-1. Sector Classification**

| No. | Notation | Sectors | VSIC 1993 | VSIC 2007 | Technology level |
|---|---|---|---|---|---|
| 1 | FBT | Food processing, Beverages , Tobacco Products | D15, D16 | C10, C11, C12 | Low |
| 2 | GT | Garment and Textiles | D17, D181 | C13, C14 | |
| 3 | FWL | Footwear, leather and related products | D182, D19 | C15 | |
| 4 | WP | Wood and wood-made products | D20 | C16 | |
| 5 | PP | Paper and paper products; Printing and publishing products | D21, D22 | C17, C18 | |
| 6 | CP | Chemicals and chemical products | D23, D24 | C19, C20, C21 | High |
| 7 | RP | Rubber and plastic products | D25 | C22 | Medium |
| 8 | NM | Manufacture of Other Non-metallic Mineral Products | D26 | C23 | |
| 9 | BM | Manufacture of Basic Metals | D27 | C24 | |
| 10 | FM | Manufacture of fabricated metals | D28 | C25 | |
| 11 | ME | Machinery And Equipment | D29, D33 | C28, C32, C33 | High |
| 12 | EE | Electrical and Electronics Equipments | D30, D31, D32 | C26, C27 | |
| 13 | TE | Transport Equipment | D34, D35 | C29, C30 | Medium |
| 14 | FN | Furniture | D36 | C31 | Low |

Source: Author’s classification

**Table 4A-2. Enterprises Classification**

| | | Classification standards |
|---|---|---|
| **Scale** | Small | Number of employees ∈ [11,200] |
| | Medium | Number of employees ∈ [201,300] |
| | Large | Number of employees ≥ 301 |
| **Ownership** | SOEs<br>(State Owned Enterprises) | (1) State owned enterprises at central and local level<br>(2) State limited liability companies at central and local level<br>(3) Joint stock companies or limited liability companies with more than 50% state owned capital |
| | DPEs<br>(Domestic Private Enterprises) | (1) Private enterprises<br>(2) Partnership enterprises<br>(3) Limited liability companies with less than 50% of state owned capital<br>(4) Shareholding companies without state owned capital<br>(5) Shareholding companies with less than 50% of state owned capital |
| | FIEs<br>(Foreign Invested Enterprises) | (1) 100% foreign owned enterprises<br>(2) Joint venture companies. |

Source: Author's classification

**Table 4A-3. Sub-indices of the Provincial Competitiveness Index (PCI)**

| | 2007 | 2009 | 2011 |
|---|---|---|---|
| 1 | Entry Costs | Entry Costs | Entry Costs |
| 2 | Land Access and Security of Tenure | Land Access and Security of Tenure | Land Access and Security of Tenure |
| 3 | Transparency and Access to Information | Transparency | Transparency |
| 4 | Time Costs and Regulatory Compliance | Time Costs and Regulatory Compliance | Time Costs |
| 5 | Informal Charges | Informal Charges | Informal Charges |
| 6 | SOE Bias (Competition environment) | | |
| 7 | Proactivity of Provincial Leadership | Proactivity | Proactivity |
| 8 | Private Sector Development Services | Business Support Services | Business Support Services |
| 9 | Labor and Training | Labor Policy | Labor policy |
| 10 | Legal Institutions | Legal Institutions | Legal institutions |

Source: VCCI and VNCI

**Table 4A-4. Indicators of the Provincial Competitiveness Index (PCI)**

| | Sub-indices | 2007 | 2009 | 2011 |
|---|---|---|---|---|
| 1 | **Entry Costs** | | | |
| | Length of business registration in days | o | o | o |
| | Length of business registration in days | o | o | o |
| | Firms requiring additional documentation (%) | | | • |
| | Number of licenses and permits necessary to start operations (Median). If any additional documents were required (after 2010). | o | o | o |
| | Wait for Land Use Rights Certificate (LURC) | o | o | o |
| | Percentage of firms waiting more than a month to complete all steps necessary to start operations (%) | o | o | o |
| | Percentage of firms waiting more than three months to complete all steps necessary to start operations (%) | o | o | o |
| | Percentage of firms having difficulty obtaining all licenses and permits necessary to do business | o | | |
| 2 | **Land Access and Security of Tenure** | | | |
| | Percentage of firms in possession of an LURC (%) | o | o | o |
| | Total land in province with official LURCs (%) | o | o | o |
| | Firm rating of expropriation risk (1: Very High to 5: Very Low) | o | o | o |
| | If land expropriated, firms receive fair compensation (% Always or Usually) | o | o | o |
| | Changes in government land prices reflect changes in market prices (% Agree). | | • | • |
| | Firm checked no land problems list of possible problems | | • | • |
| | Firm rating of changes in lease contracts. (1: Very High to 5: Very Low) | o | | |
| | Percentage of firms that feel land availability constrains their business expansion | o | | |
| | Percentage of firms rating provincial land conversion policies as good or very good. | o | | |
| | If changes in leases contracts, is there a fair process for disputing them (% Always or Usually) | o | | |
| 3 | **Transparency and Access to Information** | | | |
| | Transparency of planning documents. | o | o | o |
| | Transparency of legal decisions and decrees | o | o | o |
| | Relationship necessary to get access to provincial documents (% | o | o | o |

| | | | | |
|---|---|---|---|---|
| | Important or Very Important) | | | |
| | Negotiations with tax authority are an essential part of doing business (% Agree or Strongly Agree) | o | o | o |
| | Predictability of implementation of central laws at the provincial level (% Usually or Always) | o | o | o |
| | Openness of provincial webpage score | o | o | o |
| | Firm gives comments on government regulation (%) | | • | • |
| | Do Business Associations play an important role in advising and countering provincial polices (% Important or Very Important) | | • | • |
| **4** | **Time Costs** | | | |
| | Percentage of firms spending over 10 percent of their time dealing with bureaucracy or bureaucratic regulations (%) | o | o | o |
| | Median number of inspections (all agencies) | o | o | o |
| | Median tax inspection hours | o | o | o |
| | Government officials have become more effective (% Yes) | | • | • |
| | Trips to obtain stamps and signatures reduced (% Yes) | | • | • |
| | Paperwork reduced (% Yes) | | • | • |
| | Fees reduced (% Yes) | | • | • |
| | No improvements (% Yes) | | • | • |
| **5** | **Informal Charges** | | | |
| | Percentage of firms that felt that enterprises in their line of business were subject to bribe requests from provincial authorities (%). | o | o | o |
| | Percentage of firms paying over 10 percent of their revenue in extra payments (%) | o | o | o |
| | Government uses compliance with local regulations to extract rents (% Strongly Agree or Agree) | o | o | o |
| | Informal charges delivered expected result (% Usually or Always) | o | o | o |
| | Do firms pay commissions on government contracts? (Yes) | | • | • |
| | Actual Bribes Paid During Registration (%) | | • | • |
| **6** | **Proactivity** | | | |
| | Provincial officials are knowledgeable enough about present national laws to find opportunities within existing laws to solve firm problems (% Strongly Agree or Agree) | o | o | o |
| | Provincial officials are creative and clever about working within national laws to solve the problems of private sector firms (% Strongly Agree or Agree) | o | o | o |

| | | | | |
|---|---|---|---|---|
| | Perceived attitude of provincial government toward private sector (% Very Positive or Very Positive). | o | o | o |
| | All good initiatives come from the provincial government, but the center frustrates them (% Strongly Agree or Agree) | o | | |
| | There are no good initiatives at the provincial level; all important policy comes from the central government. (% Strongly Agree or Agree) | o | | |
| **7** | **Business Support Services** | | | |
| | Trade fairs held by province in previous year and registered for present year. | o | o | o |
| | Number of private providers for public services in province | o | o | o |
| | Firm has used business information search services (%) | | • | • |
| | Firm used private provider for above business information search services (%) | | • | • |
| | Firm intends to use above service provider again for business information search services (%) | | • | • |
| | Firm has used consulting on regulatory information (%) | | • | • |
| | Firm used private provider for consulting on regulatory information (%) | | • | • |
| | Firm intends to use above service provider again for consulting on regulatory information (%) | | • | • |
| | Firm has used business match making services (%) | | • | • |
| | Firm used private provider for business match making services (%) | | • | • |
| | Firm intends to use above service provider again for business match making services (%) | | • | • |
| | Firm has used trade promotion services (%) | | • | • |
| | Firm used private provider for trade promotion services (%) | | • | • |
| | Firm intends to use above service provider again for trade promotion services (%) | | • | • |
| | Firm has used technology related services (%) | | • | • |
| | Firm used private provider for technology related services (%) | | • | • |
| | Firm intends to use above service provider again for technology related services (%) | | • | • |
| **8** | **Labor Policy** | | | |
| | Services provided by provincial agencies: general education (% Very Good or Good) | o | o | o |

| | | | | |
|---|---|---|---|---|
| | Services provided by provincial agencies: labor vocational training (% Very Good or Good) | o | o | o |
| | Firm has used labor exchange services (%) | | • | • |
| | Firm used private provider for above labor exchange services (%) | | • | • |
| | Firm intends to use above service provider again for labor exchange services (%) | | • | • |
| | Percentage of total business costs spent on labor training (%) | | • | • |
| | Percentage of total business costs spent on labor. | | • | • |
| | Overall Satisfaction with Labor (% Agreeing labor meets firm needs). | | • | • |
| | Vocational training school graduates/ untrained laborers | | • | • |
| | Secondary school graduates (% of workforce). | | • | • |
| **9** | **Legal Institutions** | | | |
| | Legal system provided mechanism for firms to appeal officials' corrupt behavior (% Always or Usually) | o | o | o |
| | Firm confident that legal system will uphold property rights and contracts (% Strongly Agree or Agree) | o | o | o |
| | Cases filed by non-state entities at Provincial Economic Court per 100 firms. | o | o | o |
| | Non-state claimants as a percentage of claimants at Provincial Economic Court (%). | | • | • |
| | Business used courts or other legal institutions to resolve disputes (%) | | • | • |
| | Median months to resolve court cases | | • | • |
| | Median formal and informal costs as a percentage of case (%) | | • | • |

Source: Malesky et al. (2012)

Note: 1. The sign "o" shows the indicator existence. 2. • represents a new indicator.

# CHAPTER 5

# EFFICIENCY PERFORMANCE OF VIETNAMESE MANUFACTURING ENTERPRISES

## 5.1. Literature Review

### 5.1.1. Studies on Efficiency for the Vietnamese Manufacturing Sector

Firm performance and efficiency in particular has been studied in Vietnam since the 2000s. And, most studies focus on technical efficiency, which vary from the manufacturing industry (Nguyen & Truong, 2007; Hoang, Carlin, & Pham, 2008; Chu & Kalirajan, 2010; Pham, Dao, & Reilly, 2010; Pham, 2013; Vu, 2013), to sectors (Vixathep, 2008; Luong, 2009) to scales ( Nguyen et al., 2007; C. L. V. Le, 2010) to ownership types (Vu, 2002; Tran, Grafton, & Kompas, 2008; Phan & Ngo, 2012; Vu, 2013). Some selected studies on technical efficiency for the manufacturing firm are summarized below.

#### *5.1.1.1. Efficiency Study on Manufacturing Sectors*

Nguyen & Truong (2007) employed the DEA method to estimate technical efficiency for manufacturing firms in the period 2000-2003, and found that the overall technical efficiency, pure technical efficiency and scale efficiency were 43.8%, 47.5%, and 92.6%, respectively and efficiency levels dispersed among industries. Only 3.4% and 8.9% of firms were at full technical efficiency and at the optimal scale, respectively.

Pham et al. (2010) determined factors affecting technical efficiency of manufacturing firms by applying the stochastic frontier estimation for enterprises in 2003. The estimated results showed that average technical efficiency of manufacturing firms was nearly 62.0% and export orientation and trade openness had positive impacts on technical efficiency.

Chu & Kalirajan (2010) investigated the effect of trade liberalization on technical efficiency of manufacturing firms by applying the Stochastic Production Frontier (SPF) model for firm balanced-panel data over the period 2000-2003. On average, technical efficiency of manufacturing firms increased from 55.0% in 2000 to 63.8% in 2003 and the overall technical efficiency level for the whole period was 60.5%. Across three groups (less-traded, export oriented and import competing firms) the export-oriented firms were less efficient, but their technical efficiency levels reported improvement. Trade liberalization positively and robustly influenced firm performance by creating more competition pressures and opportunities, promoting domestic institutional reforms and competition. Furthermore, skilled labour had significant effect on firm efficiency while higher capital intensity related to lower efficiency.

Vu (2013) made use of the Enterprise Survey data during the period 2000-2009 to quantify technical efficiency levels of the manufacturing firms by the SFPF method. It is found low technical efficiency levels, in the range of 49-62%. FIEs recorded the lowest level of technical efficiency (0.431-0.565) except in 2008, while DPEs had the highest and increasing technical efficiency level in most years (0.592-0.700). Technical efficiency level of SOEs is between that of FIEs and DPEs, but it seems to decrease. Among determinants, moderate competition and small scale are main sources restraining efficiency improvement.

#### *5.1.1.2. Efficiency Study to Manufacturing SMEs*

Nguyen et al. (2007) quantified and investigated determinants of pure technical efficiency for manufacturing SMEs from 2000-2002 by the parametric (SFPF) and non-parametric approaches (DEA) under the specification VRS. It is revealed that manufacturing SMEs opearate at a low efficiency level (39.9% by the VRS DEA and 49.7 by the SFPF) and efficiency levels varied among sub-industries and regions. While ownership types and regions did not impact efficiency, firm age positively influenced efficiency.

Tran et al. (2008) examined efficiency performance of non-state manufacturing SMEs and determinants by using the Stochastic Frontier Model and data of five sub-sectors (food processing, chemicals, manufactured goods classified chiefly by materials, machinery and transport equipment and miscellaneous manufactured articles) during the period 1996-2001. The results reported a relatively high technical efficiency level, and its average in five sub-sectors varied from 0.719 to 0.835 in 1996 and from 0.824 to 0.908 in

2001. However, efficiency of individual firms showed a large dispersion. Firm scale and metropolitan location promoted efficiency, while firm age negatively related to efficiency. Though government assistance and policies reported no clear relationship with technical efficiency, the finding indicated some benefits from credit and non-financial service to firms' performance.

C. L. V. Le (2010) used SFPF to estimate technical efficiency for non-state SMEs in nine sub-manufacturing sectors in three years 2002, 2005 and 2007. On average, manufacturing SMEs had relatively high technical efficiency (84.25%-92.55%). Sources of inefficiency were identified from firm characteristics and business environment. It is found that major product improvement, government assistance in credit, household and collective ownership positively affected technical efficiency, while firm size, age, location, government assistance in terms of land at start-up and in credit during operation negatively impacted technical efficiency. Exporting did not influence efficiency.

#### *5.1.1.3. Efficiency Study on Ownership Types*

Vu (2002) calculated the technical efficiency levels for 164 industrial SOEs in 1997 and 1998 and compared to that of non-SOEs by using the SFPF model. He revealed that, on average, non-SOEs were more efficient and had higher possibility to perform more productively than SOEs. The findings suggested that the leading role of the SOEs sector should be reconsidered and the non-state sector should receive further development. A larger proportion of skilled workers, and export activities enhanced technical efficiency, whereas a capital-intensive development strategy had a negative impact on the TE.

Phan & Ngo (2012) examined technical efficiency performance of foreign and domestic enterprises during the period 2005-2009 and identified determinants of efficiency by using SFPF model. The estimation results showed that on average, SMEs yielded low and downward technical efficiency levels (from 3.23% in 2005 to 3.03% in 2009), while large firms yielded higher and upward technical efficiency levels (44.26% in 2005 and 45.15% in 2009). In terms of sources of efficiency, firm age, location, ownership, capital to labour ratio, types of sub-industries and some possible interactions among them significantly related to technical efficiency.

#### *5.1.1.4. Studies on Cost Efficiency*

To date, there are few studies on allocative efficiency and cost efficiency in Vietnam and all of them are for specific sectors, for instance, the fishery processing or banking.

Nguyen (2005) used the DEA method to calculate technical efficiency, allocative efficiency and overall efficiency for 294 enterprises of 5 industry sectors in Hanoi. The different results obtained under the specified VRS and CRS showed clear inefficiency in production of these sectors: cost efficiency averaged at 60.6% and suggested that firms are likely to reduce their cost and achieve profitability by improving efficiency.

Pham (2006) used the DEA method with the assumption of CRS to gauge technical efficiency, allocative efficiency and cost efficiency for 128 firms in the fishery processing industry in period 2000-2004, and showed that fishery processing firms were in low efficiency levels, but large deviation. Geographical location and return variables did not affect the efficiency measurements. Younger firms and non-state owned firms were more technical and cost efficient than older firms and state owned firms. Meanwhile capital equipment levels appeared to affect overall efficiency and allocative efficiency.

Vu & Turnell (2010) measured cost efficiency for 56 banks during period 2000-2006, which constituted 90% of banking total assets in Vietnam, by the Bayesian Stochastic Frontier Approach. On average, the banking industry achieved quite high cost efficiency, 87.21%, while efficiency difference among ownership types was very small and insignificant. State-Owned Commercial Banks registered higher scores and different trends of cost efficiency compared to the banking industry as a whole and private banks. Yet, a decline in cost efficiency was observed for the banking industry and all types of ownership in 2005 as a result of banking technology investment, spending on enhancing service quality, extending network, and increased interest rate.

#### *5.1.1.5. Studies on Metafrontier*

Up to now, in the best of the author's knowledge, there are only three studies using the metafrontier method in Vietnam and all of them are for agriculture (Quan, 2011; Nguyen, 2013; Diep, 2014). Quan (2011) compared technical efficiency of intensive and non-intensive rice farmers by using the DEA method. Nguyen (2013) also used the DEA method to measure metafrontier and group-frontier technical efficiency for shrimp farmers, in which groups of farmers were divided by their type of practice: intensive, semi-intensive, and extensive. Meanwhile, Diep (2014) compared technical efficiency of rice producers across regions in Vietnam.

By reviewing the literature, it is found that there has been no study evaluating efficiency performance in terms of cost efficiency and no study on metafrontier for the Vietnamese manufacturing industry. This study, therefore, is to fill the research gap.

### 5.1.2. Studies on Cost Efficiency for Manufacturing Industry

Data of input prices are needed to measure cost efficiency. Due to the availability of input prices data, there are various studies on cost efficiency for the agriculture and the banking field, but few studies for the manufacturing industry. This section is to review some studies on cost efficiency for manufacturing industry.

Tripathy (2006) employed the Stochastic Frontier Model (SFM) and Data Envelopment Analysis (DEA) model for Indian manufacturing firms during 1990-2000 to examine the hypothesis that foreign firms may be less allocatively efficient than their domestic counterparts due to using inappropriate technology. The empirical results showed that foreign firms were more technical efficient than domestic firms, but less allocative efficient.

Ray (2008) utilized the DEA model to estimate cost efficiency for Indian manufacturing firms and compared the efficiency across states. The empirical results suggested a quite low cost efficiency level, at 58.6% on average. If all firms were fully cost efficient, the average cost would reduce 23%, and cost efficiency improvement would increase the world market share of Indian manufacturing firms, even with the current technology. Average cost disparity across states may have stemmed from cost efficiency inequality, input prices and/or output scale. Most firms worked at small scale compared to the optimal output scale. Two third of total states are fully technical efficient, even in some states with a low cost efficiency level.

### 5.1.3. Efficiency and Metafrontier

In 2002, Battese & Rao presented a stochastic metafrontier model for different groups of firms, which may not have used similar technology to compare their technical efficiencies. Battese, Rao, & O'Donnell (2004), then, developed a stochastic metafrontier model for time-varying inefficiency effect, which followed Battese & Coelli (1992). The method was used to compare technical efficiency of Indonesian garment firms in five regions during 1990-1995. The empirical results strongly rejected the similarity of the stochastic frontier by regions. Moreover, five regions did not share the same inefficiency model. In 2008, O'Donnell, Rao, & Battese went further by introducing the metafrontier model for the SFA method and DEA method. After that, there are some studies applying the metafrontier method for efficiency comparison.

Bhandari & Ray (2007) used the nonparametric method to calculate and compare technical efficiency for Indian textile firms in different periods during 1985-2002. Textile firms' performance was compared by three criteria, i.e. state, ownership and organization. It is appeared that the metafrontier technical efficiency of Indian textile enterprises was quite low, fluctuating from 8.9% to 47.0%. It also recorded an improvement of the Technology Closeness Ratio of firm in different states over time, especially in the two latest periods. By ownership, private firms registered better performance compared to public firms in terms of metafrontier technical efficiency and TCR value. By organizational type, public limited companies appeared with superior technology compared to others.

A similar comparison for Textile and Apparel firms in Egypt was conducted by El-Atroush & Montes-Rojas (2011) by using the stochastic metafrontier method. Since regions differing in economic features, social and economic infrastructure, access to resources, production technology was assumed to be different among regions. Empirical results found a large efficiency variation for private firms in the textile sector (0.054-0.856), but smaller dispersion for the apparel sector (0.630-0.969).

Liu (2011) made use the stochastic metafrontier method to investigate regional disparity in Chinese SOEs performance during 1980-1994. It is found that metafrontier technical efficiency of four provinces (Jiangsu, Sichuan, Shanxi, Jilin) ranges from 0.788 to 0.904. Technical gap ratio was from 0.920 (Shanxi) to 0.972 (Jiangsu) as a result of better marketing facilities, technical service and infrastructure investment for the superior province.

The metafrontier framework is not only applied for the production function to obtain the technical efficiency and technology gap ratio, but also applied for the cost function to measure the cost efficiency level and the cost gap ratio between the metafrontier cost efficiency and cost efficiencies of alternative groups. For example, Huang & Chiang (2007) compared cost efficiency of 828 banks in 16 European countries during 1994-2003 by the metafrontier cost function. Overall, the metafrontier cost efficiency for pooled sample was 29.23%, while the metafrontier cost efficiency of a single country was between 7.04% and 35.83%. Few banks could operate on the metafrontier and most banks need more effort to reach the potential technology level with their capability to adopt the best technology, react to external changes and combine inputs optimally.

Huang and Fu (2013) utilized the stochastic metafrontier cost function to compare cost efficiencies and cost gap ratios of 33 banks in Taiwan and 36 banks in China in 2005-2009, which made up more than 80% of bank assets in the two countries Empirical results showed lower country-specific cost efficiency and lower meta-based cost efficiency of Taiwan's banks (55.23% and 46.46%, respectively) than that of China's banks (84.35% and 63.06%, respectively), indicating that banks in China operated better than their counterparts in Taiwan. However, the Taiwanese banks' cost frontier placed closer to the cost metafrontier.

### 5.2. Efficiency Performance of Manufacturing Firms in Vietnam

Suppose that manufacturing enterprises in each group share the same group frontier and enterprises in the pooled sample share the metafrontier, this section evaluates efficiency performance defined by the metafrontier and group frontiers. The first section is to analyze efficiency performance by metafrontier. The second part shows efficiencies by scale-group frontiers, technical gap ratio and cost gap ratio compared to efficiencies by the metafrontier. The third and fourth section introduce the same content for firms by ownership type and by sector.

### 5.2.1. Efficiency Performance-Metafrontier

This section represents efficiency scores of manufacturing enterprises following the metafrontier. Table 5-1 shows that on average, manufacturing firms in Vietnam are quite far from full efficiency level. The mean of technical efficiency (58.0%), allocative efficiency (69.9%) and cost efficiency (38.9%) imply the existence of inefficiency in production. In particular, manufacturing firms need to reduce their cost by 42.0%, 30.1% and 61.1% to reach full technical efficiency, allocative efficiency and cost efficiency, respectively.[49] Thus, there is large room to improve those efficiencies.

**Table 5-1. Metafrontier Efficiency Scores by Time**

| | | CE | TE | AE |
|---|---|---|---|---|
| 2007 | Mean | 0.388 | 0.597 | 0.678 |
| | S.D | 0.088 | 0.152 | 0.165 |
| | Min | 0.267 | 0.363 | 0.273 |
| | Max | 1.000 | 1.000 | 1.000 |
| 2009 | Mean | 0.391 | 0.577*** | 0.706*** |
| | S.D | 0.083 | 0.150 | 0.160 |
| | Min | 0.270 | 0.353 | 0.279 |
| | Max | 1.000 | 1.000 | 1.000 |
| 2011 | Mean | 0.387 | 0.565** | 0.712 |
| | S.D | 0.080 | 0.146 | 0.155 |
| | Min | 0.269 | 0.359 | 0.301 |
| | Max | 1.000 | 1.000 | 1.000 |
| **Pooled** | **Mean** | **0.389** | **0.580*****  | **0.699*** ** |
| | **S.D** | **0.084** | **0.150** | **0.161** |
| | **Min** | **0.267** | **0.353** | **0.273** |
| | **Max** | **1.000** | **1.000** | **1.000** |

Source: Author's calculation

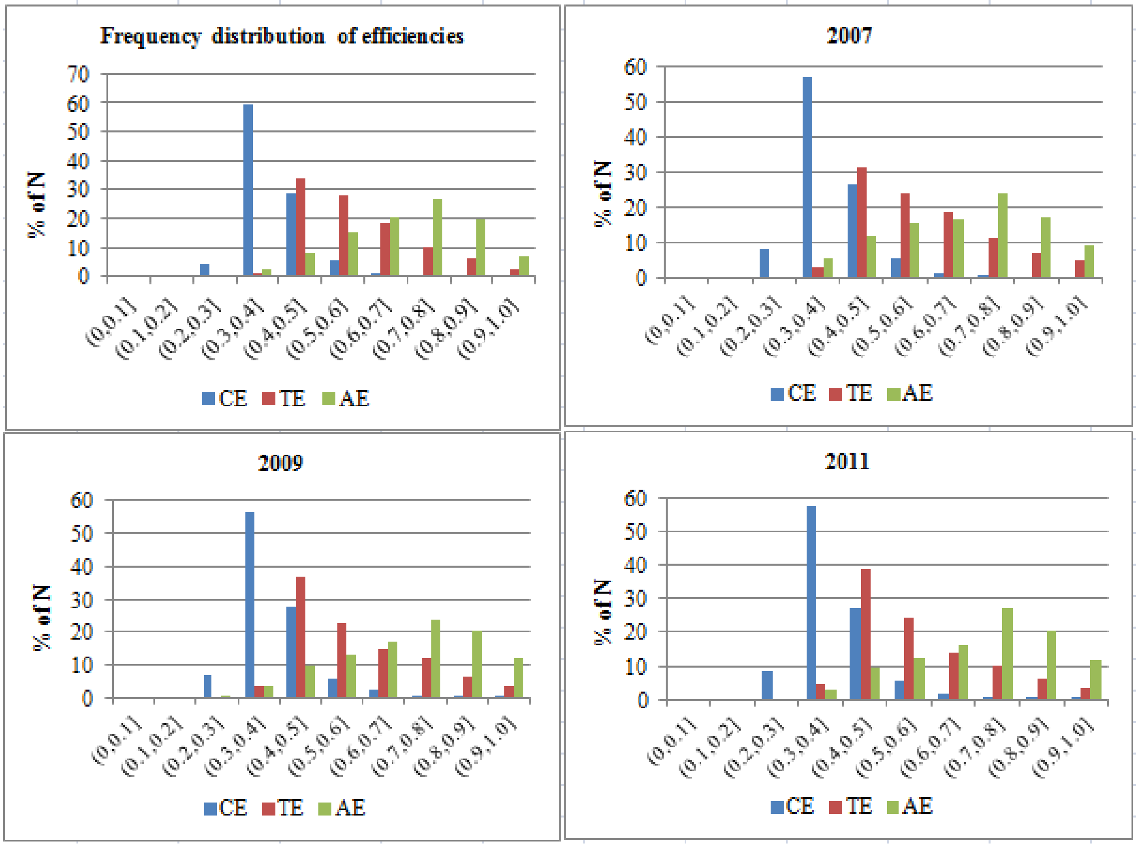
Note: 1. *, **, *** present significant difference at level 10%, 5% and 1% of efficiencies by time. 2. Efficiency comparison by time is divided into two types: comparison for the three years (presented in Pooled sample) and comparison for two years. Efficiency comparison for years 2007 and 2009 is shown in year 2009, and comparison for years 2009 and 2011 is shown in year 2011.

[49] This study uses a cost-based production possibility set to measure technical efficiency and cost efficiency. Input-oriented technical efficiency, in this situation, reflects the maximum input costs can be reduced rationally to produce a given output under a given technology.

On average, cost efficiency ranges from 26.7% to 100% and there are 4 firms in 2007, 2 firms in 2009 and 1 firm in 2011 that are fully cost efficient. The frequency distribution of efficiency indices (Figure 5-1) shows that firms with technical efficiency ranging from 40%-70% account for the largest number of firms and the share of firms with higher technical efficiency decreases continuously. Around 67% of firms are in the range of 60%-80% allocative efficiency while nearly 88% of firms are in the range of 30%-50% cost efficiency. Moreover, the shares of enterprises in the range of 40%-70% technical efficiency and in the range of 60%-80% allocative efficiency tend to increase over time.

Overall inefficiency is attributed to technical inefficiency and allocative inefficiency. Technical inefficiency contributes to cost inefficiency through direct and indirect channels. The direct channel occurs as technical efficiency is a component of cost efficiency. The indirect channel of technical inefficiency effect was stated by Kalirajan & Shand (1999) that "where technical inefficiency exists, it will exert an influence on allocative efficiency and that there will be a cumulative negative effect on economic efficiency".

**Figure 5-1. Frequency Distribution of Efficiency Measurements**




Source: Author's calculation

The average technical efficiency of manufacturing firms in this research (58.0%) is consistent with that of Chu & Kalirajan (2010) and Pham et al. (2010), which are 60.5% during 2000-2003 and 62.0% in 2003, respectively. However, this technical efficiency result seem higher than those of Nguyen & Truong (2007), Hoang et al. (2008), Phan & Ngo (2012) (Table 5A-1 and 5A-2). In the scope of manufacturing firms, this result is quite similar to the average technical efficiency level 58.0% (in 1995-96) in Pakistan (Din, Ghani, & Mamooh, 2007).

Over time, efficiency measurements have smaller disperson, but average value of efficiencies report two opposite trends. Average allocative efficiency registers a continuously increasing tendency, from 67.8% to 70.6% and to 71.2%, during 2007-2011. Inversely, average technical efficiency records a decreasing tendency from 59.8% in 2007 to 57.8% in 2009 and 56.5% in 2011. Meanwhile, average overall efficiency seems unchanged. The one-way Analysis of Variance (ANOVA) was applied to compare cost efficiency for the three years, while the t-test was utilised to compare cost efficiency for each two years (2007 and 2009, 2009 and 2011).[50] It is reported no disparity of cost efficiency by time. Inequality of technical efficiency is recognized for the whole period at 1% statistical significance, and for each two years (1% significance for period 2007-2009, and 5% significance for period 2009-2011). Meanwhile, the disparity in allocative efficiency is observed for the whole period and for 2007-2009, both at 1% statistical significance. Notably, the two measurements of efficiency vary with slower pace by time. Particularly, technical efficiency decreases 2.0 percentage points during 2007-2009 and 1.2 percentage points during 2009-2011, while allocative efficiency increases 2.7 percentage points in the first period and only 0.7 percentage points in the second period.

### 5.2.2. Efficiency Performance by Scale

Efficiency comparison of different groups can be carried out by using the metafrontier efficiency. Table 5-2 suggests better performance of LEs than SMEs with regard to metafrontier efficiency levels. In particular, mean metafrontier technical

[50] One-way Analysis of Variance (ANOVA) is used to compare difference of means in more than two independent groups, while the t-test is applied to compare difference of means in two independent groups.

efficiency, allocative efficiency and cost efficiency of large enterprises are 63.0%, 78.2% and 47.8%, respectively, while those of SMEs are 57.1%, 68.4% and 37.3%, respectively, indicating that LEs seem to be more efficient than SMEs. In other words, if using the benchmark technology, LEs employ lower inputs and lower production cost to produce the same output as SMEs. The disparity in efficiency of LEs and SMEs is significant at the 1% level.

**Table 5-2. Metafrontier Efficiency and Scale-frontier Efficiencies**

| | | Mean | S.D | Min | Max |
|---|---|---|---|---|---|
| LE | $TE^k$ | 0.714 | 0.139 | 0.440 | 1.000 |
| | TGR | 0.884*** | 0.122 | 0.418 | 1.000 |
| | TE | 0.630*** | 0.152 | 0.392 | 1.000 |
| | $AE^k$ | 0.721 | 0.142 | 0.378 | 1.000 |
| | AE | 0.782*** | 0.138 | 0.423 | 1.000 |
| | $CE^k$ | 0.506 | 0.116 | 0.347 | 1.000 |
| | CGR | 0.956 | 0.092 | 0.429 | 1.000 |
| | CE | 0.478*** | 0.092 | 0.336 | 1.000 |
| SME | $TE^k$ | 0.578 | 0.152 | 0.353 | 1.000 |
| | TGR | 0.990 | 0.033 | 0.648 | 1.000 |
| | TE | 0.571 | 0.148 | 0.353 | 1.000 |
| | $AE^k$ | 0.710 | 0.162 | 0.273 | 1.000 |
| | AE | 0.684 | 0.160 | 0.273 | 1.000 |
| | $CE^k$ | 0.396 | 0.100 | 0.267 | 1.000 |
| | CGR | 0.956 | 0.082 | 0.500 | 1.000 |
| | CE | 0.373 | 0.071 | 0.267 | 1.000 |

Source: Author's calculation

Note: 1. TE, AE, CE are technical efficiency, allocative efficiency and cost efficiency defined by the metafrontier, respectively. 2. $TE^k$, $AE^k$, $CE^k$ are technical efficiency, allocative efficiency and cost efficiency defined by the scale-group frontiers. 3. TGR and CGR are technical gap ratio and cost gap ratio, respectively. 4. $TE = TE^k \times TGR$, $CE = CE^k \times CGR$. 5. *,**,*** indicates inequality of mean of metafrontier efficiencies of two groups at the 10%, 5%, and 1% level.

SMEs may be less efficient since they are unable to take economies of scale, face financial constraint and have less information of suppliers and consumers (Alvarez & Crespi, 2003). In contrast, LEs are likely to use inputs better and to achieve economies of scale and be more efficient (Jovanovic, 1982). Large enterprises in this study have a higher technical level, higher single factor productivity (labor productivity, capital productivity, lower intermediate input and energy for one VND of value added) connected with a higher ratio of gross output to production cost. The positive relationship between firm size and technical efficiency of electronics firms in Taiwan was investigated by Yang & Chen (2009). They argued that the two groups have different production frontiers since SMEs use labor-intensive technology, while LEs use capital-intensive technology. LEs tend to use higher capital-intensive technology and hence, obtain higher technical efficiency. Larger firms also achieve higher labor and intermediate inputs productivity. Thus, the lower labor productivity of SMEs seems to correlate with the labor-intensive technology they use. Seth (1995) stated that generally labor-intensive firms have lower labor productivity and the higher labor productivity of larger firms is generally associated with technical advantages, such as economies of scale. In this sample, SMEs achieve lower ratio of total revenue to production cost (1.288 compared to 1.302), suggesting that they must pay higher cost to obtain one VND total revenue in comparison to larger firms. Moreover, SMEs, due to their lower labor productivity (VND0.640 million per worker compared to VND 0.704 per worker) are likely to pay lower wages to keep competitiveness (VND17.70 million compared to VND27.23 million). This result is consistent with that of Seth (1995).

A metafrontier efficiency contains group-frontier efficiency and a technical gap ratio or cost gap ratio. Although group-frontier efficiency is not comparable, LEs register higher scale-based efficiencies ($TE^k, AE^k, CE^k$) than SMEs. Nonetheless, large enterprises have a lower technical gap ratio (TGR) and cost gap ratio (CGR) than small and medium enterprises. Particularly, mean TGR of LEs is 0.884 compared to 0.990 of that of SMEs, suggesting that 11.6% of scale-based cost frontier of LEs and only 1% of scale-based cost frontier of SMEs deviates from the meta-cost frontier. Mean comparison registers a significant difference of average TGR of two groups at the 1% level, indicating that the production frontier of SMEs is closer to the meta-production frontier than that of LEs. The maximum value of TGR for both groups equals 1, suggesting the tangency of group production frontiers to the meta-production frontier. Meanwhile, average CGR of LEs and SMEs report insignificant difference, implying similar gaps between group-specific cost frontiers of two groups and the meta-cost frontier.

### 5.2.3. Efficiency Performance by Ownership

It is found that SOEs lead in metafrontier technical efficiency and cost efficiency, but lag in the technical gap ratio and cost gap ratio. SOEs report the highest level of technical efficiency and cost efficiency (0.635 and 0.439), followed by DPEs (0.580 and 0.373) and FIEs (0.576 and 0.422). The t-test results imply a significant difference of metafrontier technical efficiency of SOEs compared to that of DPEs and FIEs, meaning that generally, SOEs are more technical efficient than DPEs and FIEs. The results surprise us and contradict existing studies on technical efficiency in which SOEs are the least technically efficient (Vu, 2003a; Hallward-Driemeier et al., 2006; Nguyen et al., 2007; Hoang et al., 2008; Vixathep, 2008; Phan & Ngo, 2012; Vu, 2013). However, the different approach of this study may cause the different result. First, existing studies on technical efficiency use the output-oriented approach that measures the ability to maximize output without changing inputs. Meanwhile, in this study, the author measures technical efficiency by the input-oriented approach, or measures the ability to minimize inputs employed to produce the given output. As mentioned in sections 3.3.2.2, input-oriented technical efficiency, here, connects with the input cost-output relation. It appears that SOEs in this sample bear the lowest level of capital price as a result of their preferential treatment as shown in Table 4-3. As a result, average production cost of SOEs is the lowest, 0.789 compared to 0.807 of FIEs and 0.833 of DPEs, leading to their highest overall efficiency level. The lowest mean production cost, therefore, leads to the highest overall efficiency level for SOEs. Notably, the maximum metafrontier cost efficiency of SOEs is 65.3%, meaning that none of the SOEs is fully overall efficient, while some DPEs and FIEs are fully overall efficient.

FIEs' lower metafrontier technical efficiency and cost efficiency than those of SOEs does not mean that FIEs are less efficient than SOEs. It might result from transfer mispricing of FIEs in order to minimize taxes paid or avoid paying taxes. In recent years, transfer mispricing in Vietnam has been more popular.[51] An inspection by the General Department of Taxation in 2014 on FDI firms having business transactions reported losses

[51] According to Malesky et al. (2014), transfer mispricing is "rai[sing] the price of internal purchases of goods and services to lower reported profits".

but intended business expansion revealed that 720 out of 870 inspected firms engaged transfer mispricing. Recently, the FDI survey module belonging to the PCI survey in 2014 found that 19.9% of respondents involved in transfer mispricing activities in 2013, and not only lost firms took part in the activities. Especially, the share of extremely profitable (over 20% profit margin) and highly profitable firms (10-20% profit margin) involved in transfer mispricing activities is very high, 65.1% and 44.5%, respectively (Malesky et al., 2014).

**Table 5-3. Metafrontier Efficiency and Ownership-frontier Efficiencies**

| | | **Mean** | **S.D.** | **Min** | **Max** |
|---|---|---|---|---|---|
| **SOE** | $TE^k$ | 0.940 | 0.059 | 0.794 | 1.000 |
| | TGR | 0.671 | 0.138 | 0.489 | 1.000 |
| | TE | 0.635 | 0.152 | 0.414 | 1.000 |
| | $AE^k$ | 0.877 | 0.082 | 0.682 | 1.000 |
| | AE | 0.721 | 0.155 | 0.428 | 0.966 |
| | $CE^k$ | 0.825 | 0.096 | 0.621 | 1.000 |
| | CGR | 0.533 | 0.049 | 0.398 | 0.653 |
| | CE | 0.439 | 0.065 | 0.293 | 0.653 |
| **DPE** | $TE^k$ | 0.663 | 0.132 | 0.456 | 1.000 |
| | TGR | 0.868 | 0.071 | 0.536 | 1.000 |
| | TE | 0.580 | 0.149 | 0.367 | 1.000 |
| | $AE^k$ | 0.754 | 0.141 | 0.394 | 1.000 |
| | AE | 0.673 | 0.161 | 0.273 | 1.000 |
| | $CE^k$ | 0.488 | 0.094 | 0.364 | 1.000 |
| | CGR | 0.764 | 0.062 | 0.515 | 1.000 |
| | CE | 0.373 | 0.075 | 0.268 | 1.000 |
| **FIE** | $TE^k$ | 0.601 | 0.158 | 0.354 | 1.000 |
| | TGR | 0.961 | 0.062 | 0.527 | 1.000 |
| | TE | 0.576 | 0.151 | 0.353 | 1.000 |
| | $AE^k$ | 0.739 | 0.152 | 0.297 | 1.000 |
| | AE | 0.757 | 0.144 | 0.297 | 1.000 |
| | $CE^k$ | 0.429 | 0.094 | 0.275 | 1.000 |
| | CGR | 0.987 | 0.050 | 0.486 | 1.000 |
| | CE | 0.422 | 0.091 | 0.267 | 1.000 |

Source: Author's calculation
Note: Comparison results of efficiencies are in Table 5A-3.

FIEs are observed to have the highest metafrontier allocative efficiency level and it is significantly different from those of SOEs and DPEs. It can be said that FIEs are more allocatively efficient, which originates from their superior technology and financial strength as well as high management skill and experience of doing business in different markets. According to GSO (2014a), wholly foreign owned enterprises account for 79.2% and 83.4% of total FIEs in 2006 and 2011, respectively. Those enterprises have the same merits as their parent companies in home countries that induce higher allocative efficiency than SOEs.

Although leading in metafrontier technical efficiency and cost efficiency, SOEs register the lowest value of both the technical gap ratio and cost gap ratio. Average TGR, CGR of SOEs are 0.671 and 0.533 in comparison to 0.868 and 0.764 of DPEs, and 0.961 and 0.987 of FIEs, indicating that the group-production frontier and group-cost frontier of SOEs suffer the largest deviation to the meta-production frontier and the meta-cost frontier, respectively. The group-cost frontiers of DPEs and FIEs are tangential the cost meta-cost frontier, but that of SOEs is not. Meanwhile, these two group frontiers of FIEs are the closest to corresponding metafrontiers, and group frontiers of DPEs are between those of FIEs and SOEs.

### 5.2.4. Efficiency Performance by Sector

Analysis of the manufacturing sector can be done in two ways: by sector, and by technology level. In terms of sector, there are 14 sectors aggregated from 24 industries. These sectors are classified into three technology level groups: low technology, medium technology and high technology.

It is reported that nearly half of manufacturing enterprises in this sample are in low technology sectors, while only 16% are in high technology sectors. Mean metafrontier technical efficiency of sectors by technology level ranges from 0.562 (medium technology) to 0.602 (high technology), while mean metafrontier allocative efficiency ranges from 0.687 (high technology) to 0.710 (medium technology), and mean metafrontier cost efficiency ranges from 0.386 (medium technology) to 0.398 (high technology). High technology sectors have the highest level of average metafrontier technical efficiency and metafrontier cost efficiency. Average efficiency comparisons exhibit significant differences between metafrontier efficiencies of high technology sectors to medium and low technologies sectors, suggesting that high technology sectors are more technically efficient and more cost efficient than other sectors. Meanwhile, medium technology sectors have the highest metafrontier allocative efficiency, but bear the lowest technical gap ratio and cost gap ratio. Especially, the cost gap ratio of the low technology group is nearly 1, suggesting that its cost group-frontier is almost tangential the meta-cost frontier.

**Table 5-4. Metafrontier Efficiency and Sector-frontier Efficiencies**

| By sector | | N (% of N) | $TE^k$ | TGR | TE | $AE^k$ | AE | $CE^k$ | CGR | CE |
|---|---|---|---|---|---|---|---|---|---|---|
| FBT | Mean | 729 (14.48%) | 0.803 | 0.801 | 0.650 | 0.612 | 0.618 | 0.479 | 0.801 | 0.382 |
| | S.D. | | 0.130 | 0.110 | 0.168 | 0.155 | 0.168 | 0.106 | 0.106 | 0.092 |
| | Min | | 0.458 | 0.465 | 0.375 | 0.395 | 0.273 | 0.393 | 0.664 | 0.269 |
| | Max | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| GT | Mean | 459 (9.12%) | 0.771 | 0.794 | 0.617 | 0.677 | 0.707 | 0.515 | 0.827 | 0.419 |
| | S.D. | | 0.132 | 0.123 | 0.163 | 0.161 | 0.166 | 0.137 | 0.117 | 0.104 |
| | Min | | 0.479 | 0.535 | 0.367 | 0.360 | 0.311 | 0.352 | 0.593 | 0.273 |
| | Max | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| FWL | Mean | 75 (1.49%) | 0.922 | 0.621 | 0.574 | 0.785 | 0.733 | 0.720 | 0.573 | 0.411 |
| | S.D. | | 0.089 | 0.102 | 0.119 | 0.125 | 0.154 | 0.122 | 0.087 | 0.087 |
| | Min | | 0.693 | 0.458 | 0.368 | 0.552 | 0.349 | 0.552 | 0.448 | 0.280 |
| | Max | | 1.000 | 0.885 | 0.885 | 1.000 | 0.978 | 1.000 | 0.727 | 0.727 |
| WP | Mean | 279 (5.54%) | 0.817 | 0.699 | 0.576 | 0.728 | 0.679 | 0.587 | 0.645 | 0.371 |
| | S.D. | | 0.120 | 0.117 | 0.157 | 0.156 | 0.171 | 0.128 | 0.113 | 0.078 |
| | Min | | 0.564 | 0.406 | 0.366 | 0.391 | 0.309 | 0.377 | 0.508 | 0.272 |
| | Max | | 1.000 | 1.000 | 1.000 | 1.000 | 0.981 | 1.000 | 0.810 | 0.810 |
| PP | Mean | 513 (10.19%) | 0.765 | 0.652 | 0.498 | 0.605 | 0.749 | 0.461 | 0.834 | 0.363 |
| | S.D. | | 0.123 | 0.105 | 0.115 | 0.181 | 0.139 | 0.159 | 0.155 | 0.070 |
| | Min | | 0.445 | 0.467 | 0.373 | 0.301 | 0.338 | 0.274 | 0.449 | 0.270 |
| | Max | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| CP | Mean | 342 (6.79%) | 0.704 | 0.862 | 0.601 | 0.789 | 0.688 | 0.541 | 0.750 | 0.397 |
| | S.D. | | 0.185 | 0.095 | 0.156 | 0.161 | 0.162 | 0.148 | 0.105 | 0.091 |
| | Min | | 0.410 | 0.486 | 0.372 | 0.361 | 0.317 | 0.359 | 0.521 | 0.268 |
| | Max | | 1.000 | 1.000 | 1.000 | 1.000 | 0.992 | 1.000 | 0.947 | 0.947 |
| RP | Mean | 516 (10.25%) | 0.808 | 0.629 | 0.511 | 0.793 | 0.725 | 0.636 | 0.567 | 0.359 |
| | S.D. | | 0.108 | 0.073 | 0.108 | 0.111 | 0.140 | 0.104 | 0.050 | 0.057 |
| | Min | | 0.557 | 0.431 | 0.359 | 0.492 | 0.279 | 0.484 | 0.435 | 0.274 |
| | Max | | 1.000 | 0.982 | 0.982 | 1.000 | 0.998 | 1.000 | 0.655 | 0.655 |
| NM | Mean | 393 (7.81%) | 0.854 | 0.629 | 0.539 | 0.807 | 0.757 | 0.687 | 0.583 | 0.401 |
| | S.D. | | 0.085 | 0.077 | 0.103 | 0.111 | 0.127 | 0.107 | 0.029 | 0.069 |
| | Min | | 0.623 | 0.467 | 0.353 | 0.499 | 0.349 | 0.497 | 0.543 | 0.278 |
| | Max | | 1.000 | 0.880 | 0.880 | 1.000 | 0.987 | 1.000 | 0.670 | 0.670 |
| BM | Mean | 105 (2.09%) | 0.936 | 0.619 | 0.582 | 0.883 | 0.621 | 0.825 | 0.418 | 0.345 |
| | S.D. | | 0.052 | 0.133 | 0.143 | 0.068 | 0.139 | 0.062 | 0.038 | 0.045 |
| | Min | | 0.810 | 0.429 | 0.373 | 0.733 | 0.380 | 0.716 | 0.355 | 0.274 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Max | | 1.000 | 0.964 | 0.964 | 1.000 | 0.873 | 1.000 | 0.495 | 0.495 |
| FM | Mean | 549 (10.91%) | 0.740 | 0.822 | 0.611 | 0.823 | 0.669 | 0.597 | 0.660 | 0.393 |
| | S.D. | | 0.143 | 0.076 | 0.146 | 0.150 | 0.158 | 0.119 | 0.064 | 0.085 |
| | Min | | 0.465 | 0.488 | 0.364 | 0.460 | 0.328 | 0.454 | 0.522 | 0.267 |
| | Max | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| ME | Mean | 258 (5.13%) | 0.765 | 0.751 | 0.577 | 0.835 | 0.710 | 0.633 | 0.627 | 0.398 |
| | S.D. | | 0.127 | 0.090 | 0.137 | 0.119 | 0.148 | 0.117 | 0.044 | 0.086 |
| | Min | | 0.530 | 0.549 | 0.368 | 0.496 | 0.350 | 0.477 | 0.514 | 0.285 |
| | Max | | 1.000 | 1.000 | 1.000 | 1.000 | 0.991 | 1.000 | 0.800 | 0.800 |
| EE | Mean | 183 (3.64%) | 0.868 | 0.730 | 0.639 | 0.777 | 0.654 | 0.672 | 0.600 | 0.402 |
| | S.D. | | 0.102 | 0.118 | 0.152 | 0.128 | 0.155 | 0.130 | 0.051 | 0.086 |
| | Min | | 0.584 | 0.521 | 0.363 | 0.490 | 0.355 | 0.469 | 0.553 | 0.280 |
| | Max | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| TE | Mean | 183 (3.64%) | 0.839 | 0.708 | 0.595 | 0.851 | 0.745 | 0.708 | 0.609 | 0.429 |
| | S.D. | | 0.120 | 0.127 | 0.150 | 0.119 | 0.144 | 0.121 | 0.083 | 0.085 |
| | Min | | 0.550 | 0.458 | 0.379 | 0.530 | 0.368 | 0.518 | 0.386 | 0.273 |
| | Max | | 1.000 | 1.000 | 1.000 | 1.000 | 0.950 | 1.000 | 0.746 | 0.746 |
| FN | Mean | 450 (8.94%) | 0.859 | 0.643 | 0.555 | 0.890 | 0.746 | 0.765 | 0.521 | 0.399 |
| | S.D. | | 0.074 | 0.126 | 0.132 | 0.084 | 0.157 | 0.099 | 0.044 | 0.069 |
| | Min | | 0.611 | 0.461 | 0.364 | 0.604 | 0.377 | 0.568 | 0.460 | 0.281 |
| | Max | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| **By technology level** | | **N (% of N)** | **$TE^k$** | **TGR** | **TE** | **$AE^k$** | **AE** | **$CE^k$** | **CGR** | **CE** |
| High | Mean | 783 (15.55%) | 0.680 | 0.892 | 0.602 | 0.790 | 0.687 | 0.523 | 0.772 | 0.398 |
| | S.D. | | 0.173 | 0.085 | 0.151 | 0.156 | 0.157 | 0.132 | 0.086 | 0.088 |
| | Min | | 0.368 | 0.606 | 0.363 | 0.359 | 0.317 | 0.358 | 0.610 | 0.268 |
| | Max | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Medium | Mean | 1746 (34.68%) | 0.686 | 0.817 | 0.562 | 0.866 | 0.710 | 0.584 | 0.662 | 0.386 |
| | S.D. | | 0.134 | 0.078 | 0.134 | 0.134 | 0.149 | 0.105 | 0.061 | 0.076 |
| | Min | | 0.465 | 0.488 | 0.353 | 0.460 | 0.279 | 0.452 | 0.532 | 0.267 |
| | Max | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Low | Mean | 2505 (49.76%) | 0.678 | 0.861 | 0.585 | 0.595 | 0.694 | 0.388 | 1.000 | 0.388 |
| | S.D. | | 0.146 | 0.106 | 0.159 | 0.162 | 0.169 | 0.088 | 0.003 | 0.087 |
| | Min | | 0.386 | 0.601 | 0.364 | 0.273 | 0.273 | 0.269 | 0.954 | 0.269 |
| | Max | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

Source: Author's calculation

Note: 1. The name of sectors are in Table 4A-1. 2.Mean comparisons are in Table 5A-2 and Table 5A-3.

With respect to sector, the results include: First, the Food processing, Beverages, Tobacco Products sector (FBT) is observed to have the highest metafrontier technical efficiency, but the lowest metafrontier allocative efficiency. Meanwhile, the Paper and Paper products, Printing and Publishing products sector (PP) records the lowest metafrontier technical efficiency level, and the Manufacture of Other Non-metallic Mineral

Products sector (NM) records the highest metafrontier allocative efficiency. The average metafrontier cost efficiency is between 0.345 and 0.429, in which the Manufacture of Basic Metals sector (BM) has the lowest level of metafrontier cost efficiency, and the Transport Equipment sector (TE) has the highest level of metafrontier cost efficiency. Furthermore, it is found that the BM sector has the lowest technical gap ratio and the lowest cost gap ratio, suggesting that the cost group frontier of this sector is the farthest from the cost metafrontier and it is the least cost efficient.

## Appendix of Chapter 5

**Table 5A-1. Selected Studies on Manufacturing Firm Performance in Vietnam**

| **Author(s)** | **Year/ period** | **Sample size, industry** | **Method** | **Technical efficiency** |
|---|---|---|---|---|
| Vu (2003) | 1997-1998 | Industrial SOEs, N=164 | SPPF | 78.8% (1997)<br>78.9% (1998) |
| Rand and Tarp (2006) | 1991-2001 | Manufacturing SMEs, N=1128 | SPFP | 61% |
| Nguyen et al. (2007) | 2000-2003 | Manufacturing SMEs, N=1492 | SPPF and DEA | 49.7% (SPPF)<br>39.9% (DEA) |
| Nguyen and Truong (2007) | 2000-2003 | Manufacturing firms, N=1000 | DEA | 43.8% |
| Tran et al. (2008) | 1996 and 2001 | Private manufacturing SMEs, N=608 | SFPF | 79.6% (1996)<br>86.7% (2001) |
| Hoang et al. (2009) | 2001-2005 | Manufacturing firms, N=1000 | DEA | 45%-53% (depending on sectors) |
| C. L. V. Le (2010) | 2002, 2005, 2007 | Private manufacturing SMEs: N=1388 (2002), 2739 (2005) and 2492 (2007) | SFPF | 84.25% (2002)<br>92.55% (2005)<br>92.34% (2007) |
| Chu and Kalijaran (2010) | 2000-3003 | Balanced panel data, N=1312 observations a year | SFPF | 60.5% (overall TE)<br>55% (2000)<br>60.3% (2001)<br>63.1% (2002)<br>63.8% (2003)<br>45.8%-80.2% (depending on sectors and years) |
| Pham et al. (2010) | 2003 | Manufacturing firms, N=10759 | SFPF | 62% |
| Phan and Ngo (2012) | 2005-2009 | Manufacturing firms, N=25411 | SFPF | 43.6%-45.1% (Large enterprises)<br>3.02%-3.23% (SMEs) |
| Pham (2013) | 2005, 2009 | Manufacturing firms, N=2289 | SPFP | |
| Vu (2013) | 2000-2009 | N = 9393 (2000), N=38770 (2009) | SFPF | 43.1%-56.5% (FIEs)<br>49.2%-62% (SOEs)<br>58.9%-70% (DPEs) |

Source: Adapted from C. L. V. Le (2010) and author’s compilation.

**Table 5A-2. Selected Studies on Cost Efficiency**

| Author(s) | Country | Sample size, industry | Method | Results |
|---|---|---|---|---|
| Vu and Turnell (2008) | Vietnam | Banks, T = 2000-2006 | Baynesian | Overall CE: 87.2% |
| Ray (1998) | India | Industrial firms, T= 2000-2001 | DEA | Overall CE: 77.1% |
| Wadud (2003) | Bangladesh | Farms | SFA and DEA | - SFA: 80% (TE), 77% (AE), 61% (CE)<br>- DEA-VRS: 91% (TE), 87% (AE), 79% (CE)<br>- Positive Spearman's rank correlation. |
| Tripathy (2006) | India | Manufacturing firms, T = 1990-2000, N = 6008 | SFA and DEA | - SFA:<br>CE: 52.1%-90.9% (FEs, depending on sectors); 54.9%-89.5% (DEs)<br>TE: 60.5%-90.3% (FEs); 66.4%-93.4% (DEs).<br>- DEA:<br>CE: 59%-92.5% (FEs); 49.4%-89.8% (DEs)<br>TE: 93.6%-96.8% (FEs); 83.5%-96.4% (DEs)<br>AE: 73.5%-96.4% (FEs); 51.8%-93% (DEs)<br>- Positive Spearman's rank correlation. |
| Chen (2009) | The US | Manufacturing firms, T = 1992, 1997, and 2002 | DEA | - In 2002: CE: 72.9%-100% (depending on states); TE: 86.2%-100%; AE: 84.7%-100%.<br>- In 1997: CE: 58.3%-100%; AE: 76%-100%; 65.2%-100%<br>- In 1992: CE: 74.4%-100%; TE: 85.6%-100%; AE: 74.6%-100%. |

Source: Author's compilation.

**Table 5A-3. Metafrontier Efficiencies and TGR, CGR Comparison by Ownership**

| **TE** | SOE | DPE | FIE | **AE** | SOE | DPE | FIE | **CE** | SOE | DPE | FIE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SOE | | *** | *** | SOE | | ** | * | SOE | | *** | - |
| DPE | | | - | DPE | | | *** | DPE | | | *** |
| FIE | | | | FIE | | | | FIE | | | |

| **TGR** | SOE | DPE | FIE | **CGR** | SOE | DPE | FIE |
|---|---|---|---|---|---|---|---|
| SOE | | *** | *** | SOE | | *** | *** |
| DPE | | | *** | DPE | | | *** |
| FIE | | | | FIE | | | |

Source: Author's calculation.
Note: 1. One-way ANOVA is used to compare mean differences in the variables by ownership. 2. *, **, *** denote statistical significance at 10%, 5%, and 1%. 3. "-" implies insignificance.

**Table 5A- 4.Metafrontier Efficiencies and TGR, CGR Comparison by Technology Level**

| **TE** | High | Medium | Low | **AE** | High | Medium | Low | **CE** | High | Medium | Low |
|---|---|---|---|---|---|---|---|---|---|---|---|
| High | | *** | ** | High | | *** | - | High | | *** | *** |
| Medium | | | *** | Medium | | | *** | Medium | | | - |
| Low | | | | Low | | | | Low | | | |

| **TGR** | High | Medium | Low | **CGR** | High | Medium | Low |
|---|---|---|---|---|---|---|---|
| High | | *** | *** | High | | *** | *** |
| Medium | | | *** | Medium | | | *** |
| Low | | | | Low | | | |

Source: Author's calculation.
Note: 1. One-way ANOVA is used to compare mean differences in the variables by technology. 2. *, **, *** denote statistical significance at 10%, 5%, and 1%. 3. "-" implies insignificance..

# CHAPTER 6

# FACTORS DRIVING EFFICIENCY PERFORMANCE: THE CASE OF MANUFACTURING ENTEPRISES IN VIETNAM

## 6.1. Literature Review

Theoretically, there are a number of possible determinants of efficiency performance. This section reviews determinants theoretically and empirically based on the availability of data, including (i) firm-specific factors (firm age, firm size, ownership structure, sectors, location, capital intensity, human capital), (ii) finance (leverage), (iii) industry-specific factors (concentration), (iv) Foreign Direct Investment spillovers (horizontal effect, vertical effect), and (v) business environment.

### 6.1.1. Firm Characteristics

#### *6.1.1.1. Firm Age*

Firm age is a possible source of efficiency. Normally, the number of years in operation of firms is considered as firm age. Age can relate to efficiency positively through the “learning-by-doing” effect, meaning that along with the operating period, firms can accumulate more knowledge and experience as well as learn from their mistakes. Therefore, older firms have higher chance to be more efficient ( Phan, 2004). In addition, new firms may suffer higher costs in terms of marketing, research and development cost and might perform not as good as older counterparts (Nguyen & Le, 2005). According to Jovanovic (1982), age can impact efficiency through the selection process that firms only realize their efficiency level or optimal scale after some periods in performance. Thereafter, firms decide to stay, remain the scale or extend, or leave the industry on the basis of estimated efficiency.

The positive relationship between year in operation and enterprises’ efficiency has been found in a number of studies (Page, 1984; Phan, 2004; Taymaz, 2005; Nguyen et al., 2007; Amornkitvikai, 2011; Charoenrat, 2012; Saignaleuth, 2013), indicating the concept of learning-by-doing and accumulation of knowledge and experience over time. Taymaz (2005) found that new entrants in Turkey manufacturing are less efficient than existing counterparts and their efficiency has wide dispersion. Over time, their efficiency improved through two learning channels, i.e. passive learning and active learning. Passive learning implies that new firms with lower efficiency tend to leave the market after realizing their modest competitiveness. Whereas, active learning suggests that establishments with improved efficiency enjoy higher surviving opportunity and smaller efficiency dispersion.

On the other hand, some studies revealed that efficiency decreases with increasing operation age (Pitt and Lee, 1981; Page, 1984; Lundvall and Battese, 2000; Liedholm, 2001; Tran et al., 2008; Aggrey et al., 2010; Le, 2010). It is explained that older firms tend to use old machinery or techniques, while younger counterparts implement advanced technology, new machinery and equipment. Aggrey et al. (2010) suggested the tradeoff of experience and old styled capital stock, while Lundvall and Battese (2000) emphasized the weaker impact of the selection process and learning-by-doing in comparison with depreciation of capital stock.

Some studies revealed the U-shaped relation between firm efficiency and firm age (Soderbom and Teal, 2004) meaning that efficiency decreases by year in operation and the tendency remains until a threshold. And, firms with an age higher than the threshold become more efficient over time.

#### *6.1.1.2. Firm Size*

Firm size is an important determinant of efficiency. Firms of different size employ different technologies, and, consequently, cope with different factor choices and factor prices. The un-uniform factor choices and factor prices induce the variation in efficiency of different firms (Soderbom and Teal, 2004; Yang and Chen, 2009). Theoretically, the relationship between firm size and firm efficiency is ambiguous. On the one hand, efficiency may be positively related to scale or larger firms tending to perform more efficiently. Large firms take advantage of economies of scale, investment in new technology as well as research and development, credit access, management skill, market power and outward orientation (Alvarez and Crespi, 2003; Kim, 2003; Sinani, Jones, and Mygind, 2003; Yang and Chen, 2009; Saignaleuth, 2013). These firms also employ efficient human capital including owners education, skilled workers (Alvarez and Crespi, 2003; Taymaz, 2005; Yang and Chen, 2009; Aggrey et al., 2010). Moreover, with better ability in coordinating resources, large firms tend to suffer lower average production cost (Seth, 1995; Sinani et al., 2003; Taymaz, 2005; Yang and Chen, 2009). In contrast, small and medium firms are impossible to be economies of scale, lacking in market power and qualified human capital. Furthermore, credit constraints prevent them from acquiring advanced technologies or investment in research and development (Kim, 2003; Yang and Chen, 2009).

On the other hand, smaller firms may be more efficient than larger firms because they can adjust their activities and respond to outside change quickly (Taymaz, 2005; Yang and Chen, 2009), their simple organization structure causes no agency problem and lowers agency cost (Kim, 2003; Aggrey et al., 2010). In addition, some causes lowering efficiency of large firms have been examined. Aggrey et al. (2010) argued that large firms tend to pay attention to process, form and bureaucracy besides performance result. Meanwhile Yang and Chen (2009) stated that large enterprises are likely to operate in a more monopolistic environment compared to SMEs and therefore, they have little motivation to improve efficiency.

The positive impact of firm size on efficiency can be found in many studies including Lundvall and Battese (2000), Sinani et al. (2003), Nguyen et al. (2007), Chu and Kalirajan (2010), and Amornkitvikai (2011). Chu and Kalirajan (2010) found that medium and large firms tend to be more efficient than small firms as their advantage of scale economies and larger firms tend to perform at a lower cost curve. In contrast, the negative effect of firm size on efficiency is revealed in a number of studies including Liedholm (2001), Tran et al. (2008), Le (2010), Charoenrat (2012). If firm size and its efficiency are not linearly related, the (inverse) U-shaped relation can be revealed. For instance, the U-shaped relationship between size and efficiency is found in Kim (2003), while the inverse U-shaped relation is found in Aggrey et al. (2010).

#### *6.1.1.3. Ownership Types*

Performance of ownership types have been compared by a number of authors for different countries. Among three ownership types, i.e. SOEs, DPEs and FIEs, SOEs have received preferential treatments due to tradition of favoring SOEs (Nguyen & van Dijk, 2012). Considered as leading economic sector, SOEs enjoy various priorities, i.e. land, credit and export quotas, market information and policy facilitation (Nguyen and Le, 2005; Pham et al., 2013; Truong, 2013). Despite this bias treatment, SOEs have registered moderate outcomes. For instance, SOEs accounted for 45% of total investment during 2006-2010, but generated only 27.8% of GDP and 25.5% of industry's gross output and created no new jobs. Meanwhile, DPEs generated 46.7% of GDP, 28.3% of gross output of industry and created nearly three-fourths of total new employment, but this sector made up only 27.5% of total investment.

Domestic private enterprise sector is recognized as a dynamic economic sector and a driving force of the economy by its impressive contribution, especially in GDP growth, industrial output, and job creation (Nguyen & Luu, 2010). DPEs have accounted for 82-97% of the total number of enterprises and 30-61% of total employees working in enterprises. However, most DPEs are young and small, and they usually operate in labor-intensive areas and obtain low labor productivity, and, consequently, their performance lags behind SOEs and FIEs. DPEs, moreover, bear some constraints and obstacles, i.e. weak corporate governance, land access, finance and technology, administrative barriers, and informal charges (micro-corruption, commission, extra payments) that lessen their performance.

FIEs relate to MNCs and inherit merits from the parent companies. FIEs, in a review of Bellak, (2004), expose performance gaps against domestic counterparts in productivity, technology, profit ability, wage, skills and growth. These advantages stem from their superiority in managerial skills, technical know-how, market information, better access to export (Hallward-Driemeier et al., 2006; Aggrey et al., 2010). FIEs are found to outperform against domestic counterparts in some studies (Hallward-Driemeier et al., 2006; Aggrey et al., 2010; Amornkitvikai, 2011; Charoenrat, 2012), while its ambiguous performance is found in other studies (Nguyen et al., 2007; Hoang et al., 2008; Phan & Ngo, 2012). Following Hoang et al. (2008), Vietnamese manufacturing FIEs are more technically efficient than SOEs, but less than DPEs. In the same line, L. Phan & Ngo, (2012) found that variation in operating results of FIEs by cooperative type with domestic counterparts and by industry does not ensure their top performance. Performance comparison between SOEs and DPEs and in some cases FIEs, always introduce the lower efficiency of SOEs (Vu, 2003a; Hallward-Driemeier et al., 2006; Nguyen et al., 2007; Hoang et al., 2008; Vixathep, 2008; Phan & Ngo, 2012) due to their weak management, and less motivation to be efficient.

#### *6.1.1.4. Location*

Empirical studies suggested the importance of a convenient location for firm efficiency. Firms located in an urban, municipality or metropolitan area are believed to have better access to capital, quality labor, and technology, more market opportunities, market information and communication. Positive evidence of locating in an urban, municipality or metropolitan area can be found in Tran et al. (2008) and Charoenrat (2012). Tran et al. (2008) suggested that owners and employees in metropolitan areas might be more educated and have better technical and management knowledge. In contrast with those studies, C. L. V. Le (2010) argued that high land and labor cost and space constraint prevent firms in urban areas from being more efficient.

Different geographical locations are not the same in natural endowment, infrastructure, economic growth level, regulations, and so on. Therefore, firms in more convenient areas are expected to perform better. Hoang et al. (2008) used provincial GDP as a proxy for provinces and investigate the positive association between provincial GDP and firm efficiency.

#### *6.1.1.5. Capital Intensity*

Capital intensity calculated by the ratio of capital to labor is an important measure of technology level that affects enterprise efficiency. A firm is efficient if its technology is appropriate with operating condition (Hoang et al., 2008). Therefore, in reality, a negative relationship between firm efficiency and capital intensity is recorded by Nguyen et al. (2007), Chu and Kalirajan (2010), and Saignaleuth (2013). Chu and Kalirajan (2010) suggested that low skilled labor ratio in Vietnam implies a modest ability in adopting new technologies. In the same vein, Saignaleuth (2013) explained the inappropriateness of labor skill level to new machinery in Laos. In contrast, the positive correlation investigated by Nguyen et al. (2007) indicates that SMEs in Vietnam use labor-intensive technology.

#### *6.1.1.6. Human Capital*

Human capital is an important factor influencing firm efficiency and productivity. Huffman (1977) emphasized the role of human capital on allocative efficiency through the allocative ability that is an acquired skill to reveal changes in economic conditions and react effectively. The ability can be enhanced through education, experience of reallocating resources and useful information. Heads of a firm with higher education are likely to facilitate higher allocative efficiency.

Quality of human capital can be measured by the share of skilled workers out of total employees or by wage or labor cost. In many studies, human capital quality has been found to be positively related to firm efficiency (Nguyen and Truong, 2007; Chu and Kalirajan, 2010; Charoenrat, 2012). Chu and Kalirajan (2010) not only found a positive impact of the share of skilled labor to firm technical efficiency, but also revealed the connection between share of skilled labor and capital intensity.

### 6.1.2. Leverage

Financial leverage of a firm determined by the ratio of debt to total assets is a measure of a firm’s capital structure. Leverage may relate to firm efficiency positively or negatively through two main mechanisms, i.e. the agency cost theory and the free cash-flow theory.

The agency cost theory was mentioned by Jensen and Meckling (1976) representing the interest conflict between borrowers and lenders. While lenders want to protect their money, borrowers tend to invest in risky projects for higher return. Lenders do not benefit more if borrowers gain, but they are likely to lose their money if borrowers fail. Hence, lenders may raise the interest rate or collateral conditions and induce “underinvestment” leading to higher indebted firms suffering higher cost and lower performance. The agency cost theory, thus, represents a negative relation between leverage and firm performance. Russell (2013) suggested that disposal costs, monitoring costs and costs pertaining to risks, i.e. higher interest rates, are some possible forms of agency costs.

Another channel of leverage effect is the free cash-flow theory indicating that firms with higher external debt tend to perform better. This theory proposed by Jensen (1986) introduces the conflict between shareholders and managers. Managers are supposed to use the substantial free cash flow for their own benefit without considering wasteful resources or shareholders' desire of maximizing firm value. However, the pressure of debt financing and debt's interest payment forces them to reduce the wasteful use of a firm's cash flow and hence, enhance the firm's operation. The reduction of free cash flow implies lower debt and higher efficiency.

Moreover, Russell (2013) suggested a mechanism in which debt ratio affects cost efficiency. Firms prefer to use debt for their operation rather than equity since the cost of debt is cheaper than the cost of equity. Interest payment also lessens tax obligations and lowers the cost structure of a firm. In this manner, a firm's cost efficiency is positively related to the firm's debt. Nevertheless, so much debt induces an inverse impact as the higher firm's debt is accompanied with higher risk leading to a higher interest rate set by lenders and resulting in higher cost of capital and lower cost efficiency.

A number of studies suggest that financial constraints positively correlate to firm efficiency (Sena, 2006; Amornkitvikai and Harvie, 2011), while Margaritis & Psillaki (2008) found an inverse relation. Sena (2006) found the positive effect of finance constraints to technical efficiency improvement of Italian manufacturing firms during 1989-1994. Finance constraints is proxied by the debt-to-ratio, meaning that the high debt ratio induces less chance to borrow from external sources. Subsequently, that situation encourages firms to reduce technical inefficiencies in order to ensure positive profits and gains in productivity.

### 6.1.3. Concentration/ Competition Degree

One common measure of market concentration degree is the Herfindahl-Hirschman Index (HHI) or Herfindahl index, in short. HHI is defined by the summation of squared share of each firm in the market or in the industry. A higher value of HHI implies higher concentration or lower competition degree. A lower value of the HHI means higher competition, and in a highly competitive market firms are forced to be more efficient instead of stagnating or leaving the market. Therefore, a competitive industry or market is expected to induce more efficient firms.

Some studies revealed the positive impact of competition on firm efficiency. For instance, Hoang et al. (2008) and Vu (2013) for Vietnamese manufacturing firms, and Sinani et al. (2003) for Estonian firms. Vu (2013) stated that private enterprises utilize their existing production technologies more efficiently in the moderate competition market, while Hoang et al. (2008) claimed that more effectively allocated resources induce the improvement of firms' technical efficiency. In contrast with those studies, Chu and Kalirajan (2010) found the inverse role of competition in enhancing technical efficiency of manufacturing firms in Vietnam. The authors concluded that the existence of some low competitive industries not only negatively influences performance of efficient firms in the industries, but also lowers the effort to be more efficient of other firms in the market. This finding is the same as that of Zhang, Zhang, and Zhao (2001) for Chinese enterprises.

### 6.1.4. Foreign Direct Investment Spillover

Foreign Direct Investment (FDI) is an important external source of capital, technology and knowledge for host countries and their domestic enterprises. The presence of multinational companies' subsidies provides additional capital source, new technologies, managerial skills and marketing techniques that contributively improve productivity and competitiveness of local enterprises through technological transfer and knowledge spillover (Javorcik, 2004). Nguyen, Simpson, Saal, Nguyen, & Pham (2008) mentioned the benefits of FDI to the host economy and to domestic firms that the host economy benefits from growth of workers, increase in exports, the raise of tax revenue as well as knowledge diffusion. Whereas, domestic enterprises benefit from the presence of FDI through narrowed marginal products of capital and labor, and spillovers of new technologies and management skills. Moreover, the fierce competition forces local firms to perform more efficiently.

FDI influences local firms through some sorts of spillovers, which can be understood as "the impact of the presence of multinational enterprises (MNEs) on the productivity of local firms" (Gerschewski, 2013). There are two main sorts of spillover effects, horizontal spillovers and vertical spillovers. Horizontal spillovers or intra-industry spillovers occur between MNE affiliates and domestic firms within an industry, while vertical spillovers or inter-industry spillovers occur between MNEs and their customers (forward linkage) or suppliers (backward linkage).

Horizontal spillover effects capture knowledge and technology transfer from MNCs to local firms in the same industry that take place through three channels: (i) demonstrated effect, (ii) labor movement (labor mobility) effect, (iii) competitive effect (Nguyen et al., 2008; Gerschewski, 2013). In terms of demonstration effects, domestic firms adapt new technologies introduced by MNE affiliates by imitating them. Gerschewski (2013) suggested that local firms copy a new technology from MNEs since they have no knowledge about it or they cannot afford to adapt it. In order to compete with local firms in a strange environment, foreign investors use their advantage of modern technology and new products. In response, domestic enterprises imitate the advanced technologies and new product method. The imitation effect results in the upgrade of technology and the improvement in productivity of local firms (Nguyen, 2008). In contrast, the negative impact of the demonstration effect appears if the current technology level of domestic firms is very far from that of MNCs (wide technology gap) and they cannot absorb modern technologies from MNCs. This phenomenon relates to the concept of "absorptive capacity", reflecting capacity of firms in identification, assimilation and usage of knowledge from the environment (Blalock & Simon, 2009). Furthermore, MNC subsidiaries might protect their technology leakage and prevent spillovers through intellectual property protection, trade secrecy, and/or use a location where local firms have low imitation ability (Javorcik, 2004).

The labor mobility effect happens when workers who worked for and experienced training course by MNCs move to the domestic sector, and then diffuse the knowledge obtained from MNCs. In turn, domestic firms benefit in terms of productivity enhancement. The importance of the labor movement effect for developing countries with a low share of skilled labors is emphasized by Gorg & Strobl (2005). In contrast, MNC affiliates prevent the movement by paying higher wages to their employees and restrict the labor mobility effect (Javorcik, 2004).

The competitive effect or market stealing effect implies that the presence of foreign owned companies will reduce market share of domestic enterprises and raise competitive levels. Local firms can overcome the competitive pressure by updating new technologies and/or increase the efficiency level of using resources that enhance their efficiency and productivity. Also, the competitive effects boost the speed of adoption or imitation of new technologies of domestic enterprises. Blomstrom (1986) found that competitive effect is the most important spillover effect of FDI in Mexico. However, the market stealing effect of FDI can negatively impact the performance of domestic firms. In this situation, it is named the crowding-out effect, which reflects the inability of local firms to compete with MNCs. Aitken and Harrison (1999) emphasized the failure of domestic firms in competition with MNC affiliates in the short-run. They argued that foreign firms taking advantage of lower marginal costs are likely to produce new products that compete directly to similar products of domestic counterparts. It leads to the reduction in production of domestic firms and, consequently, reduction in their productivity.

The vertical spillover encompasses two effects, forward linkage and backward linkage. The forward linkage (upstream effects) occurs between MNC subsidies and their local clients. Local firms benefit by product improvement from their foreign owned suppliers as well as training programs, technical support, and cheaper intermediate inputs (Javorcik, 2004; Nguyen et al., 2008). The backward linkage (downstream effects) occurs between the MNC subsidiaries and local suppliers. The downstream effects include the provision of production and job opportunities for domestic partners, direct channel for knowledge diffusion, and greater interactions. The effects are also conducted through knowledge transfer, i.e. technical assistance in production processes. MNC subsidies can ask for higher quality products as well as punctual delivery that force the improvement of technological capacity and management of local suppliers. Consequently, local suppliers achieve higher productive efficiency levels (Javorcik, 2004; Nguyen et al., 2008). In addition, Javorcik (2004) emphasized that demand for intermediate inputs rises with the presence of MNCs affiliates, and, in return, local suppliers can achieve economies of scale. The impact of FDI spillover is expected to be positive and the relation has been found in many empirical studies. However, a negative effect or no effect has been revealed in some studies. Javorcik (2004) claimed that, in nature, spillovers are more vertical than horizontal. And inside vertical effects, backward linkage is the more likely channel (Kokko, 1992, p.47; Javorcik, 2004). Blalock and Simon (2009) provided two reasons for the frequently-arisen downstream effect: (i) MNC affiliates tend to transfer technology to local suppliers to increase productivity of MNCs rather than sharing technology to competitors in host countries, and (ii) technologies transferred to local suppliers are less complex, so the host country's suppliers can adopt.

Generally, FDI produces positive effects on domestic macroeconomy, industry and firms. The spillover effects, nevertheless, are not automatic. The impacts not only depend on domestic firm characteristics (technology gap, absorptive capacity, etc.) but also depend on characteristics of MNCs (the speed of building upstream and downstream networks, information leakage protection) or MNCs technology's "appropriateness" (Kokko, 1994), and the country's/industry's characteristics (country development level, business environment, skill and capacity of the host country). For instance, type of entry strategy, MNC ownership structure, MNC affiliates' market orientation and their international operations are possible factors influencing the backward linkage (Javorcik, 2004).

The topic of FDI spillover has been studied widely for developed and developing countries. Most studies, nonetheless, concentrate on analyzing FDI spillover effects on productivity in FDI's destinations. To date, the number of studies on FDI effects to firm efficiency is modest. This line might have started by Sinha's study (1993) for Indian industry and has continued in the studies of Driffield & Munday (2001) for the United Kingdom, Ghali & Rezgui (2008) for Tunisia, Suyanto & Salim (2013) for Indonesia, Saignaleuth (2013) for Laos, Nguyen et al. (2008), Le and Pomfret (2011) and Nguyen, Nguyen, Pham, & Ha (2014) for Vietnam. Among these studies, some consider horizontal spillover only (Driffield and Munday, 2001; Saignaleuth, 2013) and some consider both horizontal and vertical spillovers (Ghali & Rezgui, 2008; Nguyen et al., 2008; Suyanto & Salim, 2013; Nguyen et al., 2014). While Driffield and Munday (2001), Nguyen et al. (2008) and Saignaleuth (2013) found a positive impact of horizontal spillover, Nguyen et al. (2014) found a negative impact. The evidence of a significantly positive role of backward spillover is found in Suyanto and Salim (2013) and Nguyen et al. (2014), while a significantly positive forward linkage is only found in Nguyen et al. (2008).

Ghali and Rezgui (2008) aim to investigate FDI contribution to technical efficiency of Tunisian manufacturing firms. Different from other studies, the authors used the dummy variable of foreign ownership and the share of FDI to gross fixed capital of each sector as the proxies for FDI spillover. The empirical results show no evidence of spillover from FDI to firms' technical efficiency for the whole sample. It may suggest that the difference of variable definition leads to those results.

Suyanto and Salim (2013) examined the spillover effect of FDI on technical efficiency for the Indonesian pharmaceutical sector. They employed the stochastic frontier production function for a total of 1001 observations during the period 1990-1995. The estimation for the whole sample and domestic firms share confirms a significantly positive contribution of backward linkage to inefficiency reduction. The positive relations indicate that local suppliers benefit from updated knowledge from foreign firms in order to produce high quality inputs for foreign clients. The horizontal effect is insignificant to technical efficiency for the whole sample, implying few acquirements of domestic firms from foreign counterparts. Whereas, the negative and significant relation between technical efficiency and FDI horizontal spillover for domestic firms indicates an excessive competitive effect compared to the demonstration effect.

Saignaleuth (2013) examined spillover effects of FDI on Laos firm performance by estimating technical efficiency with spillover, characteristics of firm (age, location, size, foreign ownership) and capital-labor ratio for 291 manufacturing and service firms in 2009. Age and size impact positively firm technical efficiency, while no relationship between efficiency and location was found. The insignificant relationship between foreign ownership and efficiency is explained by the small share of foreign-owned firms. Moreover, most of them are of medium and large scale, and tend to deal with big investment projects that take time to start and receive benefits. The finding of the positive relationship between FDI spillovers and technical efficiency of Laos manufacturing and service firms implies that firms with higher foreign shares tend to use resources more efficiently and obtain improvements in technical efficiency and productivity. However, the spillover effect used in this study is horizontal effect, meaning that vertical effects were not mentioned.

Nguyen et al. (2008) analyzed the impacts of FDI spillover on the technical efficiency of Vietnamese manufacturing small and medium firms during 2002-2004 in an attempt to fill the big gap of empirical studies on FDI spillover to firms' technical efficiency. They examined horizontal and vertical spillover effects. One emerging point making the study different from other studies is that the authors separated two measures of horizontal effect: the horizontal output spillover and the horizontal employment spillover. The former exhibits the demonstration effect and the competition effect, and the latter exhibits the labor movement effect. The coefficients of the horizontal output variable are positive and significant at 10% confirming the reduction of productive inefficiency of domestic manufacturing SMEs to compete with FIEs. In contrast, the significantly negative coefficient of the horizontal labor suggests no movement of skilled employees from FIEs to DPEs. The positive relation between technical efficiency and forward linkage implies that domestic firms benefit from new, improved, and/or cheaper intermediate inputs by FIEs. Surprisingly, there is no evidence of backward linkage on firm technical efficiency. This might be explained by FIEs having benefited from cheap labor and rich natural resource endowments by using labor-intensive techniques and purchasing raw materials from local suppliers. Following Nguyen et al. (2008), the author uses two types of horizontal spillover for clear contributions of labor mobility effect and demonstration effect, competitive effect.

The latest study on this field for Vietnam is one by Nguyen et al. (2014). The authors examined FDI effects on technical efficiency and efficiency convergence of firms in four manufacturing sectors (food, beverage and tobacco, textile and garment, footwear and wood products) in the period 2000-2011. The findings show a significantly negative impact of horizontal spillover and a significantly positive effect of backward linkage. Horizontal spillover increases technical inefficiency, suggesting the predomination of labor mobility effect and imitation effect over the competition effect. Meanwhile, backward linkage induces improvement of efficiency, forward linkage presents no impact, perhaps, due to more costly and inappropriate inputs provided by FIEs.

All the above studies analyze the effects of FDI spillover to technical efficiency, whereas none of them consider FDI spillovers' impact on allocative efficiency. Following Caves (1974), the productive spillovers might include the improvement of technological transfer, technical efficiency and allocative efficiency. Technical efficiency improvement may result from competitive pressure and demonstration effects, while allocative efficiency enhancement may result from less monopolistic distortions. Moreover, as analyzed above, under the competitive pressure by the presence of MNCs, domestic firms must use their resources more efficiently (Javorcik, 2004; Suyanto and Salim, 2013), which might lead to improvement of allocative efficiency as well. Also, FDI spillovers can influence overall efficiency since this measure is the product of technical efficiency and allocative efficiency.

### 6.1.5. Business Environment

The business environment or investment climate is "the institutional, policy, and regulatory environment in which firms operate" (Dollar, Hallward-Driemeier, and Mengistae, 2005). Kinda (2009) emphasized the importance of investment climate factors including infrastructure, finance, human capital, institutions, regulatory policies in productivity variation in developing countries. Dollar et al. (2005) suggested that a good regulatory framework for infrastructure, accession to the international market and financial services may induce the improvement in productivity and profitability of firms. Furthermore, regulation environment was introduced as an major factor of allocative inefficiency for banks in Pakistan by Niazi (2003) that regulation may be a barrier for banks to allocate resources optimally.

For the Vietnamese case, Nguyen and Le (2005) found the institutional constraints including credit, land, and export quotas induced the lower productivity level of domestic private firms and foreign firms in comparison to state-owned enterprises. Supposing that those obstacles are removed, DPEs and FIEs yield higher productivity than SOEs and FIEs yield higher TFP level than SOEs. Tran, Grafton, and Kompas (2009) investigated the positive effect of PCI 2006 on labor productivity of manufacturing firms in 2005, while they found the positive impact of some sub-indices. Particularly, private sector development service, land tenure and labor training recorded their role on improving firm operation through providing market information, land reforms and labor training. However, there were no evidence of transparency, dispute and transaction cost. Nguyen, Le, and Bryant (2013) revealed the positive role of information transparency on a firm's performance, and emphasized that apart from firm endowments, i.e. resources, geographical location, its choice of place to operate relates to institutions and business factors at the province-level. Pham (2013)'s findings suggest the robust importance of infrastructure, finance, investment-friendly and transparent environment in enhancing firm technical efficiency. Among investment climate factors, security is recognized as the largest constraint.

## 6.2. Empirical Results and Discussion

In the second stage of the two-stage DEA model, the Tobit model is utilized to investigate factors associated with efficiencies of manufacturing firms in Vietnam.[52] Based on the aggregate data, some data groups are divided for regression. First, the Tobit model is regressed for pooled sample. Second, the Tobit model is applied for subsets of firm size, particularly, LEs and SMEs, in order to reveal whether impacts of determinants vary by firm scale. Finally, the DPEs subset is extracted from the aggregate data set to examine possible effects of FDI spillovers and PCI.

Empirical results for determinants of efficiency for aggregate manufacturing enterprises are summarized and presented in Table 6-1, while results for manufacturing LEs and SMEs are exhibited in Table 6-2 and Table 6-3, respectively. Table 6-4 shows summary of efficiency effects for manufacturing DPEs. Those tables are recapped from fully empirical results in Table 6-15 to Table 6-26, respectively. Then, influences of each factor to efficiencies are represented in the following sections.

[52] The OLS regression is also carried out to check the robustness. It is appeared that empirical results estimated by two methods are similar, confirming the robustness of the results by the Tobit model. The OLS regression's results are not included in this thesis.

**Table 6-1. Determinants of Efficiency for Manufacturing Enterprises**

| | Dependent variable: TE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| lnAge | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LE | + | + | + | + | + | + | + | + | + | + | + | + | + |
| DPE | | - | | | | | | | | | | | |
| FIE | | | 0 | | | | | | | | | | |
| Urban | + | 0 | + | + | + | + | + | 0 | + | + | + | + | + |
| lnCAPIN | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Vocatn | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Univpost | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Leverage | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HHI | | | | + | | | | | | | | | |
| HZ_GO | | | | + | | | | | | | | | |
| HZ_L | | | | - | | | | | | | | | |
| FW | | | | - | | | | | | | | | |
| BW | | | | + | | | | | | | | | |
| PCI | 0 | 0 | 0 | - | | | | | | | | | |
| Entrycost | | | | | 0 | | | | | | | | |
| Land | | | | | | 0 | | | | | | | |
| Transprn | | | | | | | 0 | | | | | | |
| Timecost | | | | | | | | 0 | | | | | |
| Informal | | | | | | | | | 0 | | | | |
| Proact | | | | | | | | | | 0 | | | |
| Support | | | | | | | | | | | 0 | | |
| Laborpolicy | | | | | | | | | | | | 0 | |
| Institution | | | | | | | | | | | | | 0 |

| | Dependent variable: AE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| lnAge | + | + | + | + | + | + | + | + | + | + | + | + | + |
| LE | + | + | + | + | + | + | + | + | + | + | + | + | + |
| DPE | | - | | | | | | | | | | | |
| FIE | | | + | | | | | | | | | | |
| Urban | + | 0 | 0 | + | + | + | + | + | + | + | + | + | + |
| lnCAPIN | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Vocatn | 0 | 0 | 0 | 0 | - | - | 0 | - | - | 0 | - | 0 | - |
| Univpost | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Leverage | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HHI | | | | - | | | | | | | | | |
| HZ_GO | | | | - | | | | | | | | | |
| HZ_L | | | | + | | | | | | | | | |
| FW | | | | 0 | | | | | | | | | |
| BW | | | | - | | | | | | | | | |
| PCI | + | + | + | + | | | | | | | | | |
| Entrycost | | | | | + | | | | | | | | |
| Land | | | | | | + | | | | | | | |
| Transprn | | | | | | | + | | | | | | |
| Timecost | | | | | | | | + | | | | | |
| Informal | | | | | | | | | + | | | | |
| Proact | | | | | | | | | | + | | | |
| Support | | | | | | | | | | | 0 | | |
| Laborpolicy | | | | | | | | | | | | + | |
| Institution | | | | | | | | | | | | | + |

| | Dependent variable: CE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| lnAge | + | + | + | + | + | + | + | + | + | + | + | + | + |
| LE | + | + | + | + | + | + | + | + | + | + | + | + | + |
| DPE | | - | | | | | | | | | | | |
| FIE | | | + | | | | | | | | | | |
| Urban | + | + | + | + | + | + | + | + | + | + | + | + | + |
| lnCAPIN | 0 | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vocatn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Univpost | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Leverage | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HHI | | | | 0 | | | | | | | | | |
| HZ_GO | | | | + | | | | | | | | | |
| HZ_L | | | | - | | | | | | | | | |
| FW | | | | - | | | | | | | | | |
| BW | | | | 0 | | | | | | | | | |
| PCI | + | + | + | + | | | | | | | | | |
| Entrycost | | | | | + | | | | | | | | |
| Land | | | | | | + | | | | | | | |
| Transprn | | | | | | | + | | | | | | |
| Timecost | | | | | | | | + | | | | | |
| Informal | | | | | | | | | + | | | | |
| Proact | | | | | | | | | | + | | | |
| Support | | | | | | | | | | | 0 | | |
| Laborpolicy | | | | | | | | | | | | + | |
| Institution | | | | | | | | | | | | | + |

Source: Author's calculation. Note: "+" or "-" means significantly positive or negative relation, 0 means a coefficient is statistically insignificant.

**Table 6-2. Determinants of Efficiency for Manufacturing Large Enterprises**

| | Dependent variable: TE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| lnAge | - | - | - | - | - | - | - | - | - | - | - | - | - |
| DPE | | 0 | | | | | | | | | | | |
| FIE | | | 0 | | | | | | | | | | |
| Urban | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| lnCAPIN | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Vocatn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Univpost | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Leverage | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HHI | | | | + | | | | | | | | | |
| HZ_GO | | | | + | | | | | | | | | |
| HZ_L | | | | - | | | | | | | | | |
| FW | | | | 0 | | | | | | | | | |
| BW | | | | 0 | | | | | | | | | |
| PCI | 0 | 0 | 0 | - | | | | | | | | | |
| Entrycost | | | | | 0 | | | | | | | | |
| Land | | | | | | 0 | | | | | | | |
| Transprn | | | | | | | 0 | | | | | | |
| Timecost | | | | | | | | 0 | | | | | |
| Informal | | | | | | | | | 0 | | | | |
| Proact | | | | | | | | | | 0 | | | |
| Support | | | | | | | | | | | 0 | | |
| Laborpolicy | | | | | | | | | | | | 0 | |
| Institution | | | | | | | | | | | | | 0 |

| | Dependent variable: AE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| lnAge | + | + | + | + | + | + | + | + | + | + | + | + | + |
| DPE | | 0 | | | | | | | | | | | |
| FIE | | | 0 | | | | | | | | | | |
| Urban | + | + | + | + | + | + | + | + | + | + | + | + | + |
| lnCAPIN | + | + | 0 | + | + | + | + | + | + | + | + | + | + |
| Vocatn | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Univpost | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Leverage | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HHI | | | | - | | | | | | | | | |
| HZ_GO | | | | - | | | | | | | | | |
| HZ_L | | | | + | | | | | | | | | |
| FW | | | | 0 | | | | | | | | | |
| BW | | | | 0 | | | | | | | | | |
| PCI | 0 | 0 | 0 | + | | | | | | | | | |
| Entrycost | | | | | 0 | | | | | | | | |
| Land | | | | | | 0 | | | | | | | |
| Transprn | | | | | | | 0 | | | | | | |
| Timecost | | | | | | | | 0 | | | | | |
| Informal | | | | | | | | | 0 | | | | |
| Proact | | | | | | | | | | 0 | | | |
| Support | | | | | | | | | | | + | | |
| Laborpolicy | | | | | | | | | | | | 0 | |
| Institution | | | | | | | | | | | | | 0 |

| | Dependent variable: CE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| lnAge | + | + | + | + | + | + | + | + | 0 | + | + | + | + |
| DPE | | 0 | | | | | | | | | | | |
| FIE | | | 0 | | | | | | | | | | |
| Urban | + | + | + | + | + | + | + | + | + | + | + | + | + |
| lnCAPIN | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Vocatn | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Univpost | 0 | 0 | 0 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Leverage | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HHI | | | | 0 | | | | | | | | | |
| HZ_GO | | | | 0 | | | | | | | | | |
| HZ_L | | | | 0 | | | | | | | | | |
| FW | | | | 0 | | | | | | | | | |
| BW | | | | 0 | | | | | | | | | |
| PCI | 0 | 0 | 0 | 0 | | | | | | | | | |
| Entrycost | | | | | 0 | | | | | | | | |
| Land | | | | | | 0 | | | | | | | |
| Transprn | | | | | | | 0 | | | | | | |
| Timecost | | | | | | | | 0 | | | | | |
| Informal | | | | | | | | | - | | | | |
| Proact | | | | | | | | | | 0 | | | |
| Support | | | | | | | | | | | 0 | | |
| Laborpolicy | | | | | | | | | | | | 0 | |
| Institution | | | | | | | | | | | | | 0 |

Source: Author's calculation. Note: "+" or "-" means significantly positive or negative relation, 0 means a coefficient is statistically insignificant.

**Table 6-3. Determinants of Efficiency for Manufacturing Small and Medium Enterprises**

| | Dependent variable: TE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| lnAge | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DPE | | - | | | | | | | | | | | |
| FIE | | | + | | | | | | | | | | |
| Urban | + | + | + | + | + | + | + | + | + | + | + | + | + |
| lnCAPIN | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Vocatn | 0 | 0 | + | 0 | 0 | 0 | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Univpost | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Leverage | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HHI | | | | + | | | | | | | | | |
| HZ_GO | | | | + | | | | | | | | | |
| HZ_L | | | | - | | | | | | | | | |
| FW | | | | - | | | | | | | | | |
| BW | | | | + | | | | | | | | | |
| PCI | 0 | 0 | 0 | 0 | | | | | | | | | |
| Entrycost | | | | | 0 | | | | | | | | |
| Land | | | | | | 0 | | | | | | | |
| Transprn | | | | | | | 0 | | | | | | |
| Timecost | | | | | | | | 0 | | | | | |
| Informal | | | | | | | | | 0 | | | | |
| Proact | | | | | | | | | | 0 | | | |
| Support | | | | | | | | | | | 0 | | |
| Laborpolicy | | | | | | | | | | | | 0 | |
| Institution | | | | | | | | | | | | | 0 |

| | Dependent variable: AE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| lnAge | + | + | + | + | + | + | + | + | + | + | + | + | + |
| DPE | | - | | | | | | | | | | | |
| FIE | | | + | | | | | | | | | | |
| Urban | + | + | 0 | + | + | + | + | + | + | + | + | + | + |
| lnCAPIN | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Vocatn | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - |
| Univpost | + | + | + | 0 | + | + | + | + | + | + | + | + | + |
| Leverage | - | - | 0 | - | - | - | - | - | - | - | - | - | - |
| HHI | | | | - | | | | | | | | | |
| HZ_GO | | | | - | | | | | | | | | |
| HZ_L | | | | + | | | | | | | | | |
| FW | | | | 0 | | | | | | | | | |
| BW | | | | - | | | | | | | | | |
| PCI | + | + | + | + | | | | | | | | | |
| Entrycost | | | | | 0 | | | | | | | | |
| Land | | | | | | + | | | | | | | |
| Transprn | | | | | | | + | | | | | | |
| Timecost | | | | | | | | + | | | | | |
| Informal | | | | | | | | | + | | | | |
| Proact | | | | | | | | | | + | | | |
| Support | | | | | | | | | | | 0 | | |
| Laborpolicy | | | | | | | | | | | | + | |
| Institution | | | | | | | | | | | | | + |

| | Dependent variable: CE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| lnAge | + | + | + | + | + | + | + | + | + | + | + | + | + |
| DPE | | - | | | | | | | | | | | |
| FIE | | | + | | | | | | | | | | |
| Urban | + | + | + | + | + | + | + | + | + | + | + | + | + |
| lnCAPIN | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Vocatn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Univpost | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Leverage | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HHI | | | | 0 | | | | | | | | | |
| HZ_GO | | | | + | | | | | | | | | |
| HZ_L | | | | - | | | | | | | | | |
| FW | | | | - | | | | | | | | | |
| BW | | | | 0 | | | | | | | | | |
| PCI | + | + | + | + | | | | | | | | | |
| Entrycost | | | | | 0 | | | | | | | | |
| Land | | | | | | + | | | | | | | |
| Transprn | | | | | | | + | | | | | | |
| Timecost | | | | | | | | + | | | | | |
| Informal | | | | | | | | | + | | | | |
| Proact | | | | | | | | | | + | | | |
| Support | | | | | | | | | | | 0 | | |
| Laborpolicy | | | | | | | | | | | | + | |
| Institution | | | | | | | | | | | | | + |

Source: Author's calculation.

Note: "+" or "-" means significantly positive or negative relation, 0 means a coefficient is statistically insignificant.

**Table 6-4. Determinants of Efficiency for Manufacturing Private Domestic Enterprises**

| | Dependent variable: TE | | | | | | | | | | | | Dependent variable: AE | | | | | | | | | | | | Dependent variable: CE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| lnAge | 0 | 0 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| LE | | + | | | | | | | | | | | | + | | | | | | | | | | | | + | | | | | | | | | | |
| Urban | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| lnCAPIN | - | - | - | - | - | - | - | - | - | - | - | - | + | + | + | + | + | + | + | + | + | + | + | + | - | - | - | - | - | - | - | - | - | - | - | - |
| Vocatn | + | 0 | 0 | 0 | + | 0 | + | + | 0 | + | + | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Univpost | 0 | 0 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | + | 0 | + | + | 0 | + | + | 0 | 0 | 0 | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Leverage | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HHI | | | + | | | | | | | | | | | | - | | | | | | | | | | | | 0 | | | | | | | | | |
| HZ_GO | | | + | | | | | | | | | | | | - | | | | | | | | | | | | + | | | | | | | | | |
| HZ_L | | | - | | | | | | | | | | | | + | | | | | | | | | | | | 0 | | | | | | | | | |
| FW | | | - | | | | | | | | | | | | - | | | | | | | | | | | | - | | | | | | | | | |
| BW | | | + | | | | | | | | | | | | 0 | | | | | | | | | | | | + | | | | | | | | | |
| PCI | 0 | 0 | 0 | | | | | | | | | | + | + | + | | | | | | | | | | + | + | + | | | | | | | | | |
| Entrycost | | | | - | | | | | | | | | | | | + | | | | | | | | | | | | 0 | | | | | | | | |
| Land | | | | | 0 | | | | | | | | | | | | + | | | | | | | | | | | | + | | | | | | | |
| Transprn | | | | | | 0 | | | | | | | | | | | | + | | | | | | | | | | | | + | | | | | | |
| Timecost | | | | | | | 0 | | | | | | | | | | | | + | | | | | | | | | | | | + | | | | | |
| Informal | | | | | | | | 0 | | | | | | | | | | | | + | | | | | | | | | | | | + | | | | |
| Proact | | | | | | | | | 0 | | | | | | | | | | | | + | | | | | | | | | | | | + | | | |
| Support | | | | | | | | | | 0 | | | | | | | | | | | | 0 | | | | | | | | | | | | 0 | | |
| Laborpolicy | | | | | | | | | | | 0 | | | | | | | | | | | | + | | | | | | | | | | | | + | |
| Institution | | | | | | | | | | | | 0 | | | | | | | | | | | | + | | | | | | | | | | | | + |

Source: Author’s calculation
Note: “+” or “-“ means significantly positive or negative relation, 0 means a coefficient is statistically insignificant.

### 6.2.1. Firm Characteristics

#### *6.2.1.1. Firm Age*

Firm age is one source of firm efficiency. For the whole of manufacturing firms, SME and DPE groups, firm age exhibits no relation with technical efficiency, but relates negatively for LEs, meaning that for large enterprises, younger firms tend to be more efficient. This result is consistent with the findings of some studies (Pitt and Lee, 1981; Page, 1984; Lundvall and Battese, 2000; Liedholm, 2001; Tran, Grafton, and Kompas, 2008; Aggrey et al., 2010; C. L. V. Le, 2010). Firm age associates positively with allocative efficiency for all datasets, implying that firms with longer time in operation are likely to be more allocative efficient. Older firms, according to Jovanovic (1982), may learn from failures and realize their efficiency level or optimal scale, and react to market changes quickly and effectively. The significant and positive impact of age on allocative efficiency outweighs insignificant impact on technical efficiency and leads to the increasing trend of overall efficiency by time in operation, which indicates the "learning-by-doing" effect.

**Table 6-5. Firm Age and Efficiencies**

| **lnAge** | **TE** | **AE** | **CE** |
|---|---|---|---|
| All manufacturing | 0 | + | + |
| Large enterprises | - | + | + |
| Small and medium enterprises | 0 | + | + |
| Domestic private enterprises | 0 | + | + |

Source: Author's calculation
Note: "+" or "-" means significantly positive or negative relation, 0 means a coefficient is statistically insignificant.

#### *6.2.1.2. Firm Size*

Being consistent with our prediction, large firms outperform SMEs in terms of efficiencies. The predominance is presented for aggregate manufacturing firms, and for DPEs. Large firms tend to be more efficient because of superior organization or technology knowledge. Moreover, LEs are more technology intensive and have larger capability in allocating resources (Seth, 1995; Sinani et al., 2003; Taymaz, 2005; Adeoti, 2009; Yang and Chen, 2009). In this sample, these corresponding figures support these authors' idea.

Particularly, large manufacturing firms and large DPEs are higher in capital intensity and lower in average cost than SMEs. On average, LEs' capital intensity ratio is VND124.87 million per head compared to VND120.34 million SMEs. Average production cost of LEs is 0.787 and lower than that of SMEs (0.831), while large DPEs' average cost is 0.773 compared to 0.838 of small and medium DPEs.

**Table 6-6. Firm Size and Efficiencies**

| LE (dummy) | TE | AE | CE |
|---|---|---|---|
| All manufacturing | + | + | + |
| Domestic private enterprises | + | + | + |

Source: Author's calculation
Note: "+" or "-" means significantly positive or negative relation, 0 means a coefficient is statistically insignificant.

Various empirical studies found that large firms take advantage of economies of scale and market power (Sinani et al., 2003; Kim, 2003; Amornkitvikai, 2011; Charoenrat, 2012; Yang and Huang, 2012; Saignaleuth, 2013). 56.5% of large firms in our data are FIEs having higher possibility in obtaining new machinery or technologies than domestic private counterparts. Generally, large firms are less likely to face capital constraint than smaller ones, so they can get new machinery or technologies faster. This explanation is consistent with Charoenrat (2012).

#### *6.2.1.2. Ownership Types*

Efficiency may vary by type of ownership. The empirical results represent that DPEs are likely to be less efficient than SOEs for manufacturing firms as a whole, and for SMEs. As mentioned in section 5.2.3, this finding is inconsistent with previous studies, representing the lower technical efficiency level of SOEs than other ownership types. Manufacturing firms in this sample differ in input prices. In particular, SOEs take advantage of cheap credit access to banks and pay lower interest rates compared to DPEs, and as a result they have the lowest average production cost. Therefore, SOEs are observed with higher efficiency than DPEs. Disparity of all efficiency measurements of SOEs and DPEs as reported in Chapter 5, are significant at the 1% level.

**Table 6-7. Types of Ownership and Efficiencies**

| | *DPE* | | | *FIE* | | |
|---|---|---|---|---|---|---|
| | **TE** | **AE** | **CE** | **TE** | **AE** | **CE** |
| All manufacturing | - | - | - | 0 | + | + |
| Large enterprises | 0 | 0 | 0 | 0 | 0 | 0 |
| Small and medium enterprises | - | - | - | + | + | + |

Source: Author's calculation
Note: "+" or "-" means significantly positive or negative relation, 0 means a coefficient is statistically insignificant.

FIEs appear to be more cost efficient than SOEs for all manufacturing enterprises and for manufacturing SMEs since they are more allocative efficient than SOEs. For SME sample, FIEs are even more efficient than SOEs. The higher allocative efficiency lever of FIEs originates from their superior technology and financial strength. They register absolutely higher capital intensity level than SOEs, VND206.9 million per employee compared to VND97.3 million. FIEs, due to their high management skill and experience of doing business in different markets, can fulfill the conditions to reallocate resources better than SOEs, i.e. realizing economic condition changes, making decisions and responding quickly and effectively. Most FIEs in Vietnam are enterprises with 100% foreign capital making up around 80% of total FIEs, which have the same merits as their parent companies in home countries and are more likely to achieve higher allocative efficiency than SOEs.

For large enterprises, insignificant coefficients suggest efficiency equality among different types of ownership. SOEs, especially large ones, enjoy priorities of financial support by the government, credit and land access, market information and policy favor. Meanwhile, large FIEs take advantage of financial strength, managerial skills, advanced technology and equipment, markets and business connections along with land and administrations (Malesky et al., 2014). Therefore, efficiency similarity of large SOEs and large FIEs is understandable. Despite most DPEs are small and medium sustaining various obstacles, large DPEs are competitive with SOEs and FIEs in the same scale. These large DPEs might be connected domestic firms, which benefit from close relationships with government officials and banks. According to the Vietnam Report 500, the number of large DPEs out of the 500 largest companies nationwide has increased continuously from 137 firms in 2007 to 221 firms in 2014, from 169 to 203 for SOEs, and from 135 to 76 for FIEs, respectively.[53]

#### *6.2.1.3. Firm Location*

The result shows evidence that manufacturing firms located in urban areas are likely to be more efficient than their counterparts in rural areas. It implies that being located in urban areas is advantageous for market information and business opportunities, accession of technology and so induces higher efficiency. The doubly positive effect of urban location on technical efficiency and allocative efficiency reduces a firm's production cost and leads to a higher overall efficiency level compared to the counterparts in rural areas. Charoenrat (2012) found that Thai manufacturing SMEs operating in urban areas take advantage of good infrastructure, and easy access to resources. Moreover, due to earlier mentioned conveniences, enterprise density in urban areas is much higher than in rural areas leading to higher competition and inducing lower average production cost and higher cost efficiency.

**Table 6-8. Firm Location and Efficiencies**

| **Urban (dummy)** | **TE** | **AE** | **CE** |
|---|---|---|---|
| All manufacturing | 0/+ | 0/+ | + |
| Large enterprises | 0 | + | + |
| Small and medium enterprises | + | + | + |
| Domestic private enterprises | 0 | 0 | 0/+ |

Source: Author's calculation
Note: "+" or "-" means significantly positive or negative relation, 0 means a coefficient is statistically insignificant.

DPEs in urban areas also have lower average cost than that of DPEs in rural areas and are more overall efficient. The result might connect with some advantages of being located in urban areas, following Malesky et al. (2008): (i) labor policies and private sector development policies generate more opportunities for business match-making, labor and technicians; (ii) proactive business associations make better exchanges with local government; and (iii) high density of private enterprises is associated with better monitors and greater influences on enterprises.

[53] VNR500-The top 500 companies in Vietnam has been conducted since 2007 by the Vietnam Report Joint Stock Company, based on their revenue.

#### *6.2.1.4. Capital Intensity*

Capital intensity is found to be significantly and negatively related to technical efficiency of all samples. The results contradict with those obtained by Hoang et al. (2008), Vixathep (2008), Nguyen et al. (2014), but following those by Nguyen et al. (2007), Chu and Kalirajan (2010), Saignaleuth (2013). This paper shares the same idea with previous studies that manufacturing employees with a low level of skill have little ability in adopting new technologies or using new machines and equipment. On average, around 53% of total employees of manufacturing enterprises in this sample have no training certificates.

In contrast, capital intensity records a significantly positive relation to allocative efficiency, for the pooled sample, LEs, SMEs, and DPEs, suggesting that more capital invested per worker generates more choices for firms to reallocate resources, i.e. reduce number of workers, and firms are likely to be more allocatively efficient. The negative impact on technical efficiency outweighs positive impact on allocative efficiency and lessens overall efficiency for all manufacturing, for the LE and DPE sample. It means that higher investment in technology and machinery does not lower production cost. Adversely, the investment's impact is eroded by the low rate of skilled labor that is less likely to adopt new technology or use new machinery and equipment. Actually, the lack of skilled labor and technical know-how remains the third biggest constraint of enterprises, according to the survey on firm-level competitiveness and technology (CIEM, DoE, & GSO, 2012a, 2012b).[54] This finding suggests that improving workforce quality is more important and must be implemented prior to investment of new machinery. Only SMEs tend to be more cost efficient accompanied with a higher capital intensity level as the result of appropriate in technology level and human capital of SMEs. In particular, capital intensity of SMEs is lower than that of LEs and aggregate manufacturing enterprises (VND120.3 million per worker compared to VND 124.9 million and VND 121.0 million, respectively), but higher ratio of employees with vocational certificates (37.46% compared to 37.23% and 37.43%, respectively) and undergraduate or higher degree (9.52% compared to 7.02% and 9.15%, respectively).

[54] This is one component of the enterprise survey of GSO, and has been implemented under the cooperation of CIEM, DoE and GSO since 2011.

**Table 6-9. Capital Intensity and Efficiencies**

| lnCAPIN | TE | AE | CE |
|---|---|---|---|
| All manufacturing | - | + | 0/- |
| Large enterprises | - | 0/+ | - |
| Small and medium enterprises | - | + | + |
| Domestic private enterprises | - | + | - |

Source: Author's calculation
Note: "+" or "-" means significantly positive or negative relation, 0 means a coefficient is statistically insignificant.

#### *6.2.1.5. Human Capital*

Human capital is an important determinant of firm efficiency. In this thesis, two proxies for human capital are used, i.e. share of employees with vocational certificates (*Vocatn*) and share of employees with undergraduate or graduate certificates (*Univpost*). Human capital, however, does not exhibit a strong impact to efficiency measurements. The relation might be caused by the low skilled labor ratio.[55]

**Table 6-10. Human Capital and Efficiencies**

| | *Vocatn* | | | *Univpost* | | |
|---|---|---|---|---|---|---|
| | **TE** | **AE** | **CE** | **TE** | **AE** | **CE** |
| All manufacturing | + | 0/- | 0 | + | 0 | + |
| Large enterprises | 0 | + | + | + | 0 | 0/+ |
| Small and medium enterprises | 0/+ | 0/- | 0 | + | + | + |
| Domestic private enterprises | 0/+ | 0 | 0/+ | 0/+ | 0/+ | + |

Source: Author's calculation
Note: "+" or "-" means significantly positive or negative relation, 0 means a coefficient is statistically insignificant.

*Vocatn* associates positively with technical efficiency for aggregate manufacturing firms, SMEs and DPEs, meaning that a higher proportion of skilled labor promotes enterprises' technical efficiency. Overall efficiency also positively relates to *Vocatn* for the LE group. Whereas, *Vocatn* presents no clear-cut relation with allocative efficiency, except for LEs. Normally, employees with vocational certificates are workers, and they contribute little in business decisions that lead to improvement of allocative efficiency. Following Huffman (1977), in terms of human capital, only owners or managers of a firm contribute to its allocative efficiency enhancement, not all employees inside a firm.

[55] See section 2.1.4.4 in Chapter 2 for more details.

Compared to *Vocatn*, *Univpost* introduces a more robustly positive connection with efficiency measurements for all manufacturing enterprises. The positive relation of human quality and technical efficiency can be found in studies by Nguyen & Truong (2007), Chu & Kalirajan (2010) and Charoenrat (2012). Notably, the coefficients of *Univpost* are larger than those of *Vocatn* in all groups, indicating larger contribution of laborers with a higher education to firm performance. These findings on the relation of human capital and efficiencies combined with those of capital intensity yield some policy implications that greater effort need to be made to upgrade the education and training system as well as training programs in order to raise labor quality and meet firms' labor demand.

### 6.2.2. Leverage

Financial leverage is significantly and negatively associated with all three efficiency measurements, implying that higher debt to asset ratio induces a lower efficiency level. This result is different from the findings of Sena (2006) and Amornkitvikai (2011), which concluded that leverage forces technical inefficiency reduction. However, it is similar with Margaritis and Psillaki (2008)'s study in both sign of the leverage variable and the average debt ratio.

**Table 6-11. Financial Leverage and Efficiencies**

| Leverage | TE | AE | CE |
|---|---|---|---|
| All manufacturing | - | - | - |
| Large enterprises | - | - | - |
| Small and medium enterprises | - | -/0 | - |
| Domestic private enterprises | - | - | - |

Source: Author's calculation

Note: "+" or "-" means significantly positive or negative relation, 0 means a coefficient is statistically insignificant.

A negative relationship between firm leverage and efficiencies is the evidence of the agency-cost theory, which "traces imperfect credit markets to asymmetric information" (Tran & Santarelli, 2013). Actually, imperfection of Vietnamese capital market was confirmed by O'Toole & Newman (2012). The imperfection associated with asymmetric information originates from the fact that most enterprises in Vietnam are young and small. In this sample, 65% of manufacturing enterprises is below the average year in operation, and 79% of total enterprises are small. Since most enterprises are young, their business performance and reputation is not well-known in the market.[56] Also, young firms bear weaker legitimacy than older firms as they lack knowledge, understanding and acceptance as a result of little information of their existence and performance (Le, Venkatesh, & Nguyen, 2006). Small size, according to Le et al. (2006), is believed to be associated with poor book-keeping ability, financial statements and business plans as well as transparent business transactions. Moreover, young and small enterprises may have no strong network, which limits their recognition. Information asymmetry, subsequently, lessens accurate evaluation of lenders, and in response, higher interest rate and/or collaterals are set to mitigate higher risks. As a result, the larger credit firms borrow, the bigger cost they bear. Russell (2013) suggested that disposal costs, monitoring costs and costs pertaining to risks, i.e. higher interest rates, are some possible forms of agency costs. Vietnamese DPEs and SMEs must pay higher interest rates to obtain bank loans compared to SOEs and LEs, therefore, sustain higher agency costs that lessen their efficiencies.

### 6.2.3. Concentration Degree

The statistical description shows that the concentration of Vietnam's manufacturing industry in this study increases over time. Particularly, the Herfindahl-Hirschman index rises from 0.0191 (2007) to 0.0402 (2011). Although the low HHI indicates that the Vietnamese market is unconcentrated, the higher level of concentration suggests less competitiveness. The HHI variable is found to be positively related to technical efficiency for aggregate manufacturing firms, for all groups. Chu & Kalirajan (2010) suggested that higher concentration is associated with lower competiveness and induces little motivation for firms to be more efficient.

Whereas, negative and significant coefficients of HHI in the regression models of allocative efficiency strongly support the positive relation between competitive degree and allocative efficiency. However, the competitiveness degree represents no impact on overall efficiency as a result of opposite effects on technical efficiency and allocative efficiency. It might stem from the lower competitiveness level of the manufacturing industry.

[56] Le, Venkatesh, & Nguyen (2006) examined the relation between growth stage of firms and accessibility to bank financing. The positive relation shows that younger firms with less reputation tend to obtain fewer bank loan than experienced counterparts.

**Table 6-12. Concentration Degree and Efficiencies**

| HHI | TE | AE | CE |
|---|---|---|---|
| All manufacturing | + | - | 0 |
| Large enterprises | + | - | 0 |
| Small and medium enterprises | + | - | 0 |
| Domestic private enterprises | + | - | 0 |

Source: Author's calculation
Note: "+" or "-" means significantly positive or negative relation, 0 means a coefficient is statistically insignificant.

### 6.2.4. FDI Spillovers

FDI spillovers consist of the horizontal effects and the vertical effects. This section is to examine the impacts of the two effects on efficiency performance of Vietnamese manufacturing firms.

#### *6.2.4.1. Horizontal Effects*

*a. Demonstration Effect and Competition Effect*

The empirical findings of FDI spillovers on manufacturing firm efficiencies are ambiguous. The horizontal effect by output (*HZ_GO*) is found to have a positive relation to technical efficiency of all samples. This result is consistent with findings by Driffield and Munday (2001), Sinani et al. (2003), Nguyen et al. (2008) and Vu (2013), suggesting that the appearance of FDI forces domestic firms to increase effectiveness of existing technology, and utilize resources to compete with FIEs in the same industry (competition effect). Moreover, local enterprises benefit from imitating advanced technology of foreign counterparts within an industry (demonstration effect). All manufacturing firms, SMEs, and DPEs are more cost efficient because of their high technical efficiency. This indicates that higher competition pressure and more advanced technology accompanied by MNCs encourage reduction in production cost of local firms within the industry. Variable *HZ_GO* has negative impact on allocative efficiency.

*b. Labor Mobility Effect*

The horizontal effect by labor (*HZ_L*) positively relates to allocative efficiency for all manufacturing and subsets, implying a contribution and benefit of employees in MNC affiliates, who moved to domestic enterprises or established their owned enterprises. Those people benefit from MNCs' superior production technology, management skill, and marketing network (Phan and Ramstetter, 2004). The know-how is helpful in the rearrangement of production, reallocation of resources as well as quickly responding to market changes that improve allocative efficiency of manufacturing firms. In our in-depth interview of metal mechanics SMEs in Vietnam in the summer of 2013, it was found that owners who worked for MNC affiliates were successful in their business due to advanced knowledge, and market information obtained from MNC affiliates.

*HZ_L* negatively correlates with technical efficiency, meaning that the higher the labor movement effect is, the lower technically efficient manufacturing enterprises are. Overall, the labor mobility effect leads to lower overall efficiency for the pooled sample and SME.

**Table 6-13. FDI Spillovers and Efficiencies**

| | *HZ_GO* | | | *HZ_L* | | | *FW* | | | *BW* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **TE** | **AE** | **CE** | **TE** | **AE** | **CE** | **TE** | **AE** | **CE** | **TE** | **AE** | **CE** |
| Pooled | + | - | + | - | + | - | - | 0 | - | + | - | 0 |
| LEs | + | - | 0 | - | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SMEs | + | - | + | - | + | - | - | 0 | - | + | - | 0 |
| DPEs | + | - | + | - | + | 0 | - | - | - | + | - | + |

Source: Author's calculation
Note: "+" or "-" means significantly positive or negative relation, 0 means a coefficient is statistically insignificant.

#### *6.2.4.2. Vertical Spillovers*

*a. Forward Linkage*

Forward linkage (*FW*) reports significant and negative influences on technical efficiency and overall efficiency, except for LEs. This finding is in line with that of Javorcik (2004) who investigated the negative effect of forward linkage on performance of manufacturing firms in Lithuania. On the contrary, Ghali and Rezgui (2008), and Nguyen et al. (2008) found a positive relation between forward linkage and firm technical efficiency, which suggests that local firms, acting as clients of FIEs or MNC affiliates, benefit from advanced technology, management knowledge and improved and relatively cheap intermediate inputs. No reported improvement in technical efficiency by forward linkage probably stems from the fact that FIEs export most of their products. The ratio of export value of the FDI sector to net turnover of FIEs has increased and reached nearly 97.0% in 2011.[57] Moreover, according to the firm-level competitiveness and technology

[57] This number is calculated based on the value of commodity export of the foreign invested sector and net turnover of FIEs from the enterprise survey and is proxied for share of export to total output of the FDI sector.

report, at the enterprise level, the rate of technology transfer from overseas suppliers has been improved, but remained modest. In 2011, only 4.4% and 14.2% of enterprises received direct transfer of technology from suppliers overseas and domestically, respectively. In 2012, those numbers were higher, 14.7% and 14.0%. Forward linkage is found to lower efficiency performance of DPEs, being contrary to the expectation.

*b. Backward Linkage*

Backward linkage (*BW*) represents a significant and positive relation with technical efficiency of manufacturing firms except for LEs, indicating the positive effect of foreign firms to their local suppliers. Significant backward linkage could be seen in studies of (Javorcik, 2004; Suyanto & Salim, 2013; Nguyen et al., 2014).

The higher downstream effect encourages higher technical efficiency for the pooled sample, SMEs and DPEs. According to Blalock & Simon (2009), impacts of backward linkage may vary, depending on firm capabilities: production capabilities, absorptive capacity and complementary capabilities. Among the three capabilities, absorptive capacity (proxied by investment for R&D), and human capital (percentage of employees with senior high school or higher degrees) presented the most robust and positive correlation with firm productivity. SMEs, in our data, might have greater absorptive capacity due to their higher human capital compared to LEs.

The positive sign of *BW* on technical efficiency of DPEs presents evidence of a downstream effect on performance of domestic private firms. Technical efficiency and overall efficiency of DPEs, in return, caused by backward linkage may originate from the wide technology gap of DPEs compared to FIEs. In our survey, as mentioned above, local SMEs acting as suppliers for FIEs were recognized to have better performance. All companies having contacts with big FIEs said that they had received technical support from foreign clients in a number of ways. Moreover, FIEs' high requirement of product quality and punctual delivery forces those domestic firms to enhance their performance, efficiency and productivity.

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Net turnover was converted from VND to USD by using USD/VND exchange rate (average of year) released by the Asian Development Bank. The ratios of export to net turnover of FIEs during the period 2006-2011 are 78.2%; 89.6%; 88.2%; 64.4%; 89.3% and 96.9%, respectively.

Large firms seem not to be affected by the FDI spillovers, in terms of horizontal effect to cost efficiency and vertical effect to all efficiency measurements. No significant vertical effects were observed for LEs at all, implying that LEs are neither clients nor suppliers of MNC affiliates. Generally, spillovers from FIEs to manufacturing enterprises remain modest and some impacts do not follow the expectation.

#### 6.2.5. Business Environment

The Provincial Competitiveness Index and its sub-indices are employed to investigate the impacts of business environment to efficiency performance of manufacturing firms. The aggregate PCI and each sub-index are regressed separately to examine individual effects for in-depth policy implications for provincial governments. Business environment is observed with insignificant relations to technical efficiency. This result should be interpreted with a caution that local institution and regulation reforms are not strong enough to stimulate technical efficiency of manufacturing firms. The finding is opposite to that of Kinda (2009) and Pham (2013). Kinda (2009) made use of the Enterprise Survey by the World Bank and revealed that better business environment improves technical efficiency for enterprises in Brazil, Morocco, Pakistan, South Africa, and Vietnam. In the same line, Pham (2013) employed data from the same survey for Vietnam and found that business environment associates with technical efficiency of manufacturing enterprises.

Business environment tends to positively associate with allocative efficiency and overall efficiency, but not technical efficiency. This phenomenon happens for PCI and almost all of its sub-indices, suggesting that improvement in institutional and regulation reforms of local government results in higher ability in reacting to market change and consequently, reducing cost inefficiency. The role of business environment on allocative efficiency was emphasized by Kinda (2009), in that efficient public services and shorter time for government regulations stimulates firm allocative efficiency.

Notably, large manufacturing enterprises seem not to be affected by business environment. Large firms are believed to have close connections with government organizations and/or officials, commercial banks and credit institutions and get benefit from the relations in terms of land, credit, information, business contracts, etc. Local policy bias to SOEs, connected firms (large DPEs), and FIEs has been recognized and has caused the crowding-out effect to DPEs (Malesky et al., 2014). For DPEs, the existence of connected firms is the main reason of inequality of resources access among private enterprises. Following Perkins et al. (2013), connected firms have accessed huge amount of credit and land due to their close relations to government officials and banks. Meanwhile, credit and land are two main obstacles of other DPEs (all are small or medium). Probably, the regulation and policy reform that provincial government is trying to do for private sector is that large enterprises have already benefited. Hence, the relations between local governance and efficiencies of LEs are not recognized.

**Table 6-14. Business Environment and Efficiencies**

| | *PCI* | | | *Entrycost* | | | *Land* | | | *Transprn* | | | *Timecost* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **TE** | **AE** | **CE** | **TE** | **AE** | **CE** | **TE** | **AE** | **CE** | **TE** | **AE** | **CE** | **TE** | **AE** | **CE** |
| Pooled | 0 | + | + | 0 | + | + | 0 | + | + | 0 | + | + | 0 | + | + |
| LEs | 0/- | 0/+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SMEs | 0 | + | + | 0 | 0 | 0 | 0 | + | + | 0 | + | + | 0 | + | + |
| DPEs | 0 | + | + | - | + | 0 | 0 | + | + | 0 | + | + | 0 | + | + |

| | *Informal* | | | *Proact* | | | *Support* | | | *Laborpolicy* | | | *Institution* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **TE** | **AE** | **CE** | **TE** | **AE** | **CE** | **TE** | **AE** | **CE** | **TE** | **AE** | **CE** | **TE** | **AE** | **CE** |
| Pooled | 0 | + | + | 0 | + | + | 0 | 0 | 0 | 0 | + | + | 0 | + | + |
| LEs | 0 | 0 | - | 0 | 0 | 0 | 0 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SMEs | 0 | + | + | 0 | + | + | 0 | 0 | 0 | 0 | + | + | 0 | + | + |
| DPEs | 0 | + | + | 0 | + | + | 0 | 0 | 0 | 0 | + | + | 0 | + | + |

Source: Author's calculation
Note: "+" or "-" means significantly positive or negative relation, 0 means a coefficient is statistically insignificant.

For sub-indices of PCI, some have similar impacts to efficiency performance. Particularly, *Land, Transprn, Timecost, Proact,* and *Laborpolicy* do not affect technical efficiency, and efficiencies of LEs, but they encourage allocative efficiency and lead to higher overall efficiency level for almost all manufacturing enterprises, SMEs and DPEs. The findings imply that manufacturing firms benefit from local government's effort in easing entry procedures and related procedures during firm operation, improving policy and information transparency, enhancing proactivity and encouraging skilled labor supply. This finding is consistent with the results of Nguyen et al. (2013) and Pham & Nguyen

(2014), suggesting the encouragement of institutional environment on performance of private manufacturing firms in Vietnam.

With regard to transparency (*Transprn*), better transparency of regulation and plans and better access to information stimulates firm's allocative efficiency. It means that the greater information, especially regulation information, a firm acquires, the better projection it makes. The prediction is the basis for building the business strategy and business plans, and better utilization of resources. Subsequently, the enterprise's allocative and overall efficiency is improved. This finding is consistent with that of Nguyen et al. (2013), and McCulloch, Malesky, & Nguyen (2013), but inconsistent with that of Tran et al. (2009). McCulloch et al. (2013)'s finding emphasizes the importance of transparency in the aspect that better access to business information, regulatory information, risk mitigation, and fewer personal connections encourages private firms to invest and expand their investment.

With respect to informal charges (*Informal),* lower informal charges stimulate inputs allocation and consequently, reduce production cost. Informal charges including bribes and extra payments in regulatory compliance negatively affects firms through the payments and disturbance. The result is supported by the study of Nguyen & van Dijk (2012) that the private sector's growth is debilitated by corruption. Similarly, Pham (2013) found that corruption and payments for "speed-up" bureaucracy are two obstacles lowering technical efficiency of manufacturing enterprises.

*Entrycost* shows moderate impact on manufacturing enterprises' efficiency. The whole manufacturing enterprises benefit from lower start-up costs through the improvement of allocative efficiency and cost efficiency. Nevertheless, the DPEs, the object of local economic governance, undergo a negative effect of the market entry cost on their technical efficiency. This result surprises us since the cost of market entry has been reduced significantly in all indicators of this index. Yet, improvement of entry costs stimulates DPEs' allocative efficiency as a compensation for the inverse effect on their technical efficiency. Overall, entry cost's enhancement seems not to be along with cost efficiency improvement for DPEs.

Among PCI's sub-indices, the index *Support* is recognized least impact on performance of manufacturing firms. As mentioned in Chapter 4, by 2008, this index is the

Private Sector Development index, which evaluates quality of the services provided by provincial agencies, i.e. business information search services, consulting on regulatory information, business match-making, trade promotion, technology information and training. Since 2009, with the new name Business Support Services, this index examines quality of these support services through the usage, share of private participation in the services, and the ability to reuse of the service. The variable *Support* does not have significant impacts on efficiencies of all samples, only relates positively with allocative efficiency of LEs, suggesting that the above mentioned services have just been enhanced in scope and number of providers, while not enough consideration has been done to improve quality of the services. Actually, the percentage of enterprises plan to reuse the services is much lower than the percentage of enterprises have used the services. In addition, the positive association with allocative efficiency of LEs suggests that only large enterprises can access and benefit the supports. The result yields a policy implication that along with diversifying supporting services for private enterprises, quality of services should be improved appropriately. Moreover, all types of enterprises should have equal opportunities in accessing these supports.

In sum, regulation and institution reforms by provincial government record positive effect on efficiency performance of manufacturing enterprises, suggesting initial achievements of local government in improving provincial business environment. Positive impacts on allocative efficiency and overall efficiency are observed for the PCI and most sub-indices. Meanwhile, variables of business environment do not affect technical efficiency. Moreover, there is no effects of business environment on large firms, which have close connections with local government organizations/officials, with commercial banks. These results combined with modest effects of market entry cost and business support services yield policy implications that the provincial-level regulation and institution reforms must be continued along with country-level business environment improvements. Enterprises evaluation in the Provincial Competitiveness Index dataset is a useful reference for local government in making a better business environment at the provincial level.

**Table 6-15. Determinants of Technical Efficiency for Manufacturing Enterprises**

| | Dependent variable: TE (Sample: Pooled data) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** |
| C | 0.759*** | 0.780*** | 0.767*** | 0.698*** | 0.779*** | 0.756*** | 0.775*** | 0.736*** | 0.757*** | 0.753*** | 0.744*** | 0.746*** | 0.750*** |
| | (0.026) | (0.028) | (0.027) | (0.023) | (0.035) | (0.024) | (0.026) | (0.025) | (0.025) | (0.019) | (0.020) | (0.023) | (0.023) |
| lnAge | -0.001 | -0.001 | -0.001 | 0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 |
| | (0.003) | (0.003) | (0.003) | (0.004) | (0.003) | (0.003) | (0.003) | 0.003 | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| LE | 0.068*** | 0.065*** | 0.066*** | 0.065*** | 0.068*** | 0.068*** | 0.068*** | 0.068*** | 0.068*** | 0.068*** | 0.068*** | 0.068*** | 0.068*** |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| DPE | | -0.010* | | | | | | | | | | | |
| | | (0.005) | | | | | | | | | | | |
| FIE | | | 0.008 | | | | | | | | | | |
| | | | (0.005) | | | | | | | | | | |
| Urban | 0.008* | 0.007 | 0.007* | 0.007* | 0.008* | 0.008* | 0.009** | 0.007 | 0.008* | 0.009* | 0.008* | 0.008* | 0.008* |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| lnCAPIN | -0.032*** | -0.033*** | -0.033*** | -0.032*** | -0.032*** | -0.032*** | -0.032*** | -0.032*** | -0.032*** | -0.032*** | -0.032*** | -0.032*** | -0.032*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Vocatn | 0.0001* | 0.0001* | 0.0001* | 0.0001* | 0.0001* | 0.0001* | 0.0001* | 0.0001** | 0.0001* | 0.0001* | 0.0001* | 0.0001* | 0.0001* |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| Univpost | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001** | 0.001** | 0.001*** | 0.001*** | 0.001** | 0.001** | 0.001** | 0.0006*** | 0.001*** |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Leverage | -0.043*** | -0.041*** | -0.041*** | -0.046*** | -0.043*** | -0.043*** | -0.043*** | -0.042*** | -0.043*** | -0.043*** | -0.043*** | -0.043*** | -0.043*** |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| HHI | | | | 0.241*** | | | | | | | | | |
| | | | | (0.063) | | | | | | | | | |
| HZ_GO | | | | 0.291*** | | | | | | | | | |
| | | | | (0.024) | | | | | | | | | |
| HZ_L | | | | -0.190*** | | | | | | | | | |
| | | | | (0.020) | | | | | | | | | |
| FW | | | | -0.090*** | | | | | | | | | |
| | | | | (0.028) | | | | | | | | | |
| BW | | | | 0.017*** | | | | | | | | | |
| | | | | (0.006) | | | | | | | | | |
| PCI | -0.0002 | -0.0003 | -0.0003 | -0.001* | | | | | | | | | |
| | (0.0003) | (0.0003) | (0.0003) | (0.0003) | | | | | | | | | |
| Entrycost | | | | | -0.004 | | | | | | | | |
| | | | | | (0.004) | | | | | | | | |
| Land | | | | | | -0.001 | | | | | | | |
| | | | | | | (0.002) | | | | | | | |
| Transprn | | | | | | | -0.005 | | | | | | |
| | | | | | | | (0.003) | | | | | | |
| Timecost | | | | | | | | 0.002 | | | | | |
| | | | | | | | | (0.003) | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Informal | | | | | | | | | -0.001 | | | | |
| | | | | | | | | | (0.003) | | | | |
| Proact | | | | | | | | | | -0.001 | | | |
| | | | | | | | | | | (0.001) | | | |
| Support | | | | | | | | | | | 0.0005 | | |
| | | | | | | | | | | | (0.001) | | |
| Laborpolicy | | | | | | | | | | | | 0.0003 | |
| | | | | | | | | | | | | (0.002) | |
| Institution | | | | | | | | | | | | | -0.001 |
| | | | | | | | | | | | | | (0.003) |
| Dsector | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dyear | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log pseudo likelihood | 2729.9 | 2732.0 | 2731.1 | 2519.5 | 2730.3 | 2729.9 | 2730.8 | 2730.0 | 2729.9 | 2730.2 | 2729.8 | 2729.7 | 2729.8 |
| F | 51.7 | 49.6 | 49.6 | 43.6 | 51.7 | 51.6 | 51.8 | 51.7 | 51.7 | 51.7 | 51.7 | 51.7 | 51.7 |
| Prob > F | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Obs. | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 |

Source: Author’s calculation
Note: 1. Robust standard errors (S.E.) are in parentheses. 2. *, **, and *** indicate that the coefficients are statistically significant at 10%, 5%, and 1%, respectively. 3. Collinearity for all variables were tested.

**Table 6-16. Determinants of Allocative Efficiency for Manufacturing Enterprises**

| | Dependent variable: AE (Sample: Pooled data) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** |
| C | 0.369*** | 0.449*** | 0.411*** | 0.472*** | 0.387*** | 0.410*** | 0.364*** | 0.431*** | 0.394*** | 0.428*** | 0.446*** | 0.418*** | 0.423*** |
| | (0.027) | (0.029) | (0.027) | (0.024) | (0.036) | (0.024) | (0.027) | (0.026) | (0.026) | (0.019) | (0.020) | (0.023) | (0.023) |
| lnAge | 0.018*** | 0.017*** | 0.019*** | 0.015*** | 0.018*** | 0.018*** | 0.017*** | 0.018*** | 0.019*** | 0.018*** | 0.017*** | 0.017*** | 0.018*** |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| LE | 0.081*** | 0.070*** | 0.071*** | 0.084*** | 0.082*** | 0.082*** | 0.081*** | 0.082*** | 0.081*** | 0.081*** | 0.082*** | 0.081*** | 0.082*** |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.005) | (0.005) | (0.006) | (0.005) | (0.005) | (0.006) | (0.005) | (0.005) | (0.005) |
| DPE | | -0.040*** | | | | | | | | | | | |
| | | (0.005) | | | | | | | | | | | |
| FIE | | | 0.042*** | | | | | | | | | | |
| | | | (0.005) | | | | | | | | | | |
| Urban | 0.009** | 0.006 | 0.005 | 0.011** | 0.013*** | 0.009* | 0.010** | 0.012*** | 0.009* | 0.009* | 0.014*** | 0.013*** | 0.011** |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.004) | (0.005) | (0.004) | (0.004) | (0.005) | (0.005) | (0.004) | (0.004) | (0.004) |
| lnCAPIN | 0.031*** | 0.026*** | 0.025*** | 0.032*** | 0.032*** | 0.032*** | 0.032*** | 0.032*** | 0.032*** | 0.031*** | 0.032*** | 0.032*** | 0.032*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Vocatn | -0.0001 | -0.0001 | -0.0001 | -0.0001 | -0.0001* | -0.0001* | -0.0001 | -0.0001* | -0.0001* | -0.0001 | -0.0001* | -0.0001 | -0.0001* |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| Univpost | 0.00002 | 0.00004 | 0.0001 | -0.0003 | 0.00001 | 0.0001 | -0.00002 | 0.000005 | 0.0001 | 0.00004 | -0.00004 | -0.00003 | 0.00001 |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Leverage | -0.044*** | -0.036*** | -0.035*** | -0.045*** | -0.043*** | -0.042*** | -0.043*** | -0.043*** | -0.042*** | -0.044*** | -0.044*** | -0.044*** | -0.043*** |
| | (0.008) | (0.008) | (0.008) | (0.009) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| HHI | | | | -0.338*** | | | | | | | | | |
| | | | | (0.066) | | | | | | | | | |
| HZ_GO | | | | -0.226*** | | | | | | | | | |
| | | | | (0.025) | | | | | | | | | |
| HZ_L | | | | 0.166*** | | | | | | | | | |
| | | | | (0.022) | | | | | | | | | |
| FW | | | | 0.038 | | | | | | | | | |
| | | | | (0.029) | | | | | | | | | |
| BW | | | | -0.024*** | | | | | | | | | |
| | | | | (0.006) | | | | | | | | | |
| PCI | 0.001*** | 0.001*** | 0.001*** | 0.002*** | | | | | | | | | |
| | (0.0003) | (0.0003) | (0.0003) | (0.0003) | | | | | | | | | |
| Entrycost | | | | | 0.008** | | | | | | | | |
| | | | | | (0.004) | | | | | | | | |
| Land | | | | | | 0.007*** | | | | | | | |
| | | | | | | (0.003) | | | | | | | |
| Transprn | | | | | | | 0.014*** | | | | | | |
| | | | | | | | (0.003) | | | | | | |
| Timecost | | | | | | | | 0.003 | | | | | |
| | | | | | | | | (0.003) | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Informal | | | | | | | | | 0.009*** | | | | |
| | | | | | | | | | (0.003) | | | | |
| Proact | | | | | | | | | | 0.005*** | | | |
| | | | | | | | | | | (0.001) | | | |
| Support | | | | | | | | | | | 0.001 | | |
| | | | | | | | | | | | (0.001) | | |
| Laborpolicy | | | | | | | | | | | | 0.006** | |
| | | | | | | | | | | | | (0.002) | |
| Institution | | | | | | | | | | | | | 0.008** |
| | | | | | | | | | | | | | (0.003) |
| Dsector | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dyear | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log pseudo likelihood | 2602.3 | 2630.2 | 2631.9 | 2423.3 | 2595.4 | 2597.3 | 2603.1 | 2593.8 | 2598.9 | 2601.3 | 2593.5 | 2596.1 | 2595.9 |
| F | 59.2 | 58.7 | 59.0 | 58.8 | 58.1 | 58.6 | 59.1 | 58.0 | 58.6 | 59.0 | 57.9 | 58.5 | 58.4 |
| Prob > F | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Obs. | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 |

Source: Author's calculation
Note: 1. Robust standard errors (S.E.) are in parentheses. 2. *, **, and *** indicate that the coefficients are statistically significant at 10%, 5%, and 1%, respectively. 3. Collinearity for all variables were tested.

**Table 6-17. Determinants of Cost Efficiency for Manufacturing Enterprises**

| | Dependent variable: CE (Sample: Pooled data) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** |
| C | 0.309*** | 0.363*** | 0.336*** | 0.327*** | 0.326*** | 0.328*** | 0.318*** | 0.332*** | 0.318*** | 0.340*** | 0.351*** | 0.332*** | 0.338*** |
| | (0.013) | (0.014) | (0.013) | (0.013) | (0.017) | (0.011) | (0.013) | (0.012) | (0.012) | (0.008) | (0.009) | (0.010) | (0.011) |
| lnAge | 0.010*** | 0.009*** | 0.011*** | 0.010*** | 0.010*** | 0.010*** | 0.010*** | 0.010*** | 0.010*** | 0.010*** | 0.010*** | 0.010*** | 0.010*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| LE | 0.100*** | 0.093*** | 0.094*** | 0.100*** | 0.101*** | 0.101*** | 0.100*** | 0.101*** | 0.100*** | 0.100*** | 0.101*** | 0.100*** | 0.101*** |
| | (0.003) | (0.003) | (0.003) | (0.004) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| DPE | | -0.027*** | | | | | | | | | | | |
| | | (0.002) | | | | | | | | | | | |
| FIE | | | 0.026*** | | | | | | | | | | |
| | | | (0.003) | | | | | | | | | | |
| Urban | 0.009*** | 0.006*** | 0.006*** | 0.009*** | 0.010*** | 0.008*** | 0.009*** | 0.009*** | 0.008*** | 0.008*** | 0.011*** | 0.011*** | 0.009*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| lnCAPIN | -0.0004 | -0.004*** | -0.004*** | -0.00004 | 0.0001 | -0.00004 | -0.0002 | 0.00001 | -0.0002 | -0.0004 | 0.0001 | -0.0002 | -0.00002 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Vocatn | 0.00001 | 0.00002 | 0.00003 | 0.00004 | -0.00001 | -0.000004 | 0.000003 | -0.000004 | -0.000001 | 0.00001 | -0.00001 | 0.000003 | -0.000001 |
| | (0.00003) | (0.00003) | (0.00003) | (0.00003) | (0.00003) | (0.00003) | (0.00003) | (0.00003) | (0.00003) | (0.00003) | (0.00003) | (0.00003) | (0.00003) |
| Univpost | 0.0004*** | 0.0004*** | 0.0004*** | 0.0005*** | 0.0004*** | 0.0004*** | 0.0004*** | 0.0004*** | 0.0004*** | 0.0004*** | 0.0004*** | 0.0004*** | 0.0004*** |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Leverage | -0.064*** | -0.059*** | -0.059*** | -0.067*** | -0.064*** | -0.063*** | -0.064*** | -0.064*** | -0.063*** | -0.064*** | -0.064*** | -0.064*** | -0.064*** |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| HHI | | | | -0.045 | | | | | | | | | |
| | | | | (0.029) | | | | | | | | | |
| HZ_GO | | | | 0.051*** | | | | | | | | | |
| | | | | (0.012) | | | | | | | | | |
| HZ_L | | | | -0.018* | | | | | | | | | |
| | | | | (0.011) | | | | | | | | | |
| FW | | | | -0.034*** | | | | | | | | | |
| | | | | (0.013) | | | | | | | | | |
| BW | | | | -0.003 | | | | | | | | | |
| | | | | (0.003) | | | | | | | | | |
| PCI | 0.001*** | 0.001*** | 0.0005*** | 0.001*** | | | | | | | | | |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | | | | | | | | | |
| Entrycost | | | | | 0.003* | | | | | | | | |
| | | | | | (0.002) | | | | | | | | |
| Land | | | | | | 0.004*** | | | | | | | |
| | | | | | | (0.001) | | | | | | | |
| Transprn | | | | | | | 0.006*** | | | | | | |
| | | | | | | | (0.002) | | | | | | |
| Timecost | | | | | | | | 0.003** | | | | | |
| | | | | | | | | (0.001) | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Informal | | | | | | | | | 0.006*** | | | | |
| | | | | | | | | | (0.001) | | | | |
| Proact | | | | | | | | | | 0.003*** | | | |
| | | | | | | | | | | (0.001) | | | |
| Support | | | | | | | | | | | 0.0004 | | |
| | | | | | | | | | | | (0.001) | | |
| Laborpolicy | | | | | | | | | | | | 0.004*** | |
| | | | | | | | | | | | | (0.001) | |
| Institution | | | | | | | | | | | | | 0.004** |
| | | | | | | | | | | | | | (0.002) |
| Dsector | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dyear | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log pseudo likelihood | 6143.5 | 6195.1 | 6192.0 | 6092.3 | 6134.9 | 6139.4 | 6139.7 | 6136.3 | 6142.0 | 6142.5 | 6133.6 | 6137.6 | 6136.3 |
| F | 73.7 | 74.5 | 73.0 | 93.5 | 71.5 | 73.0 | 73.1 | 71.9 | 73.5 | 73.6 | 71.6 | 72.3 | 72.4 |
| Prob > F | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Obs. | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 | 5034 |

Source: Author's calculation

Note: 1. Robust standard errors (S.E.) are in parentheses. 2. *, **, and *** indicate that the coefficients are statistically significant at 10%, 5%, and 1%, respectively. 3. Collinearity for all variables were tested.

**Table 6-18. Determinants of Technical Efficiency for Manufacturing LEs**

| | Dependent variable: TE (Sample: Large Enterprises) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** |
| C | 1.086*** | 1.078*** | 1.079*** | 1.132*** | 1.033*** | 1.039*** | 1.080*** | 1.058*** | 1.108*** | 1.056*** | 1.100*** | 1.088*** | 1.093*** |
| | (0.095) | (0.096) | (0.095) | (0.067) | (0.105) | (0.079) | (0.090) | (0.091) | (0.085) | (0.074) | (0.078) | (0.088) | (0.085) |
| lnAge | -0.027*** | -0.027*** | -0.027*** | -0.023*** | -0.027*** | -0.026*** | -0.027*** | -0.027*** | -0.027*** | -0.027*** | -0.026*** | -0.026*** | -0.027*** |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| DPE | | 0.006 | | | | | | | | | | | |
| | | (0.011) | | | | | | | | | | | |
| FIE | | | -0.010 | | | | | | | | | | |
| | | | (0.012) | | | | | | | | | | |
| Urban | 0.003 | 0.004 | 0.004 | -0.008 | 0.002 | 0.000 | 0.003 | 0.002 | 0.005 | 0.000 | 0.000 | 0.002 | 0.004 |
| | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.010) | (0.011) |
| lnCAPIN | -0.047*** | -0.046*** | -0.045*** | -0.049*** | -0.047*** | -0.047*** | -0.047*** | -0.047*** | -0.046*** | -0.047*** | -0.047*** | -0.047*** | -0.047*** |
| | (0.007) | (0.007) | (0.007) | (0.006) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| Vocatn | 0.00003 | 0.00003 | 0.00002 | 0.000 | 0.00004 | 0.00004 | 0.00003 | 0.00004 | 0.00003 | 0.00004 | 0.00001 | 0.00003 | 0.00003 |
| | (0.0001) | (0.0001) | (0.0001) | (0.000) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| Univpost | 0.002** | 0.002** | 0.002** | 0.002** | 0.002** | 0.002** | 0.002** | 0.002** | 0.002** | 0.002** | 0.002** | 0.002** | 0.002** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Leverage | -0.074*** | -0.075*** | -0.075*** | -0.090*** | -0.074*** | -0.074*** | -0.074*** | -0.074*** | -0.073*** | -0.073*** | -0.076*** | -0.075*** | -0.074*** |
| | (0.022) | (0.022) | (0.022) | (0.023) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HHI | | | | 0.330** | | | | | |
| | | | | (0.156) | | | | | |
| HZ_GO | | | | 0.321*** | | | | | |
| | | | | (0.061) | | | | | |
| HZ_L | | | | -0.207*** | | | | | |
| | | | | (0.051) | | | | | |
| FW | | | | 0.018 | | | | | |
| | | | | (0.079) | | | | | |
| BW | | | | -0.006 | | | | | |
| | | | | (0.018) | | | | | |
| PCI | -0.0002 | -0.0002 | -0.0001 | -0.003*** | | | | | |
| | (0.001) | (0.001) | (0.001) | (0.001) | | | | | |
| Entrycost | | | | | 0.005 | | | | |
| | | | | | (0.010) | | | | |
| Land | | | | | | 0.004 | | | |
| | | | | | | (0.006) | | | |
| Transprn | | | | | | | -0.001 | | |
| | | | | | | | (0.008) | | |
| Timecost | | | | | | | | 0.002 | |
| | | | | | | | | (0.008) | |
| Informal | | | | | | | | | -0.006 |
| | | | | | | | | | (0.007) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proact | | | | | | | | | | 0.002 | | | |
| | | | | | | | | | | (0.003) | | | |
| Support | | | | | | | | | | | -0.004 | | |
| | | | | | | | | | | | (0.003) | | |
| Laborpolicy | | | | | | | | | | | | -0.003 | |
| | | | | | | | | | | | | (0.007) | |
| Institution | | | | | | | | | | | | | -0.005 |
| | | | | | | | | | | | | | (0.022) |
| Dsector | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dyear | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log pseudo likelihood | 449.3 | 449.4 | 449.7 | 386.2 | 449.4 | 449.6 | 449.3 | 449.3 | 449.6 | 449.4 | 450.0 | 449.3 | 449.4 |
| F | 20.4 | 19.7 | 19.9 | 10.5 | 20.4 | 20.5 | 20.4 | 20.5 | 20.6 | 20.7 | 20.4 | 20.4 | 20.5 |
| Prob > F | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Obs. | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 |

Source: Author’s calculation

Note: 1. Robust standard errors (S.E.) are in parentheses. 2. *, **, and *** indicate that the coefficients are statistically significant at 10%, 5%, and 1%, respectively. 3. Collinearity for all variables were tested.

**Table 6-19. Determinants of Allocative Efficiency for Manufacturing LEs**

| | Dependent variable: AE (Sample: Large Enterprises) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** |
| C | 0.504*** | 0.522*** | 0.517*** | 0.503*** | 0.566*** | 0.566*** | 0.472*** | 0.565*** | 0.570*** | 0.531*** | 0.463*** | 0.471*** | 0.502*** |
| | (0.095) | (0.096) | (0.095) | (0.072) | (0.110) | (0.082) | (0.094) | (0.090) | (0.088) | (0.074) | (0.078) | (0.086) | (0.084) |
| lnAge | 0.038*** | 0.038*** | 0.038*** | 0.037*** | 0.038*** | 0.037*** | 0.038*** | 0.038*** | 0.037*** | 0.038*** | 0.037*** | 0.037*** | 0.038*** |
| | (0.008) | (0.008) | (0.008) | (0.009) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| DPE | | -0.013 | | | | | | | | | | | |
| | | (0.012) | | | | | | | | | | | |
| FIE | | | 0.018 | | | | | | | | | | |
| | | | (0.012) | | | | | | | | | | |
| Urban | 0.022* | 0.020* | 0.019* | 0.027** | 0.023** | 0.027** | 0.021* | 0.025** | 0.026** | 0.024** | 0.027** | 0.022** | 0.021* |
| | (0.011) | (0.011) | (0.012) | (0.012) | (0.011) | (0.012) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.012) |
| lnCAPIN | 0.014** | 0.011* | 0.010 | 0.018*** | 0.014** | 0.014** | 0.013** | 0.013** | 0.014** | 0.014** | 0.014** | 0.013** | 0.014** |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| Vocatn | 0.0003** | 0.0003** | 0.0003** | 0.0003** | 0.0003* | 0.0003** | 0.0003** | 0.0003* | 0.0003* | 0.0003* | 0.0003*** | 0.0003** | 0.0003** |
| | (0.0001) | (0.0001) | (0.0001) | (0.0002) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| Univpost | 0.0001 | 0.0002 | 0.0003 | -0.00001 | 0.0001 | -0.00001 | 0.0001 | 0.00003 | 0.00001 | 0.0001 | -0.0001 | 0.0001 | 0.0001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Leverage | -0.090*** | -0.088*** | -0.088*** | -0.085*** | -0.090*** | -0.090*** | -0.090*** | -0.090*** | -0.089*** | -0.091*** | -0.087*** | -0.088*** | -0.090*** |
| | (0.022) | (0.022) | (0.022) | (0.023) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HHI | | | | -0.577*** | | | | | |
| | | | | (0.159) | | | | | |
| HZ_GO | | | | -0.265*** | | | | | |
| | | | | (0.064) | | | | | |
| HZ_L | | | | 0.184*** | | | | | |
| | | | | (0.058) | | | | | |
| FW | | | | -0.112 | | | | | |
| | | | | (0.077) | | | | | |
| BW | | | | 0.001 | | | | | |
| | | | | (0.020) | | | | | |
| PCI | 0.0001 | 0.0001 | -0.00004 | 0.002** | | | | | |
| | (0.001) | (0.001) | (0.001) | (0.001) | | | | | |
| Entrycost | | | | | -0.007 | | | | |
| | | | | | (0.011) | | | | |
| Land | | | | | | -0.008 | | | |
| | | | | | | (0.006) | | | |
| Transprn | | | | | | | 0.006 | | |
| | | | | | | | (0.009) | | |
| Timecost | | | | | | | | -0.007 | |
| | | | | | | | | (0.008) | |
| Informal | | | | | | | | | -0.008 |
| | | | | | | | | | (0.007) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proact | | | | | | | | | | -0.002 | | | |
| | | | | | | | | | | (0.003) | | | |
| Support | | | | | | | | | | | 0.007* | | |
| | | | | | | | | | | | (0.004) | | |
| Laborpolicy | | | | | | | | | | | | 0.006 | |
| | | | | | | | | | | | | (0.007) | |
| Institution | | | | | | | | | | | | | 0.002 |
| | | | | | | | | | | | | | (0.009) |
| Dsector | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dyear | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log pseudo likelihood | 469.2 | 469.8 | 470.4 | 425.1 | 469.5 | 470.1 | 469.5 | 469.7 | 469.9 | 469.5 | 471.0 | 469.6 | 469.2 |
| F | 13.1 | 12.6 | 12.7 | 8.6 | 13.0 | 13.1 | 13.3 | 13.1 | 13.1 | 13.0 | 13.8 | 13.3 | 13.1 |
| Prob > F | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Obs. | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 |

Source: Author's calculation

Note: 1. Robust standard errors (S.E.) are in parentheses. 2. *, **, and *** indicate that the coefficients are statistically significant at 10%, 5%, and 1%, respectively. 3. Collinearity for all variables were tested.

**Table 6-20. Determinants of Cost Efficiency for Manufacturing LEs**

| | Dependent variable: CE (Sample: Large Enterprises) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** |
| C | 0.612*** | 0.617*** | 0.616*** | 0.641*** | 0.599*** | 0.625*** | 0.595*** | 0.634*** | 0.684*** | 0.615*** | 0.605*** | 0.601*** | 0.610*** |
| | (0.068) | (0.067) | (0.067) | (0.061) | (0.083) | (0.050) | (0.065) | (0.064) | (0.060) | (0.045) | (0.046) | (0.059) | (0.055) |
| lnAge | 0.011*** | 0.011* | 0.011* | 0.014** | 0.011* | 0.011* | 0.011* | 0.011* | 0.010 | 0.011* | 0.011* | 0.011* | 0.011* |
| | (0.006) | (0.006) | (0.006) | (0.007) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.007) |
| DPE | | -0.003 | | | | | | | | | | | |
| | | (0.010) | | | | | | | | | | | |
| FIE | | | 0.005 | | | | | | | | | | |
| | | | (0.010) | | | | | | | | | | |
| Urban | 0.018* | 0.017* | 0.017* | 0.014 | 0.018** | 0.019** | 0.017** | 0.019** | 0.022** | 0.018* | 0.019** | 0.018** | 0.018* |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.008) | (0.009) | (0.009) |
| lnCAPIN | -0.025*** | -0.026*** | -0.026*** | -0.024*** | -0.025*** | -0.025*** | -0.025*** | -0.025*** | -0.025*** | -0.025*** | -0.025*** | -0.025*** | -0.025*** |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| Vocatn | 0.0003** | 0.0003** | 0.0003** | 0.0004 *** | 0.0003** | 0.0003** | 0.0003** | 0.0003** | 0.0003** | 0.0003 | 0.0003** | 0.0003** | 0.0003** |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.000) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| Univpost | 0.001 | 0.001 | 0.001 | 0.001* | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Leverage | -0.129*** | -0.128*** | -0.128*** | -0.137*** | -0.129*** | -0.129*** | -0.129*** | -0.129*** | -0.128*** | -0.129*** | -0.128*** | -0.128*** | -0.129*** |
| | (0.018) | (0.018) | (0.018) | (0.019) | (0.018) | (0.018) | (0.018) | (0.018) | (0.018) | (0.018) | (0.018) | (0.018) | (0.018) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HHI | | | | -0.139 | | | | | |
| | | | | (0.122) | | | | | |
| HZ_GO | | | | 0.049 | | | | | |
| | | | | (0.049) | | | | | |
| HZ_L | | | | -0.027 | | | | | |
| | | | | (0.045) | | | | | |
| FW | | | | -0.051 | | | | | |
| | | | | (0.059) | | | | | |
| BW | | | | -0.009 | | | | | |
| | | | | (0.016) | | | | | |
| PCI | 0.0001 | 0.00004 | 0.00001 | -0.0002 | | | | | |
| | (0.001) | (0.001) | (0.001) | (0.001) | | | | | |
| Entrycost | | | | | 0.002 | | | | |
| | | | | | (0.010) | | | | |
| Land | | | | | | -0.001 | | | |
| | | | | | | (0.005) | | | |
| Transprn | | | | | | | 0.003 | | |
| | | | | | | | (0.007) | | |
| Timecost | | | | | | | | -0.003 | |
| | | | | | | | | (0.007) | |
| Informal | | | | | | | | | -0.010 |
| | | | | | | | | | (0.006) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proact | | | | | | | | | | 0.0003 | | | |
| | | | | | | | | | | (0.003) | | | |
| Support | | | | | | | | | | | 0.002 | | |
| | | | | | | | | | | | (0.003) | | |
| Laborpolicy | | | | | | | | | | | | 0.002 | |
| | | | | | | | | | | | | (0.006) | |
| Institution | | | | | | | | | | | | | 0.001 |
| | | | | | | | | | | | | | (0.007) |
| Dsector | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dyear | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log pseudo likelihood | 608.0 | 608.1 | 608.2 | 577.8 | 608.0 | 608.0 | 608.1 | 608.1 | 609.4 | 608.0 | 608.1 | 608.1 | 608.0 |
| F | 9.6 | 9.2 | 9.4 | 8.2 | 9.5 | 9.5 | 9.7 | 9.4 | 9.6 | 9.6 | 9.6 | 9.6 | 9.5 |
| Prob > F | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Obs. | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 | 744 |

Source: Author's calculation

Note: 1. Robust standard errors (S.E.) are in parentheses. 2. *, **, and *** indicate that the coefficients are statistically significant at 10%, 5%, and 1%, respectively. 3. Collinearity for all variables were tested.

**Table 6-21. Determinants of Technical Efficiency for Manufacturing SMEs**

| | Dependent variable: TE (Sample: Small and Medium Enterprises) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TESME | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** |
| C | 0.735*** | 0.773*** | 0.753*** | 0.666*** | 0.747*** | 0.734*** | 0.755*** | 0.712*** | 0.730*** | 0.736*** | 0.730*** | 0.730*** | 0.725*** |
| | (0.028) | (0.031) | (0.029) | (0.025) | (0.038) | (0.025) | (0.028) | (0.027) | (0.027) | (0.021) | (0.021) | (0.024) | (0.024) |
| lnAge | -0.0003 | -0.0008 | -0.00003 | 0.002 | -0.0004 | -0.0004 | -0.0002 | -0.0002 | -0.0003 | -0.0004 | -0.0004 | -0.0003 | -0.0003 |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004)() | (0.004) | (0.004) |
| DPE | | -0.018*** | | | | | | | | | | | |
| | | (0.006) | | | | | | | | | | | |
| FIE | | | 0.017*** | | | | | | | | | | |
| | | | (0.006) | | | | | | | | | | |
| Urban | 0.010** | 0.009* | 0.009* | 0.012** | 0.010** | 0.011** | 0.011** | 0.009** | 0.010** | 0.011** | 0.010** | 0.010** | 0.010** |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| lnCAPIN | -0.028*** | -0.031*** | -0.030*** | -0.029*** | -0.028*** | -0.028*** | -0.028*** | -0.028*** | -0.028*** | -0.028*** | -0.028*** | -0.028*** | -0.028*** |
| | (0.002) | (0.003) | (0.003) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Vocatn | 0.0001 | 0.0001 | 0.0001* | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001* | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| Univpost | 0.0004* | 0.0004* | 0.0004*** | 0.001*** | 0.0004* | 0.0004* | 0.0004* | 0.0004* | 0.0004* | 0.0004* | 0.0004* | 0.0004* | 0.0004* |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) |
| Leverage | -0.042*** | -0.039*** | -0.039*** | -0.044*** | -0.042*** | -0.042*** | -0.042*** | -0.042*** | -0.042*** | -0.042*** | -0.042*** | -0.042*** | -0.042*** |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HHI | | | | 0.211*** | | | | | |
| | | | | (0.069) | | | | | |
| HZ_GO | | | | 0.269*** | | | | | |
| | | | | (0.026) | | | | | |
| HZ_L | | | | -0.162*** | | | | | |
| | | | | (0.023) | | | | | |
| FW | | | | -0.107*** | | | | | |
| | | | | (0.030) | | | | | |
| BW | | | | 0.017*** | | | | | |
| | | | | (0.006) | | | | | |
| PCI | -0.0001 | -0.0002 | -0.0002 | -0.0001 | | | | | |
| | (0.0004) | (0.0004) | (0.0004) | (0.0004) | | | | | |
| Entrycost | | | | | -0.002 | | | | |
| | | | | | (0.004) | | | | |
| Land | | | | | | -0.001 | | | |
| | | | | | | (0.003) | | | |
| Transprn | | | | | | | -0.004 | | |
| | | | | | | | (0.003) | | |
| Timecost | | | | | | | | 0.003 | |
| | | | | | | | | (0.003) | |
| Informal | | | | | | | | | 0.0002 |
| | | | | | | | | | (0.003) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proact | | | | | | | | | | -0.001 | | | |
| | | | | | | | | | | (0.001) | | | |
| Support | | | | | | | | | | | 0.0002 | | |
| | | | | | | | | | | | (0.001) | | |
| Laborpolicy | | | | | | | | | | | | 0.0003 | |
| | | | | | | | | | | | | (0.003) | |
| Institution | | | | | | | | | | | | | 0.002 |
| | | | | | | | | | | | | | (0.003) |
| Dsector | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dyear | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log pseudo likelihood | 2154.5 | 2159.4 | 2158.6 | 2012.9 | 2154.6 | 2154.5 | 2155.1 | 2155.0 | 2154.5 | 2154.7 | 2154.5 | 2154.5 | 2154.6 |
| F | 34.3 | 33.1 | 33.1 | 28.1 | 34.3 | 34.3 | 34.4 | 34.4 | 34.3 | 34.4 | 34.4 | 34.4 | 34.4 |
| Prob > F | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Obs. | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 |

Source: Author's calculation

Note: 1. Robust standard errors (S.E.) are in parentheses. 2. *, **, and *** indicate that the coefficients are statistically significant at 10%, 5%, and 1%, respectively. 3. Collinearity for all variables were tested.

**Table 6-22. Determinants of Allocative Efficiency for Manufacturing SMEs**

| | **Dependent variable: AE (Sample: Small and Medium Enterprises)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** |
| C | 0.291*** | 0.416*** | 0.355*** | 0.365*** | 0.352*** | 0.345*** | 0.284*** | 0.361*** | 0.325*** | 0.368*** | 0.390*** | 0.355*** | 0.364*** |
| | (0.028) | (0.030) | (0.028) | (0.025) | (0.038) | (0.025) | (0.028) | (0.027) | (0.027) | (0.019) | (0.020) | (0.023) | (0.023) |
| lnAge | 0.025*** | 0.024*** | 0.026*** | 0.023*** | 0.025*** | 0.026*** | 0.024*** | 0.025*** | 0.026*** | 0.026*** | 0.024*** | 0.025*** | 0.025*** |
| | 0.004 | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| DPE | | -0.061*** | | | | | | | | | | | |
| | | (0.006) | | | | | | | | | | | |
| FIE | | | 0.063*** | | | | | | | | | | |
| | | | (0.006) | | | | | | | | | | |
| Urban | 0.014*** | 0.009* | 0.008 | 0.015*** | 0.018*** | 0.013*** | 0.014*** | 0.017*** | 0.013*** | 0.013** | 0.020*** | 0.019*** | 0.016*** |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| lnCAPIN | 0.049*** | 0.041*** | 0.040*** | 0.050*** | 0.051*** | 0.050*** | 0.049*** | 0.050*** | 0.050*** | 0.049*** | 0.051*** | 0.050*** | 0.050*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Vocatn | -0.0001 | -0.0001 | -0.0001 | -0.0001 | -0.0002** | -0.0002** | -0.0001* | -0.0002** | -0.0002** | -0.0001* | -0.0002** | -0.0002** | -0.0002** |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| Univpost | 0.0006*** | 0.001** | 0.001*** | 0.0003 | 0.001** | 0.001*** | 0.001** | 0.001** | 0.001*** | 0.001*** | 0.001** | 0.001** | 0.001** |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) |
| Leverage | -0.026*** | -0.015* | -0.014 | -0.029*** | -0.025*** | -0.024*** | -0.025*** | -0.025*** | -0.023*** | -0.026*** | -0.027*** | -0.027*** | -0.025*** |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HHI | | | | -0.217*** | | | | | |
| | | | | (0.069) | | | | | |
| HZ_GO | | | | -0.120*** | | | | | |
| | | | | (0.027) | | | | | |
| HZ_L | | | | 0.091*** | | | | | |
| | | | | (0.024) | | | | | |
| FW | | | | 0.020*** | | | | | |
| | | | | (0.031) | | | | | |
| BW | | | | -0.021*** | | | | | |
| | | | | (0.006) | | | | | |
| PCI | 0.002*** | 0.001*** | 0.001*** | 0.002*** | | | | | |
| | (0.0004) | (0.0004) | (0.0004) | (0.000) | | | | | |
| Entrycost | | | | | 0.007 | | | | |
| | | | | | (0.004) | | | | |
| Land | | | | | | 0.010*** | | | |
| | | | | | | (0.003) | | | |
| Transprn | | | | | | | 0.019*** | | |
| | | | | | | | (0.003) | | |
| Timecost | | | | | | | | 0.006** | |
| | | | | | | | | (0.003) | |
| Informal | | | | | | | | | 0.012*** |
| | | | | | | | | | (0.003) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proact | | | | | | | | | | 0.007*** | | | |
| | | | | | | | | | | (0.001) | | | |
| Support | | | | | | | | | | | 0.002 | | |
| | | | | | | | | | | | (0.002) | | |
| Laborpolicy | | | | | | | | | | | | 0.008*** | |
| | | | | | | | | | | | | (0.003) | |
| Institution | | | | | | | | | | | | | 0.009*** |
| | | | | | | | | | | | | | (0.004) |
| Dsector | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dyear | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log pseudo likelihood | 2198.3 | 2250.5 | 2251.7 | 2101.0 | 2185.4 | 2190.3 | 2199.6 | 2186.6 | 2192.8 | 2197.6 | 2185.2 | 2189.0 | 2188.0 |
| F | 50.8 | 57.1 | 57.5 | 60.8 | 49.5 | 50.3 | 50.7 | 49.7 | 50.6 | 50.9 | 49.3 | 50.0 | 49.8 |
| Prob > F | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Obs. | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 |

Source: Author's calculation

Note: 1. Robust standard errors (S.E.) are in parentheses. 2. *, **, and *** indicate that the coefficients are statistically significant at 10%, 5%, and 1%, respectively. 3. Collinearity for all variables were tested.

**Table 6-23. Determinants of Cost Efficiency for Manufacturing SMEs**

| | Dependent variable: CE (Sample: Small and Medium Enterprises) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CESME | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** |
| C | 0.237*** | 0.331*** | 0.284*** | 0.227*** | 0.273*** | 0.265*** | 0.246*** | 0.261*** | 0.247*** | 0.284*** | 0.301*** | 0.276*** | 0.276*** |
| | (0.019) | (0.021) | (0.019) | (0.017) | (0.024) | (0.016) | (0.019) | (0.018) | (0.018) | (0.013) | (0.014) | (0.016) | (0.016) |
| lnAge | 0.015*** | 0.014*** | 0.016*** | 0.015*** | 0.015*** | 0.016*** | 0.015*** | 0.015*** | 0.016*** | 0.015*** | 0.015*** | 0.015*** | 0.015*** |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| DPE | | -0.046*** | | | | | | | | | | | |
| | | (0.004) | | | | | | | | | | | |
| FIE | | | 0.046*** | | | | | | | | | | |
| | | | (0.004) | | | | | | | | | | |
| Urban | 0.014*** | 0.010*** | 0.010*** | 0.017*** | 0.017*** | 0.013*** | 0.015*** | 0.015*** | 0.013*** | 0.014*** | 0.017*** | 0.017*** | 0.015*** |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| lnCAPIN | 0.016*** | 0.009*** | 0.009*** | 0.015*** | 0.017*** | 0.016*** | 0.016*** | 0.016*** | 0.016*** | 0.016*** | 0.017*** | 0.016*** | 0.016*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Vocatn | -0.00001 | 0.000004 | 0.00001 | 0.00002 | -0.00005 | -0.00004 | -0.00003 | -0.00004 | -0.00003 | -0.00002 | -0.00005 | -0.00003 | -0.00003 |
| | (0.00004) | (0.00004) | (0.00004) | (0.00004) | (0.00004) | (0.00004) | (0.00004) | (0.00004) | (0.00004) | (0.00004) | (0.00004) | (0.00004) | (0.00004) |
| Univpost | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) |
| Leverage | -0.052*** | -0.043*** | -0.043*** | -0.055*** | -0.052*** | -0.051*** | -0.052*** | -0.052*** | -0.050*** | -0.052*** | -0.052*** | -0.052*** | -0.051*** |
| | (0.006) | (0.005) | (0.005) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HHI | | | | 0.013 | | | | | |
| | | | | (0.046) | | | | | |
| HZ_GO | | | | 0.105*** | | | | | |
| | | | | (0.017) | | | | | |
| HZ_L | | | | -0.046*** | | | | | |
| | | | | (0.014) | | | | | |
| FW | | | | -0.069*** | | | | | |
| | | | | (0.018) | | | | | |
| BW | | | | 0.0001 | | | | | |
| | | | | (0.004) | | | | | |
| PCI | 0.001*** | 0.001*** | 0.001*** | 0.001*** | | | | | |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | | | | | |
| Entrycost | | | | | 0.004 | | | | |
| | | | | | (0.003) | | | | |
| Land | | | | | | 0.006*** | | | |
| | | | | | | (0.002) | | | |
| Transprn | | | | | | | 0.009*** | | |
| | | | | | | | (0.002) | | |
| Timecost | | | | | | | | 0.006*** | |
| | | | | | | | | (0.002) | |
| Informal | | | | | | | | | 0.009*** |
| | | | | | | | | | (0.002) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proact | | | | | | | | | | 0.004*** | | | |
| | | | | | | | | | | (0.001) | | | |
| Support | | | | | | | | | | | 0.0005 | | |
| | | | | | | | | | | | (0.001) | | |
| Laborpolicy | | | | | | | | | | | | 0.005*** | |
| | | | | | | | | | | | | (0.002) | |
| Institution | | | | | | | | | | | | | 0.007*** |
| | | | | | | | | | | | | | (0.002) |
| Dsector | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dyear | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log pseudo likelihood | 4054.7 | 4127.2 | 4125.3 | 4010.1 | 4043.6 | 4049.3 | 4051.3 | 4048.2 | 4053.4 | 4053.4 | 4042.7 | 4046.5 | 4047.3 |
| F | 22.3 | 27.1 | 26.4 | 27.6 | 21.4 | 22.1 | 22.2 | 21.7 | 22.1 | 22.1 | 21.3 | 21.8 | 21.6 |
| Prob > F | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Obs. | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 | 4290 |

Source: Author's calculation

Note: 1. Robust standard errors (S.E.) are in parentheses. 2. *, **, and *** indicate that the coefficients are statistically significant at 10%, 5%, and 1%, respectively. 3. Collinearity for all variables were tested.

**Table 6-24. Determinants of Technical Efficiency for Manufacturing DPEs**

| | Dependent variable: TE (Sample: Domestic Private Enterprises) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** |
| C | 0.780*** | 0.805*** | 0.761*** | 0.837*** | 0.771*** | 0.798*** | 0.781*** | 0.780*** | 0.787*** | 0.781*** | 0.777*** | 0.781*** |
| | (0.027) | (0.026) | (0.025) | (0.034) | (0.024) | (0.027) | (0.025) | (0.026) | (0.019) | (0.019) | (0.022) | (0.022) |
| lnAge | 0.005 | -0.001 | 0.007* | 0.004 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.004 | 0.005 | 0.005 |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| LE | | 0.074*** | | | | | | | | | | |
| | | (0.010) | | | | | | | | | | |
| Urban | 0.005 | 0.006 | 0.005 | 0.005 | 0.004 | 0.005 | 0.005 | 0.004 | 0.005 | 0.005 | 0.005 | 0.005 |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| lnCAPIN | -0.033*** | -0.034*** | -0.036*** | -0.033*** | -0.033*** | -0.033*** | -0.033*** | -0.033*** | -0.033*** | -0.033*** | -0.033*** | -0.033*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Vocatn | 0.0001* | 0.0001 | 0.0001 | 0.0001 | 0.0001* | 0.0001 | 0.0001* | 0.0001* | 0.0001 | 0.0001* | 0.0001* | 0.0001* |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| Univpost | 0.0004 | 0.0004 | 0.001** | 0.0003 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0003 | 0.0003 | 0.0003 | 0.0004 |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) |
| Leverage | -0.017** | -0.020** | -0.019** | -0.017** | -0.016** | -0.017** | -0.017** | -0.016** | -0.017** | -0.017** | -0.017** | -0.016** |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| HHI | | | 0.219*** | | | | | | | | | |
| | | | (0.067) | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HZ_GO | | | 0.292*** | | | | | | |
| | | | (0.027) | | | | | | |
| HZ_L | | | -0.178*** | | | | | | |
| | | | (0.023) | | | | | | |
| FW | | | -0.125*** | | | | | | |
| | | | (0.029) | | | | | | |
| BW | | | 0.018*** | | | | | | |
| | | | (0.006) | | | | | | |
| PCI | 0.0001 | -0.0002 | -0.0002 | | | | | | |
| | (0.0003) | (0.0003) | (0.0003) | | | | | | |
| Entrycost | | | | -0.006* | | | | | |
| | | | | (0.004) | | | | | |
| Land | | | | | 0.002 | | | | |
| | | | | | (0.003) | | | | |
| Transprn | | | | | | -0.002 | | | |
| | | | | | | (0.003) | | | |
| Timecost | | | | | | | 0.001 | | |
| | | | | | | | (0.003) | | |
| Informal | | | | | | | | 0.001 | |
| | | | | | | | | (0.003) | |
| Proact | | | | | | | | | -0.0002 |
| | | | | | | | | | 0.001 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Support | | | | | | | | | | 0.001 | | |
| | | | | | | | | | | (0.001) | | |
| Laborpolicy | | | | | | | | | | | 0.001 | |
| | | | | | | | | | | | (0.002) | |
| Institution | | | | | | | | | | | | 0.001 |
| | | | | | | | | | | | | (0.003) |
| Dsector | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dyear | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log pseudo likelihood | 2230.3 | 2274.9 | 2089.4 | 2231.7 | 2230.7 | 2230.4 | 2230.3 | 2230.3 | 2230.3 | 2230.4 | 2230.4 | 2230.3 |
| F | 37.8 | 39.7 | 34.5 | 37.9 | 38.3 | 37.8 | 37.8 | 38.0 | 37.8 | 37.9 | 37.9 | 37.8 |
| Prob > F | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Obs. | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 |

Source: Author's calculation

Note: 1. Robust standard errors (S.E.) are in parentheses. 2. *, **, and *** indicate that the coefficients are statistically significant at 10%, 5%, and 1%, respectively. 3. Collinearity for all variables were tested.

**Table 6-25. Determinants of Allocative Efficiency for Manufacturing DPEs**

| | Dependent variable: AE (Sample: Domestic Private Enterprises) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** |
| C | 0.452*** | 0.495*** | 0.522*** | 0.471*** | 0.497*** | 0.455*** | 0.505*** | 0.494*** | 0.526*** | 0.550*** | 0.511*** | 0.524*** |
| | (0.027) | (0.027) | (0.027) | (0.037) | (0.025) | (0.027) | (0.026) | (0.027) | (0.019) | (0.020) | (0.023) | (0.023) |
| lnAge | 0.024*** | 0.014*** | 0.023*** | 0.024*** | 0.025*** | 0.024*** | 0.024*** | 0.025*** | 0.025*** | 0.024*** | 0.024*** | 0.024*** |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| LE | | 0.128*** | | | | | | | | | | |
| | | (0.007) | | | | | | | | | | |
| Urban | 0.001 | 0.003 | 0.006 | 0.003 | -0.002 | 0.0002 | 0.002 | 0.000 | 0.000 | 0.004 | 0.004 | 0.002 |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| lnCAPIN | 0.026*** | 0.026*** | 0.027*** | 0.028*** | 0.027*** | 0.026*** | 0.027*** | 0.027*** | 0.026*** | 0.027*** | 0.027*** | 0.027*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Vocatn | 0.00001 | -0.00002 | 0.00005 | -0.00004 | -0.00004 | -0.00001 | -0.00004 | -0.00003 | -0.00001 | -0.00005 | -0.00002 | -0.00003 |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| Univpost | 0.0004* | 0.0004* | 0.0003 | 0.0004* | 0.001** | 0.0003 | 0.0004* | 0.0005** | 0.0004 | 0.0003 | 0.0003 | 0.0004* |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) |
| Leverage | -0.035*** | -0.040*** | -0.036*** | -0.034*** | -0.033*** | -0.034*** | -0.034*** | -0.033*** | -0.035*** | -0.035*** | -0.035*** | -0.034*** |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) | (0.009) |
| HHI | | | -0.268*** | | | | | | | | | |
| | | | (0.071) | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HZ_GO | | | -0.181*** | | | | | | |
| | | | (0.028) | | | | | | |
| HZ_L | | | 0.149*** | | | | | | |
| | | | (0.024) | | | | | | |
| FW | | | -0.072*** | | | | | | |
| | | | (0.031) | | | | | | |
| BW | | | -0.002 | | | | | | |
| | | | (0.006) | | | | | | |
| PCI | 0.002*** | 0.001*** | 0.002*** | | | | | | |
| | (0.0004) | (0.0003) | (0.0004) | | | | | | |
| Entrycost | | | | 0.011*** | | | | | |
| | | | | (0.004) | | | | | |
| Land | | | | | 0.010*** | | | | |
| | | | | | (0.003) | | | | |
| Transprn | | | | | | 0.017*** | | | |
| | | | | | | (0.003) | | | |
| Timecost | | | | | | | 0.008*** | | |
| | | | | | | | (0.003) | | |
| Informal | | | | | | | | 0.010*** | |
| | | | | | | | | (0.003) | |
| Proact | | | | | | | | | 0.006*** |
| | | | | | | | | | (0.001) |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Support | | | | | | | | | | 0.002 | | |
| | | | | | | | | | | (0.002) | | |
| Laborpolicy | | | | | | | | | | | 0.008*** | |
| | | | | | | | | | | | (0.003) | |
| Institution | | | | | | | | | | | | 0.008** |
| | | | | | | | | | | | | (0.003) |
| Dsector | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dyear | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log pseudo likelihood | 2140.8 | 2258.8 | 2013.2 | 2132.5 | 2135.8 | 2140.3 | 2132.7 | 2134.9 | 2138.9 | 2129.5 | 2133.5 | 2132.0 |
| F | 30.4 | 48.3 | 24.1 | 29.5 | 29.9 | 30.1 | 29.6 | 29.7 | 30.2 | 29.2 | 29.8 | 29.6 |
| Prob > F | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Obs. | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 |

Source: Author's calculation

Note: 1. Robust standard errors (S.E.) are in parentheses. 2. *, **, and *** indicate that the coefficients are statistically significant at 10%, 5%, and 1%, respectively. 3. Collinearity for all variables were tested.

**Table 6-26. Determinants of Cost Efficiency for Manufacturing DPEs**

| | Dependent variable: CE (Sample: Domestic Private Enterprises) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** |
| C | 0.364*** | 0.416*** | 0.394*** | 0.415*** | 0.384*** | 0.381*** | 0.400*** | 0.388*** | 0.420*** | 0.437*** | 0.405*** | 0.418*** |
| | (0.019) | (0.018) | (0.019) | (0.024) | (0.016) | (0.019) | (0.017) | (0.017) | (0.012) | (0.012) | (0.015) | (0.015) |
| lnAge | 0.021*** | 0.009*** | 0.022*** | 0.020*** | 0.022*** | 0.020*** | 0.021*** | 0.021*** | 0.021*** | 0.020*** | 0.020*** | 0.021*** |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| LE | | 0.154*** | | | | | | | | | | |
| | | (0.008) | | | | | | | | | | |
| Urban | 0.002 | 0.005* | 0.007* | 0.004 | -0.0005 | 0.003 | 0.003 | 0.002 | 0.002 | 0.005 | 0.005 | 0.003 |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.004) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| lnCAPIN | -0.005*** | -0.006*** | -0.007*** | -0.004*** | -0.005*** | -0.005*** | -0.004** | -0.005*** | -0.005*** | -0.004** | -0.005*** | -0.004** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Vocatn | 0.0001* | 0.0001 | 0.0001** | 0.0000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.00005 | 0.0001 | 0.0001 |
| | (0.00005) | (0.00004) | (0.00005) | (0.0000) | (0.00005) | (0.00005) | (0.00005) | (0.00005) | (0.00005) | (0.00005) | (0.00005) | (0.00005) |
| Univpost | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) |
| Leverage | -0.042*** | -0.048*** | -0.044*** | -0.041*** | -0.040*** | -0.041*** | -0.041*** | -0.040*** | -0.042*** | -0.042*** | -0.042*** | -0.041*** |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| HHI | | | -0.031 | | | | | | | | | |
| | | | (0.046) | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HZ_GO | | | 0.092*** | | | | | | |
| | | | (0.020) | | | | | | |
| HZ_L | | | -0.027 | | | | | | |
| | | | (0.017) | | | | | | |
| FW | | | -0.142*** | | | | | | |
| | | | (0.021) | | | | | | |
| BW | | | 0.013*** | | | | | | |
| | | | (0.004) | | | | | | |
| PCI | 0.001*** | 0.001*** | 0.001*** | | | | | | |
| | (0.0003) | (0.0002) | (0.0003) | | | | | | |
| Entrycost | | | | 0.004 | | | | | |
| | | | | (0.003) | | | | | |
| Land | | | | | 0.010*** | | | | |
| | | | | | (0.002) | | | | |
| Transprn | | | | | | 0.010*** | | | |
| | | | | | | (0.002) | | | |
| Timecost | | | | | | | 0.007*** | | |
| | | | | | | | (0.002) | | |
| Informal | | | | | | | | 0.009*** | |
| | | | | | | | | (0.002) | |
| Proact | | | | | | | | | 0.004*** |
| | | | | | | | | | (0.001) |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Support | | | | | | | | | | 0.001 | | |
| | | | | | | | | | | (0.001) | | |
| Laborpolicy | | | | | | | | | | | 0.007*** | |
| | | | | | | | | | | | (0.002) | |
| Institution | | | | | | | | | | | | 0.006** |
| | | | | | | | | | | | | (0.003) |
| Dsector | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Dyear | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Log pseudo | 3446.8 | 3843.7 | 3376.6 | 3433.2 | 3446.5 | 3441.4 | 3437.8 | 3441.7 | 3443.6 | 3433.0 | 3439.0 | 3436.1 |
| F | 24.6 | 43.6 | 20.2 | 23.3 | 24.6 | 24.3 | 23.8 | 24.1 | 24.3 | 23.2 | 23.8 | 24.0 |
| Prob > F | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Obs. | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 | 3441 |

Source: Author's calculation

Note: 1. Robust standard errors (S.E.) are in parentheses. 2. *, **, and *** indicate that the coefficients are statistically significant at 10%, 5%, and 1%, respectively. 3. Collinearity for all variables were tested.

# CHAPTER 7

# PRODUCTIVITY PERFORMANCE OF VIETNAMESE MANUFACTURING ENTERPRISES: PRE- AND POST- GLOBAL CRISIS

## 7.1. Literature Review[58]

Since the objective of this chapter is to examine how manufacturing enterprises perform before and after the 2008 global crisis in terms of TFP growth in association with cost inefficiency, this section is to review literature on productivity in relation to cost efficiency, and studies on firm-level productivity for Vietnam.

### 7.1.1. Studies on Productivity in relation to Cost Efficiency

Research on productivity change in connection with cost function began with Denny et al. (1981) and developed by Bauer (1990). Before this, productivity growth was decomposed into technical efficiency change and technological progress. Bauer dealed with cost function for single output and multiple outputs cases, and factored TFP growth into change in overall efficiency (including changes in technical and allocative efficiency), technological progress, scale effect, and price effect term. This parametric approach required strong empirical assumptions and continuous time (Maniadakis & Thanassoulis, 2004). Bauer, then, applied the method for 12 U.S. airlines during 1970-1981. The translog cost function was used for quarterly data with multiple outputs. Thus, besides these above mentioned components, TFP change also included output effect. Due to the feature of time continuity, TFP change was measured and decomposed for the whole period.

Realizing the limitation, Shen (2009) developed an index number method that fits Bauer (1990)'s method and uses stochastic translog cost function to measure TFP change for banks of ten Asian countries. Diewert Quadratic Identity Lemma and Tornqvist approximation were employed to separate continuous time features in Bauer's method into single periods. By doing that, Shens measured overall and country-specific TFP change and its components year by year.

[58] The term "productivity" mentioned in this section is TFP.

Another line of research on productivity change is the non-parametric approach with the famous Malmquist productivity index. The Malmquist productivity index was introduced by Malmquist (1953), and then developed by Caves, Christensen & Diewert (1982). Caves et al. (1982) developed input Malmquist index and output Malmquist index based on the input distance function and output distance function, respectively. Relying on the work of Caves et al. (1982), Färe et al. (1992) represented an CRS input-based Malmquist productivity index and Färe et al. (1994) built an VRS Malmquist output index approach that the Malmquist productivity index obtains from output distance function at different discrete time points. The Malmquist TFP index, under the condition of CRS, is decomposed into technical efficiency change and technical progress, while under the condition VRS it is decomposed into pure technical efficiency change, scale efficiency change, and technical progress. Nevertheless, according to Maniadakis & Thanassoulis (2004), allocative efficiency, which reflects firm ability in selecting optimal input bundles, is not included in the Malmquist index. Therefore, the two authors developed a productivity index based on the Malmquist index, namely the cost Malmquist productivity index (CM) that involves technical efficiency change and allocative efficiency change. Two types of efficiency changes, in combination, make overall efficiency change. The cost Malmquist productivity index is a geometrical combination of overall efficiency change (OEC) and cost-technical change (CTC). In turn, OEC includes technical efficiency change (TEC), and allocative efficiency change (AEC). Meanwhile, CTC consists of technology change (TC) and input "price effect" (PEC). Maniadakis & Thanassoulis (2004), then, applied the method to 30 Greek hospitals in 1992-1993 and found productivity improvement in the Malmquist index and cost Malmquist index as a result of efficiency improvement. Meanwhile, technical change suggested a slight regress and the input price effect lowered the rate of productivity growth.

The cost Malmquist productivity index by Maniadakis & Thanassoulis (2004) should be said as an alternative approach in the same line with Bauer (1990) and Balk (1997) (as cited in Maniadakis & Thanassoulis, 2004) to measure TFP growth involving overall efficiency change. This approach, nonetheless, is only for CRS assumption. Therefore, Yang and Huang (2009) developed the cost Malmquist index under the assumption of VRS (as cited in Yang, Sheng & Huang, 2009). Yang et al. (2009) followed the method by Yang and Huang (2009) to measure the cost Malmquist productivity index for the biotech and biopharmaceutical industry in Taiwan. With the assumption of VRS, TFP growth is decomposed into pure technical efficiency change (PTEC), technical change (TC), allocative efficiency change (AEC), price effect change (PEC), and the cost scale efficiency change (CSEC). The Malmquist productivity index (MI) and the cost Malmquist productivity index (CM) for aggregate data appeared in different directions. While MI indicated nearly 9.0% declining productivity, CM suggested nearly 7.2% increasing productivity. Pure technical efficiency recorded a 19.9% decline, while technical change recorded progress of 9.0%. The scale efficiency seems unchanged, and the cost scale efficiency increased 2.1%. CM improvement attributes to allocative efficiency improvement, which augmented 34.0%. Meanwhile input price effect eroded productivity growth with a decline of 31.9%.

Baležentis (2012) applied the method of Maniadakis & Thanassoulis (2004) combined with Färe, Grosskopf, Norris, & Zhang (1994) for 200 agricultural farms in Lithuanian. As the non-parametric method works with discrete time, productivity index and its components are calculated for each one-year period. Cost productivity (the cost Malmquist productivity index) recorded a lower growth rate than technical productivity (the Malmquist productivity index) (7.7% compared to 22.4%) as a result of input price fluctuations. Technical productivity growth was attributed to pure technical efficiency change of 12.7%, while scale efficiency was quite stable. Albeit registering a progress of 8.4% for the whole period, the technical change recorded the highest variation compared to the two other components inside the technical productivity, i.e. pure technical efficiency change and scale efficiency change.

### 7.1.2. Studies on Firm-level Productivity for Vietnam

A great deal of productivity research on Vietnam's economy, industry, and enterprises has been recorded. These studies are classified in two fields of considerations:

calculating TFP and investigating its determinants, and measuring TFP change. Due to the purpose of this paper, examining TFP change of manufacturing enterprises, this section concentrates on studies for firm-level productivity change. The class of studies measuring productivity change includes Vu (2003b) for industrial SOEs during 1976-1998; Nguyen, To, Vu, & Oostendorp (2005) for the garment and textile sector over the period 1997-2000; Nguyen et al (2012) for the whole manufacturing industry and some main sub-industries in 2003-2007; Nguyen (2012) for Vietnam's commercial banks in 2007-2010. These studies are introduced in Table 7A-1.

From the review, it is found that these studies utilized the Stochastic Production Frontier ( Nguyen et al., 2005; Nguyen et al., 2012) or the econometric model (Vu, 2003b) or the Malmquist index (Nguyen, 2012), which involving the production function (the econometric model) or production frontier (the others). None of the studies examines productivity change engaging the cost frontier, changes of allocative efficiency, and change of cost efficiency. This thesis, thus, aims to fill the research gap by examining TFP growth in the relation with cost inefficiency.

## 7.2. Productivity Performance Pre- and Post- Global Crisis

### 7.2.1. Partial Productivity Performance

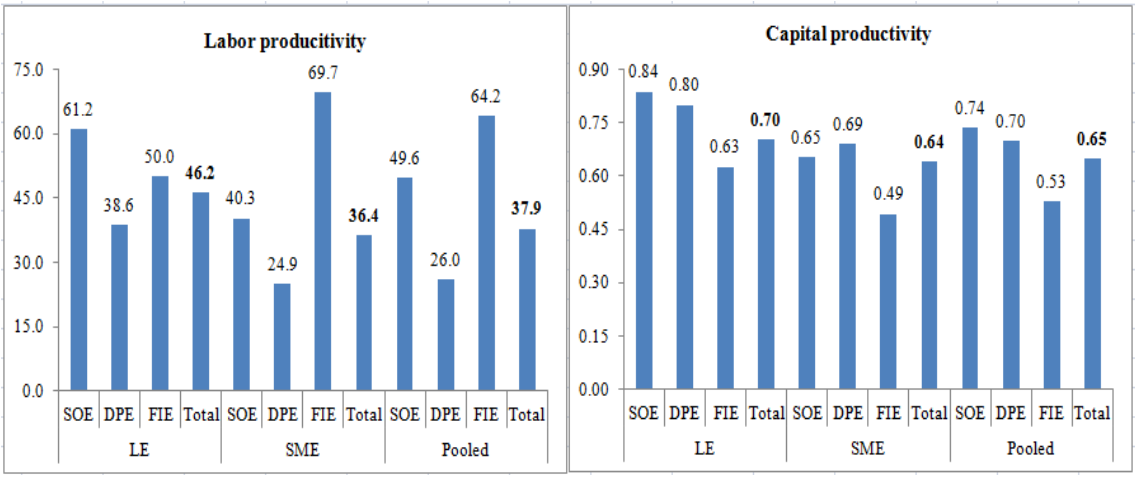
Labor productivity and capital productivity are two prevailing partial productivity terms. For firm-level, labor productivity is measured by value added divided by number of working employees or number of working hours. In this study, labor productivity is the ratio of value added to number of employees, and capital productivity is the ratio of value added to capital quantity.[59] Average labor productivity of manufacturing enterprises in the period 2007-2011 is VND37.87 million per worker, and average capital productivity is 0.649.

With respect to firm size, LEs are appeared to have higher mean productivity than SMEs. This holds true for enterprises as a whole and for almost all ownership types inside

[59] Data number of working hours is not available in the Enterprise Survey.

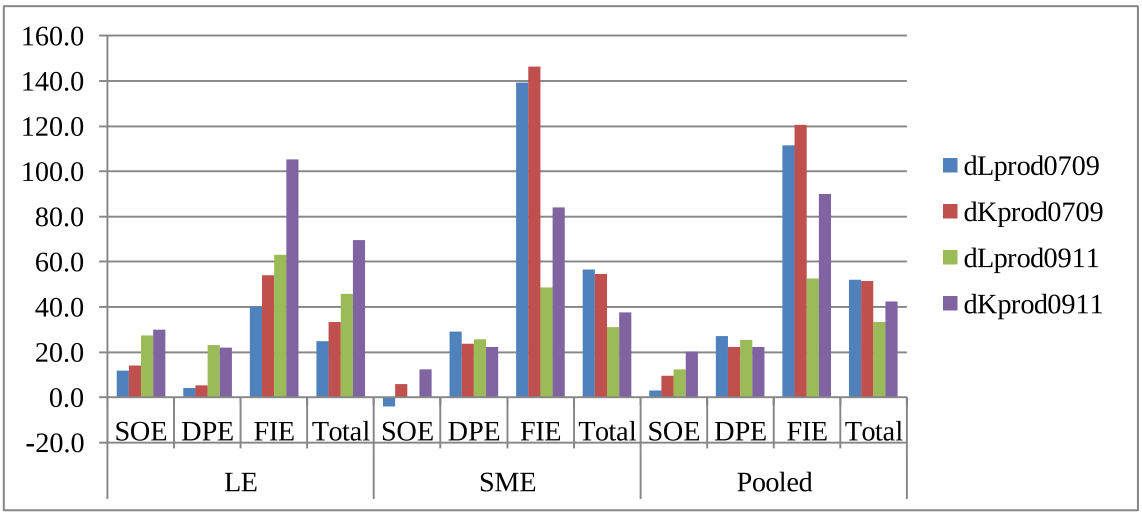
each scale, except FIEs (labor productivity), suggesting that larger manufacturing firms are likely to be more productive than their smaller counterparts. In particular, average labor and capital productivity of LEs are VND46.2 million and VND0.70, followed by those of SMEs, VND36.4 million and VND0.64, respectively.

**Figure 7-1. Partial Productivity by Scale and Ownership**




Source: Author's calculation
Note: Productivity comparisons by size (LEs and SMEs) and ownership type (SOEs, DPEs, FIEs) are in Appendix (Table 7A-2).

**Figure 7-2. Change in Partial Productivity by Scale and Ownership**




Source: Author's calculation
Note: 1. Productivity change is in percentage; 2. Comparisons of change in productivity are in Appendix (Table 7A-4).

In regards to type of ownership, DPEs lag behind SOEs and FIEs in terms of labor productivity for pooled and scale criteria. On average, each DPE worker generates VND26.0 million a year, as 40% of a colleague working in an FIE. It can be explained by differences in human capital and capital intensity between them. In particular, for aggregate manufacturing, 8.9% and 9.4% of total employees in DPEs and FIEs have undergraduate or higher degrees. Meanwhile, average capital to labor ratio of DPEs is VND84.02 million per worker, lower than VND206.89 million of FIEs. With respect to capital productivity of DPEs, the first rank within the SME group and the second rank within the LE group and aggregate data indicate great effort of DPEs to utilize capital in the circumstance that financial constraint is one of their biggest obstacles. SOEs rank first in labor productivity for the LEs group and first in capital productivity for the whole sample and LE groups; and FIEs rank at the top of labor productivity for pooled data and the SMEs group, but at the bottom of capital productivity for all groups. Notably, the capital productivity gap among different types of ownership as a whole and within each scale are narrower than the labor productivity gap.

To analyze productivity change before and after the 2008 global crisis, changes of single factor productivity in percentage between periods 2007-2009 and 2009-2011 are calculated and shown in Figure 7-2. On average, manufacturing enterprises yield positive labor and capital productivity change for the whole sample and for groups, except small and medium SOEs.

Comparison of mean productivity change by time shows no significant difference in average growth rate of single factor productivity over time. Further comparison by firm size confirms equality of mean labor productivity growth and capital productivity growth for LEs and SMEs in the two periods (Table 7A-3). Inversely, average partial productivity growth by type of ownership is different. FIEs' partial productivity measures mark higher growth than those of their domestic counterparts, implying that FIEs have been less affected by the global crisis and national economic situation. This result is consistent with previous analysis on industrial production and trade performance between the foreign-invested sector and the domestic sector. For SOEs, their slowest productivity growth compared to those of FIEs and DPEs indicates that productivity improvement is not their priority. SOEs, additionally, seem not to be affected by the global crisis and domestic economic difficulties, having a higher productivity growth rate in period 2009-2011 than that in the previous period. Shown in Table 2-8, the state sector achieved higher growth of industrial gross output in 2009-2011 compared to lower growth of that of the non-state and foreign-invested sectors.

With respect to sector, higher technology sectors tend to be more labor productive. Particularly, mean labor productivity of high technology sectors is VND56.8 million per worker, 1.4 times as that of medium sectors, and double that of low sectors. This is not the case for capital productivity, and the group of medium technology sectors is behind the two other groups. On average, labor productivity varies from VND21 million to VND76 million, in which some export-oriented sectors, i.e. Wood and Wood-made products (WP), Furniture (FN), Footwear, Leather and related products (FWL), remain below others. Meanwhile, some import-competing industries, i.e. Transport Equipment (TE), Chemicals and Chemical products (CP), and Electrical and Electronics Equipment (EE) are top-ranking for labor productivity. Mean capital productivity ranges from 0.310 to 0.964, where the Garment and Textile sector (GT) is the most capital productive.

Comparison of single factor productivity changes over time is shown in Table 7-1. Seven sectors out a of total of 14 manufacturing sectors, including Food processing, Beverages, Tobacco products (FBT), Garment and Textiles (GT), Furniture (FN), Rubber and Plastic products (RP), Manufacture of Other Non-metallic Mineral Products (NM), Manufacture of Fabricated Metals (FM), Electrical and Electronics Equipment (EE), record a lower productivity growth rate and most of them are export-oriented industries. Notably, Food Processing, Beverages, Tobacco products (FBT) witnessed a sharp reduction of partial productivity, more than ten times lower as a result of a significant decline of value added growth from 81.8% in 2007-2009 to nearly 5.0% in 2009-2011. This indicates weak international and domestic demand for food, beverage and tobacco products. Three sectors, Rubber and Plastic products (RP), Manufacture of Fabricated Metals (FM), and Electrical and Electronics Equipment (EE), remarked very high productivity growth rates in 2007-2009 and significant deterioration in the next period.

The only two sectors that recorded productivity reduction in period 2007-2009 are Footwear, Leather and related products (FWL) and Paper and Paper products; Printing and Publishing products (PP). FWL is an export-oriented sector, and the 2008 crisis immediately weakened its demand. Footwear exports growth in period 2007-2009 was only 1.8%, falling sharply from 31.6% in period 2005-2007, while the number of footwear products in 2009 dropped by 26.2 million pairs compared to the volume in 2007, and the Index of Industrial Production (IIP) of manufacturing of footwear products in 2009 is 98.8 while that in 2007 is 100. These numbers illustrate that remarkably lower export growth of the footwear sector caused a reduction in production and IIP that led to negative productivity growth of the FWL sector. A survey by GTZ (2009) for FWL enterprises in Ho Chi Minh city found that 96% of firms recorded a decline in revenue, equivalent to 36% of total revenue due to the reduction of 30% of domestic orders and 41% of export orders. In response to demand decline and contracting finance, 87% of these FWL firms reduced their production. The Paper and Paper products; Printing and Publishing products (PP) appears with negative growth of single productivity in 2007-2009, which comes from the positively lower growth rate of value added than positive growth rate of labor and capital.

**Table 7-1. Partial Productivity Levels and Changes by Sector**

| | | Lprod | Kprod | dLprod0709 | dKprod0709 | dLprod0911 | dKprod0911 |
|---|---|---|---|---|---|---|---|
| FBT | Food processing, Beverages, Tobacco products | 36.04 | 0.528 | 69.93 | 89.72 | 4.88 | 8.09 |
| GT | Garment and Textiles | 36.04 | 0.964 | 32.86 | 50.56 | 29.45 | 40.83 |
| FWL | Footwear, Leather and related products | 22.29 | 0.804 | -8.47 | -5.01 | 33.39 | 37.30 |
| WP | Wood and Wood-made products | 21.02 | 0.788 | 6.23 | 14.84 | 42.10 | 34.35 |
| PP | Paper and Paper products; Printing and Publishing products | 25.68 | 0.365 | -3.57 | -10.91 | 60.50 | 52.04 |
| FN | Furniture | 21.71 | 0.892 | 23.25 | 27.03 | 21.98 | 25.79 |
| RP | Rubber and Plastic products | 30.08 | 0.325 | 105.46 | 104.12 | 20.27 | 23.71 |
| NM | Manufacture Of Other Non-metallic Mineral products | 27.94 | 0.590 | 62.25 | 31.55 | 11.69 | 23.70 |
| BM | Manufacture Of Basic Metals | 27.39 | 0.309 | 13.92 | 14.07 | 29.29 | 57.63 |
| FM | Manufacture of Fabricated Metals | 53.94 | 0.828 | 107.58 | 94.93 | 63.65 | 89.89 |
| TE | Transport Equipment | 76.04 | 0.611 | 27.54 | 19.77 | 65.75 | 70.39 |
| CP | Chemicals and Chemical products | 66.26 | 0.593 | 11.24 | -0.50 | 37.22 | 60.83 |
| ME | Machinery And Equipment | 37.14 | 0.851 | 15.05 | 13.01 | 25.24 | 46.03 |
| EE | Electrical and Electronics Equipment | 66.68 | 0.821 | 184.43 | 183.66 | 62.28 | 85.97 |
| | | **Lprod** | **Kprod** | **dLprod0709** | **dKprod0709** | **dLprod0911** | **dKprod0911** |
| High | | 56.76 | 0.731 | 52.97 | 46.99 | 39.13 | 61.83 |
| Medium | | 41.76 | 0.572 | 82.73 | 70.64 | 37.29 | 51.45 |
| Low | | 29.26 | 0.677 | 30.26 | 39.50 | 28.84 | 30.07 |

Source: Author’s calculation
Note: 1. Productivity change is in percentage.

### 7.2.2. Total Factor Productivity Performance

#### *7.2.2.1. TFP Performance of Manufacturing Enterprises*

This thesis does not measure TFP value, but its growth index. The TFP growth index, here, is the cost Malmquist productivity index (CM), which captures productivity growth in the presence of cost inefficiency. Another TFP growth index is the Malmquist productivity index (MI). The two indices differ from each other in how they are measured. The Malmquist productivity index is extracted from the production frontier, while the cost Malmquist productivity index is calculated from the cost frontier. The cost Malmquist productivity index includes information of the Malmquist productivity index, and provides a more comprehensive picture on productivity change than the Malmquist productivity index. The CM and MI are used to measure productivity performance of Vietnam's manufacturing enterprises pre- and post- global crisis.

**Table 7-2. Descriptive Statistics for Productivity Index**

| | 2007-2009 | | 2009-2011 | | 2007-2011 | |
|---|---|---|---|---|---|---|
| | **CM** | **MI** | **CM** | **MI** | **CM** | **MI** |
| Geometric mean | 0.728 | 1.179 | 0.717 | 1.243 | 0.722 | 1.210 |
| S.D. | 0.284 | 0.259 | 0.235 | 0.229 | 0.134 | 0.144 |
| Min | 0.158 | 0.340 | 0.120 | 0.491 | 0.270 | 0.671 |
| Max | 3.900 | 2.523 | 5.844 | 2.873 | 1.699 | 1.881 |

Source: Author's calculation
Note: CM represents the Cost Malmquist productivity index, MI introduces the input-oriented Malmquist productivity index.

Prior to the analysis, it should be noted that the productivity index is less than unity implying productivity improvement and vice versa. Taking value above one, the input-oriented Malmquist productivity index (MI) exhibits productivity decrease, and the reduction seems to be worse over time.[60] In particular, Malmquist productivity drops 17.9% in period 2007-2009, 24.3% in 2009-2011 and totally loses 21.0% in 2007-2011. Meanwhile, the cost Malmquist productivity index (CM) increases 27.2% over the period 2007-2009, and even goes up at a higher rate of 28.3% in the next period 2009-2011. Over

[60] The input-oriented Malmquist productivity index is the Malmquist productivity index measured by input-oriented approach instead of the output-oriented approach (output-oriented Malmquist productivity index). Hereafter, this index is called the Malmquist index for short. Also, the cost Malmquist productivity index is called the cost Malmquist index.

the full period, TFP surges 27.8%, meaning that in spite of difficulties in supply and demand, manufacturing enterprises kept productivity enhancement. It is worthy to note that the enterprises in this sample are survivors of economic stagnation in the 2008 global crisis, and they, therefore, are capable of maintaining productivity growth.

**Table 7-3. The Cost Malmquist Productivity Index and Components**

| | CM | MI | OEC | CTC | TEC | PTEC | SEC | TC | CSEC | AEC | PEC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2007-2009 | 0.728 | 1.179 | 0.775 | 0.940 | 1.097 | 1.072 | 1.062 | 1.035 | 1.023 | 0.707 | 0.908 |
| 2009-2011 | 0.717 | 1.243 | 0.900 | 0.796 | 1.001 | 1.081 | 1.010 | 1.138 | 0.926 | 0.900 | 0.699 |
| **2007-2011** | **0.722** | **1.210** | **0.835** | **0.865** | **1.048** | **1.076** | **1.036** | **1.085** | **0.973** | **0.797** | **0.797** |

Source: Author's calculation.

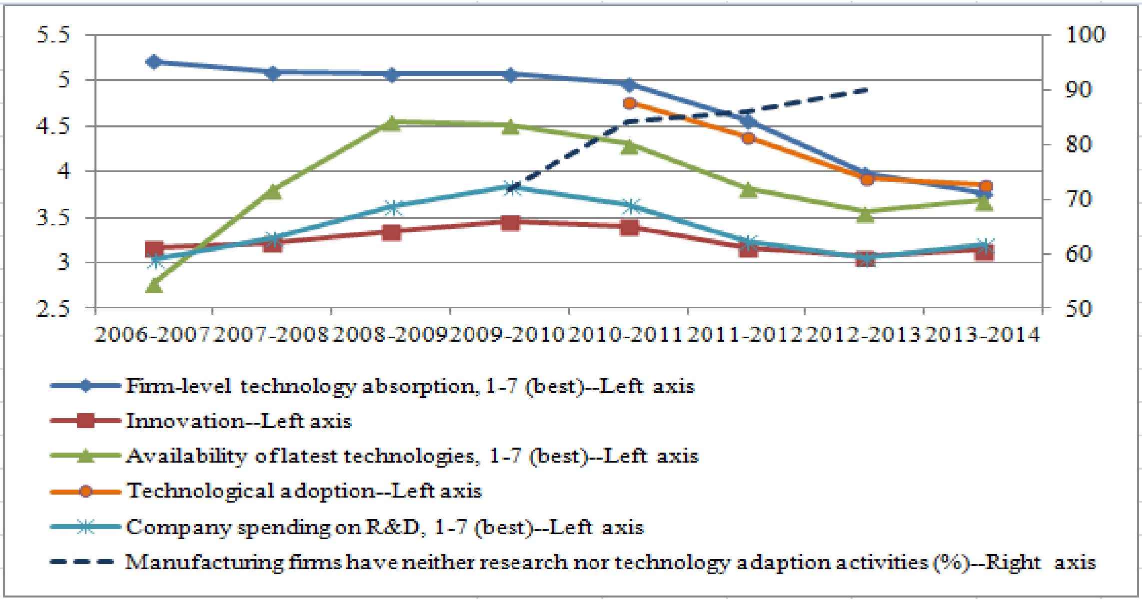
Note: 1. Geometric mean. 2. CM represents the cost Malmquist productivity index, MI-Input-oriented Malmquist productivity index, OEC-Overall efficiency change, CTC-Cost-Technical change, TEC-Technical efficiency change, PTEC-Pure Technical efficiency change, SEC-Scale efficiency change, TC-Technical change, CSEC-Cost scale efficiency change, AEC-Allocative efficiency change, PEC-Price effect change. 3. CM = OEC x CTC = (TEC x AEC) x (TC x PEC) = PTEC x CSEC x AEC x TC x PEC. 4. MI = PTEC x SEC x TC. 5. Productivity comparisons by time are in Appendix (Table 7A-5).

In the full period, overall efficiency change (OEC), cost-technical change (CTC), cost scale efficiency change (CSEC), allocative efficiency change (AEC) and price effect change (PEC) report improvement. In particular, overall efficiency surges 16.5%, followed by cost-technical changed 13.5%. Price efficiency and allocative efficiency expand 20.3%, while cost scale efficiency increases 2.7%. Yet, technical progress reduces 8.5% and technical efficiency declines 4.8%.

In terms of the cost Malmquist index, TFP improvement is attributed by increasing OEC, CTC or by increasing AEC, PEC and CSEC. TFP growth is caused by overall efficiency change in period 2007-2009, and by cost technical change in 2009-2011. In another aspect, improvement of allocative efficiency, price effect and cost scale efficiency outweigh decreasing technical efficiency and cause TFP growth. This result suggests that manufacturing firms in this sample responded quite well to the pressure from demand (retaining the production price in response to weak demand) and supply side (reducing input quantities to cope with price chances). Vietnamese manufacturing enterprises made a good input combination that leads to an increase of 29.3% of allocative efficiency in 2007-2009, while manufacturing industries achieves a 9.2% increase in industry-level allocative efficiency or price effect. Nevertheless, in period 2009-2011, manufacturing firms, which mostly are SMEs, can not keep that growth pace, and reports only 10.0% increase in allocative efficiency, suggesting that more serious difficulties in both supply and demand weakened their performance. The finding that allocative efficiency increases with slower pace is in vein with the empirical result in Chapter 5. Yet, manufacturing industries seem to be more familiar with the economic situation over time, especially price fluctuation, and made higher price effect improvement, a 30.1% increase in 2009-2011. Simultaneously, manufacturing firms get closer to optimal scale in minimizing the production cost and record an improvement of cost scale efficiency from -2.3% in 2007-2009 to 7.4% in 2009-2011.

Decreasing Malmquist productivity index originates from diminishing pure technical efficiency, decreasing scale efficiency and technical regress. For the full period, the pure technical efficiency change (PTEC) is 1.076, decreasing 7.6%. For single periods, slightly bigger reduction in the pure technical efficiency is observed. In particular, pure technical efficiency falls 7.2% in period 2007-2009, and 8.1% in the next period. The decrease of the pure technical efficiency means that manufacturing firms failed to be closer to the production frontier. The declining effect of pure technical efficiency offsets increasing cost scale efficiency and induces technical efficiency reduction. Notably, the technical efficiency is observed with smaller reduction over time, from -9.7% to only -0.1%.

**Figure 7-3. Some Indicators on Innovation and Technology-Vietnam**




Source: WEF; CIEM, DoE, & GSO (2012a, 2012b, 2013, 2014)
Note: 1. The left axis shows some technological and innovation indicators belonging to the Global Competitiveness Index (WEF). 2. The right axis represents indicator "Manufacturing firms have neither research nor technology adaption activities", from the survey on firm-level competitiveness and technology by CIEM et al. This annual dat is in 2009-2012 period.

For the whole period, mean technical change is recognized a decrease of 8.5% suggests more inputs are needed for a given output with respect to innovation and technological regress. Moreover, technological regress seems more serious over time, reducing 3.5% in 2007-2009 and 13.8% in the next period. Technical regress may associate with low proportion of firms involving Research and Development (R&D). According to CIEM, DoE, & GSO (2012a, 2012b, 2013, 2014), about three fourth of manufacturing enterprises have neither research nor technology adaption activities in 2009 and this rate steadily increased to nearly 90% in 2012 (Figure 7-3, right axis).[61] Meanwhile, following the Global Competitiveness Index, spending on R&D of Vietnamese companies continuously went down since 2009-2010. Moreover, as illustrated in Figure 7-3, firm-level technology absorption and technological adoption has dropped since 2010-2011 and at the national level, innovation is reported with no improvement, while the latest technology seems less available.[62]

At the national level, technological regress involves many aspects of low research and development (R&D) capacity, i.e. investment for scientific and technology (S&T), human capital. The latest data in 2002 represents that gross domestic expenditure on R&D made up only 0.18% of GDP, while public S&T expenditure was around 0.5%-0.6% of GDP during 2006-2011 and R&D staffs constituted about 7% of the population.[63] The share of business expenditure on R&D is even lower, accounting for 0.01% of GDP in 2002, and R&D has not received appropriate treatment from the enterprise side (OECD & The World Bank, 2014). At firm-level, capacity in absorbing new technology and knowledge as well as adapting them depends on managerial level, organization and labor

[61] The Competiveness and Technology Survey has been conducted yearly by CIEM, DoE, & GSO since 2010 to investigate the innovation and technology capability of non-state manufacturing enterprises. The sample of this survey is selected from the Enterprise Survey by GSO.

[62] Five indicators in the left axis are from the Global Competitiveness Index by the World Economic Forum. The indicator "Firm-level technology absorption, 1-7 (best)" is measured by asking "In your country, to what extent do businesses adopt new technology? [1 = not at all; 7 = adopt extensively]". The indicator "Availability of latest technologies, 1-7 (best)" is from the question "In your country, to what extent are the latest technologies available? [1 = not available at all; 7 = widely available]". The indicator "Company spending on R&D, 1-7 (best)" is from the question "In your country, to what extent do companies spend on research and development (R&D)? [1 = do not spend on R&D; 7 = spend heavily on R&D]". Two indicators "Innovation" and "Technological adoption" are aggregated indicators.

[63] Due to weakness in statistics of science and technology, only data in 2002 were collected.

force. Low managerial skill can be illustrated by the fact that 30% of managers do not have undergraduate education, according to the 2005 Investment Climate and the 2012 STEP Skills Survey by the World Bank. Poor managerial skills seems to be more severe for SMEs, which usually develop from household businesses with very little managerial experience (OECD & The World Bank, 2014). With respect to workforce, recruitment of skilled laborers remains one of enterprises' obstacles. For each 1000 SMEs, only 4 enterprises have scientists, compared to 31 for FIEs and 94 for SOEs. Furthermore, application of new organizational methods, i.e. ISO, is moderate. Only 17% of firms obtain ISO certifications, which is lower than China (36%), and Thailand (39%). The very low level of science and technology with inadequate investment and number of employees for this special field at both the national-level and firm-level have remained barriers for the promotion of technical progress. This task has become more challenging during the global crisis period, when economic recovery was the priority. For enterprises, higher production costs and significantly diminishing demand have slackened their moderate investment in technology.

#### *7.2.2.2. Productivity Index and Its Decompositions of Manufacturing Enterprises by Scale, Ownership, and Sector*

*a. Productivity Change of Manufacturing Enterprises by Scale*

It is observed that two groups of scale achieved positive growth in terms of the cost Malmquist productivity index and the LE group records higher TFP growth than the SME group, 30.8% compared to 27.2%. Inversely, the Malmquist productivity index of enterprises in two type of scale indicates negative productivity growth, but LEs register a bigger loss than SMEs, 22.3% decline compared to 20.8% decline. TFP improvement for two scale is attributed to the improvement of CTC and OEC. In another way, productivity growth is attributed to the positive growth of AEC and PEC.

For single periods, it suggests the similarity and difference in productivity trend of LEs and SMEs. The two groups of enterprises record negative and worse Malmquist productivity growth over time, but they differ in the tendency of cost Malmquist TFP growth. The cost Malmquist TFP growth of LEs was 38.7% in 2007-2009, and 21.8% in 2009-2011, being equivalent to a 16.9 percentage point reduction in TFP growth rate, while SMEs appear with 4.4 percentage points of TFP improvement in 2009-2011 compared to the previous period (increasing from 25.0% to 29.4%).

**Table 7-4. TFP Growth and its Components by Scale and Ownership**

| | | CM | MI | OEC | CTC | TEC | PTEC | SEC | TC | CSEC | AEC | PEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2007-2009 | 0.613 | 1.186 | 1.244 | 0.493 | 1.119 | 0.935 | 1.239 | 1.024 | 1.197 | 1.111 | 0.481 |
| | 2009-2011 | 0.782 | 1.260 | 0.800 | 0.978 | 0.932 | 1.114 | 1.006 | 1.124 | 0.837 | 0.858 | 0.870 |
| **LEs** | **2007-2011** | **0.692** | **1.223** | **0.997** | **0.694** | **1.021** | **1.021** | **1.117** | **1.073** | **1.001** | **0.976** | **0.647** |
| | 2007-2009 | 0.750 | 1.177 | 0.714 | 1.051 | 1.093 | 1.098 | 1.034 | 1.037 | 0.996 | 0.653 | 1.013 |
| | 2009-2011 | 0.706 | 1.240 | 0.919 | 0.768 | 1.013 | 1.075 | 1.011 | 1.141 | 0.942 | 0.907 | 0.673 |
| **SMEs** | **2007-2011** | **0.728** | **1.208** | **0.810** | **0.898** | **1.052** | **1.086** | **1.023** | **1.088** | **0.969** | **0.770** | **0.826** |
| | 2007-2009 | 0.711 | 1.192 | 1.085 | 0.656 | 1.013 | 1.004 | 1.151 | 1.032 | 1.009 | 1.072 | 0.635 |
| | 2009-2011 | 0.823 | 1.208 | 0.939 | 0.876 | 0.926 | 1.070 | 0.991 | 1.139 | 0.865 | 1.014 | 0.769 |
| **SOEs** | **2007-2011** | **0.765** | **1.200** | **1.009** | **0.758** | **0.968** | **1.036** | **1.068** | **1.084** | **0.934** | **1.042** | **0.699** |
| | 2007-2009 | 0.733 | 1.183 | 0.708 | 1.036 | 1.101 | 1.081 | 1.039 | 1.053 | 1.018 | 0.643 | 0.984 |
| | 2009-2011 | 0.706 | 1.239 | 0.912 | 0.774 | 1.010 | 1.075 | 1.009 | 1.143 | 0.939 | 0.904 | 0.677 |
| **DPEs** | **2007-2011** | **0.720** | **1.211** | **0.804** | **0.895** | **1.054** | **1.078** | **1.024** | **1.097** | **0.978** | **0.762** | **0.816** |
| | 2007-2009 | 0.717 | 1.168 | 0.934 | 0.768 | 1.092 | 1.055 | 1.112 | 0.996 | 1.035 | 0.855 | 0.771 |
| | 2009-2011 | 0.736 | 1.254 | 0.872 | 0.845 | 0.985 | 1.095 | 1.015 | 1.128 | 0.900 | 0.885 | 0.749 |
| **FIEs** | **2007-2011** | **0.727** | **1.210** | **0.902** | **0.805** | **1.037** | **1.074** | **1.062** | **1.060** | **0.965** | **0.870** | **0.760** |

Source: Author's calculation.
Note: 1. Geometric mean. 2. CM represents the cost Malmquist productivity index, MI-Input-oriented Malmquist productivity index, OEC-Overall efficiency change, CTC-Cost-Technical change, TEC-Technical efficiency change, PTEC-Pure Technical efficiency change, SEC-Scale efficiency change, TC-Technical change, CSEC-Cost scale efficiency change, AEC-Allocative efficiency change, PEC-Price effect change. 3. CM = OEC x CTC = (TEC x AEC) x (TC x PEC) = PTEC x CSEC x AEC x TC x PEC. 4. MI = PTEC x SEC x TC.

Positive TFP growth in terms of the cost Malmquist index, as indicated earlier, is attributed to the improvement of allocative efficiency and price effect. However, the two components of LEs and SMEs report different trend over time. LEs are observed with improvement in AEC, from -11.1% in period 2007-2009 to 14.2% in the next period, but their price effect shows deceleration over time. Meanwhile, it is found a change-over from negative to positive growth of price effect of SMEs, while their allocative efficiency's deceleration is recognized.

For LEs and SMEs, the decline in the Malmquist productivity index comes from technical regress and negative growth of pure technical efficiency and scale efficiency. SMEs seem to suffer larger reduction of pure technical efficiency and technical regress than large counterparts. Meanwhile, the scale efficiency change and cost scale efficiency change present smaller distance to the optimal scale of SMEs than that of LEs.

*b. Productivity Change of Manufacturing Enterprises by Ownership*

For the whole period, DPEs lead in TFP growth rate at 28.0%, followed by FIEs with a 27.3% increase, and SOEs lag behind with a 23.5% increase. The three types of enterprises record positive cost-technical change as a result of positive price effect change, while DPEs and FIEs appear with positive overall efficiency change as a result of allocative efficiency enhancement. Malmquist productivity index of all ownership types suggests reduction of productivity that is caused by no improvement in technical efficiency and worse technological regress.

In the common situation, all types of ownership suffer technical regress. Yet, FIEs' technological regress is smaller than that of domestic counterparts (-6.0% of FIEs compared to -8.4% of SOEs and -9.7% of DPEs). Technical regress of FIEs can be explained by the fact that many foreign investors come to Vietnam for the abundant and low labor cost, they mainly focus on assembling and low value added business, not many for advanced technology or technology transfer.

*c. Productivity Change of Manufacturing Enterprises by Sector*

All manufacturing sectors register productivity growth for single periods and for the whole period, ranging from 23.5% to 30.8%. While the Malmquist productivity index records higher reduction in Malmquist TFP over time, positive growth of the cost Malmquist TFP is caused by an increase of cost-scale efficiency, allocative efficiency and price effect change for all sectors. Larger depression of technical change combined with negative growth of pure technical efficiency and scale efficiency induced negative growth of the Malmquist productivity.

For enterprises by group of technology level, differences between the productivity index and its components between technology groups are minimal. The high-technology sector group observes the largest reduction of technical change (-9.4%), the lowest growth rate of AEC (20.1%) and productivity (CM, 26.6%). It can be explained that in the global value chains, high technology sectors might use high-valued imported inputs but generate low value added, and therefore, their productivity might not be equivalent. In contrast, the low technology group remarks the highest growth rate of TFP (28.1%), despite the fact that it does not lead in any productivity components.

**Table 7-5. TFP Growth and Its Components by Sector**

| | | CM | MI | OEC | CTC | TEC | PTEC | SEC | TC | CSEC | AEC | PEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2007-2009 | 0.712 | 1.231 | 0.835 | 0.853 | 1.063 | 1.064 | 1.058 | 1.093 | 0.998 | 0.786 | 0.780 |
| | 2009-2011 | 0.672 | 1.238 | 0.880 | 0.763 | 1.006 | 1.068 | 1.008 | 1.150 | 0.941 | 0.875 | 0.664 |
| FBT | **2007-2011** | 0.692 | 1.234 | 0.857 | 0.807 | 1.034 | 1.066 | 1.033 | 1.121 | 0.970 | 0.829 | 0.720 |
| | 2007-2009 | 0.805 | 1.174 | 0.874 | 0.922 | 1.021 | 1.027 | 1.079 | 1.059 | 0.994 | 0.856 | 0.870 |
| | 2009-2011 | 0.678 | 1.294 | 0.852 | 0.796 | 1.031 | 1.116 | 1.018 | 1.139 | 0.923 | 0.827 | 0.699 |
| GT | **2007-2011** | 0.739 | 1.233 | 0.863 | 0.857 | 1.026 | 1.071 | 1.048 | 1.098 | 0.958 | 0.841 | 0.780 |
| | 2007-2009 | 0.731 | 1.173 | 0.798 | 0.915 | 1.141 | 1.088 | 1.053 | 1.024 | 1.049 | 0.699 | 0.894 |
| | 2009-2011 | 0.715 | 1.268 | 0.865 | 0.827 | 0.981 | 1.080 | 1.029 | 1.141 | 0.909 | 0.881 | 0.724 |
| FWL | **2007-2011** | 0.722 | 1.220 | 0.831 | 0.870 | 1.058 | 1.084 | 1.041 | 1.081 | 0.976 | 0.785 | 0.804 |
| | 2007-2009 | 0.696 | 1.150 | 0.681 | 1.021 | 1.088 | 1.015 | 1.051 | 1.078 | 1.072 | 0.626 | 0.947 |
| | 2009-2011 | 0.748 | 1.260 | 0.944 | 0.793 | 1.000 | 1.113 | 1.007 | 1.125 | 0.899 | 0.944 | 0.705 |
| WP | **2007-2011** | 0.722 | 1.204 | 0.802 | 0.900 | 1.043 | 1.063 | 1.029 | 1.101 | 0.981 | 0.769 | 0.817 |
| | 2007-2009 | 0.658 | 1.156 | 0.656 | 1.002 | 1.223 | 1.138 | 1.069 | 0.950 | 1.074 | 0.537 | 1.055 |
| | 2009-2011 | 0.781 | 1.267 | 0.960 | 0.814 | 0.992 | 1.096 | 1.026 | 1.127 | 0.905 | 0.967 | 0.722 |
| PP | **2007-2011** | 0.717 | 1.210 | 0.794 | 0.903 | 1.101 | 1.117 | 1.047 | 1.035 | 0.986 | 0.721 | 0.873 |
| | 2007-2009 | 0.739 | 1.173 | 0.787 | 0.938 | 1.083 | 1.080 | 1.050 | 1.035 | 1.003 | 0.727 | 0.907 |
| | 2009-2011 | 0.748 | 1.207 | 0.917 | 0.816 | 0.963 | 1.049 | 1.016 | 1.133 | 0.918 | 0.952 | 0.720 |
| FN | **2007-2011** | 0.743 | 1.190 | 0.849 | 0.875 | 1.021 | 1.064 | 1.033 | 1.082 | 0.960 | 0.832 | 0.808 |
| | 2007-2009 | 0.740 | 1.191 | 0.707 | 1.047 | 1.150 | 1.152 | 1.066 | 0.969 | 0.998 | 0.614 | 1.080 |
| | 2009-2011 | 0.693 | 1.262 | 0.895 | 0.774 | 1.050 | 1.109 | 1.007 | 1.130 | 0.946 | 0.853 | 0.685 |
| RP | **2007-2011** | 0.716 | 1.226 | 0.795 | 0.900 | 1.099 | 1.130 | 1.036 | 1.047 | 0.972 | 0.724 | 0.860 |
| | 2007-2009 | 0.733 | 1.251 | 0.650 | 1.128 | 1.225 | 1.202 | 1.057 | 0.985 | 1.019 | 0.531 | 1.146 |
| | 2009-2011 | 0.700 | 1.242 | 0.938 | 0.747 | 1.021 | 1.093 | 0.999 | 1.138 | 0.935 | 0.918 | 0.657 |
| NM | **2007-2011** | 0.716 | 1.246 | 0.781 | 0.918 | 1.118 | 1.146 | 1.028 | 1.058 | 0.976 | 0.698 | 0.867 |
| | 2007-2009 | 0.732 | 1.152 | 0.823 | 0.890 | 1.070 | 1.055 | 1.038 | 1.052 | 1.014 | 0.769 | 0.846 |
| | 2009-2011 | 0.710 | 1.235 | 0.887 | 0.801 | 0.964 | 1.054 | 1.017 | 1.153 | 0.915 | 0.920 | 0.695 |
| BM | **2007-2011** | 0.721 | 1.193 | 0.854 | 0.844 | 1.016 | 1.055 | 1.027 | 1.101 | 0.963 | 0.841 | 0.767 |
| | 2007-2009 | 0.741 | 1.155 | 0.785 | 0.944 | 1.022 | 1.014 | 1.053 | 1.082 | 1.008 | 0.768 | 0.872 |
| | 2009-2011 | 0.715 | 1.224 | 0.896 | 0.797 | 0.995 | 1.071 | 0.990 | 1.154 | 0.929 | 0.901 | 0.691 |
| FM | **2007-2011** | 0.728 | 1.189 | 0.839 | 0.868 | 1.009 | 1.042 | 1.021 | 1.117 | 0.968 | 0.832 | 0.776 |
| | 2007-2009 | 0.756 | 1.121 | 0.984 | 0.768 | 1.038 | 0.968 | 1.101 | 1.052 | 1.073 | 0.948 | 0.731 |
| | 2009-2011 | 0.729 | 1.250 | 0.858 | 0.850 | 1.040 | 1.134 | 1.008 | 1.094 | 0.917 | 0.825 | 0.777 |
| TE | **2007-2011** | 0.742 | 1.184 | 0.919 | 0.808 | 1.039 | 1.048 | 1.054 | 1.072 | 0.992 | 0.884 | 0.753 |
| | 2007-2009 | 0.670 | 1.173 | 0.833 | 0.804 | 1.104 | 1.066 | 1.066 | 1.033 | 1.036 | 0.754 | 0.779 |
| | 2009-2011 | 0.735 | 1.214 | 0.894 | 0.823 | 0.967 | 1.057 | 1.014 | 1.134 | 0.915 | 0.924 | 0.726 |
| CP | **2007-2011** | 0.702 | 1.193 | 0.863 | 0.813 | 1.034 | 1.061 | 1.039 | 1.082 | 0.974 | 0.835 | 0.752 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2007-2009 | 0.771 | 1.108 | 0.784 | 0.983 | 1.038 | 0.990 | 1.066 | 1.049 | 1.049 | 0.755 | 0.937 |
| | 2009-2011 | 0.742 | 1.208 | 0.929 | 0.799 | 0.952 | 1.033 | 1.021 | 1.145 | 0.921 | 0.976 | 0.698 |
| ME | **2007-2011** | 0.756 | 1.157 | 0.854 | 0.886 | 0.994 | 1.012 | 1.043 | 1.096 | 0.983 | 0.859 | 0.808 |
| | 2007-2009 | 0.790 | 1.189 | 0.940 | 0.840 | 1.096 | 1.049 | 1.066 | 1.064 | 1.045 | 0.858 | 0.789 |
| | 2009-2011 | 0.742 | 1.232 | 0.833 | 0.890 | 0.991 | 1.037 | 1.015 | 1.170 | 0.956 | 0.840 | 0.761 |
| EE | **2007-2011** | 0.765 | 1.211 | 0.885 | 0.865 | 1.042 | 1.043 | 1.040 | 1.116 | 0.999 | 0.849 | 0.775 |
| High | 2007-2009 | 0.729 | 1.155 | 0.840 | 0.868 | 1.080 | 1.037 | 1.066 | 1.046 | 1.042 | 0.778 | 0.830 |
| | 2009-2011 | 0.739 | 1.216 | 0.890 | 0.830 | 0.968 | 1.044 | 1.017 | 1.146 | 0.927 | 0.920 | 0.724 |
| | **2007-2011** | 0.734 | 1.185 | 0.865 | 0.849 | 1.022 | 1.040 | 1.041 | 1.094 | 0.983 | 0.846 | 0.775 |
| Medium | 2007-2009 | 0.740 | 1.182 | 0.749 | 0.988 | 1.107 | 1.091 | 1.062 | 1.021 | 1.015 | 0.676 | 0.968 |
| | 2009-2011 | 0.706 | 1.243 | 0.900 | 0.784 | 1.020 | 1.092 | 1.001 | 1.137 | 0.933 | 0.883 | 0.690 |
| | **2007-2011** | 0.723 | 1.212 | 0.821 | 0.880 | 1.062 | 1.092 | 1.031 | 1.077 | 0.973 | 0.773 | 0.817 |
| Low | 2007-2009 | 0.720 | 1.184 | 0.774 | 0.930 | 1.095 | 1.070 | 1.062 | 1.042 | 1.023 | 0.707 | 0.893 |
| | 2009-2011 | 0.717 | 1.252 | 0.904 | 0.794 | 0.998 | 1.084 | 1.015 | 1.137 | 0.921 | 0.905 | 0.698 |
| | **2007-2011** | 0.719 | 1.217 | 0.836 | 0.859 | 1.045 | 1.077 | 1.038 | 1.088 | 0.971 | 0.800 | 0.789 |

Source: Author's calculation.

Note: 1. Geometric mean. 2. CM represents the cost Malmquist productivity index, MI-Input-oriented Malmquist productivity index, OEC-Overall efficiency change, CTC-Cost-Technical change, TEC-Technical efficiency change, PTEC-Pure Technical efficiency change, SEC-Scale efficiency change, TC-Technical change, CSEC-Cost scale efficiency change, AEC-Allocative efficiency change, PEC-Price effect change. 3. CM = OEC x CTC = (TEC x AEC) x (TC x PEC) = PTEC x CSEC x AEC x TC x PEC. 4. MI = PTEC x SEC x TC. 5. List of sectors is in Appendix (Table 4A-1).

## Appendix of Chapter 7

**Table 7A-1. Selected Studies on Firm-level Productivity Change in Vietnam**

| Author(s) | Sample | Method | Result |
|---|---|---|---|
| Vu (2003) | Industrial SOEs, 1976-1998 | Econometric model | Full period: 3.05%;<br>Partial reform (1982-1989): 4.22%;<br>Full reform (1990-1998): 5.37% |
| Nguyen et al. (2006) | The garment and textile, 1997-2000 | SPF | TE: 80.5%-82.0% (unweighted TE), 82.9%-90.2% (weighted TE)<br>The garment: positive and lower TFP growth, attributed by TP.<br>The textile: positive and mixed TFP growth, attributed to TEC |
| Nguyen et al (2012) | Manufacturing firms, 2003-2007, N=8057 | SFA | Positive but lower TFP growth: 5.2%<br>Positive and fluctuated TE change: 3%<br>Lower technical progress, technical regress in 2006-2007: 2.3% |
| Nguyen (2012) | Commercial banks, 2007-2010 | The Malmquist productivity index | TFP growth: 8.8%; TEC: 6.4%; TC: 2.2% |

Source: Author's compilation

**Table 7A-2. Comparison Partial Productivity by Scale and Ownership**

| | By scale (LEs, SMEs) | | By ownership type (SOEs, DPEs, FIEs) | |
|---|---|---|---|---|
| | T-test | Sig. | F-test | Sig. |
| Labor productivity | 5.076 | 0.000 | 369.902 | 0.000 |
| Capital productivity | 1.782 | 0.075 | 18.939 | 0.000 |

Source: Author's calculation

Note: 1. T-test is used to compare means of partial productivity by scale. 2. One-way ANOVA test is used to compare means of partial productivity by ownership.

**Table 7A-3. Comparison Partial Productivity Growth by Time**

| | T-test | p-value |
|---|---|---|
| dLprod0709 - dLprod0911 | 1.347 | 0.178 |
| dKprod0709 - dKprod0911 | 0.617 | 0.537 |

Source: Author's calculation
Note: T-test is used to compare means of partial productivity by time.

**Table 7A-4. Comparison Partial Productivity Growth by Scale and Ownership**

| | By size (LEs, SMEs) | | By ownership type (SOEs, DPEs, FIEs) | |
|---|---|---|---|---|
| | T-test | p-value | F-test | p-value |
| dLprod0709 | -0.882 | 0.378 | 4.668 | 0.010 |
| dKprod0709 | -0.596 | 0.551 | 6.434 | 0.002 |
| dLprod0911 | 1.095 | 0.273 | 3.602 | 0.027 |
| dKprod0911 | 1.605 | 0.109 | 9.873 | 0.000 |

Source: Author's calculation
Note: 1. T-test is used to compare means of partial productivity growth by scale. 2. One-way ANOVA test is used to compare means of partial productivity growth by ownership.

**Table 7A-5. Comparison TFP Change and Components by Time**

| | | t | p-value |
|---|---|---|---|
| Cost Malmquist productivity index | CM0709 - CM0911 | 3.097 | 0.002 |
| Malmquist productivity index | MI0709 - MI0911 | -6.067 | 0.000 |
| Overall efficiency change | OEC0709 - OEC0911 | -6.731 | 0.000 |
| Cost-Technical change | CTC0709 - CTC0911 | 16.751 | 0.000 |
| Technical efficiency change | TEC0709 - TEC0911 | 8.642 | 0.000 |
| Pure technical efficiency change | PTEC0709 - PTEC0911 | 0.576 | 0.565 |
| Scale effect change | SEC0709 - SEC0911 | 9.114 | 0.000 |
| Technical change | TC0709 - TC0911 | -24.134 | 0.000 |
| Cost-scale effect change | CSEC0709 - CSEC0911 | 11.743 | 0.000 |
| Allocative efficiency change | AEC0709 - AEC0911 | -5.686 | 0.000 |
| Price effect change | PEC0709 - PEC0911 | 21.642 | 0.000 |

Source: Author's calculation
Note: 1. T-test is used to compare means of TFP change and components by time. 2. Productivity comparison here is comparison of arithmetic means. Despite that the cost Malmquist productivity index and its components are geometric means, not many software supports comparison of geometric means. However, geometric means comparison of two or more groups is equivalent to arithmetic means comparison of logarithm form of these data. Hence, arithmetic means comparison is used to test equality of productivity indices.

# CHAPTER 8

# SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

This study is carried out in the context that since 2000, Vietnamese competitiveness and productivity did not register much improvement and lagged behind regional countries. Low competiveness, productivity and economic instability affected her economic growth and the pace to become an industrialized country. Since enterprise productivity and competitiveness determine national productivity and competitiveness, enhancement of firm-level productivity and competitiveness will boost national productivity and competitiveness. In order to improve firms productivity and competitiveness, the first important step is evaluating firm performance. Among different measures of firm performance, efficiency and productivity assessment have been widely used, in which efficiency is a primary source of productivity growth. This study evaluates efficiency performance of manufacturing firms because the industry is the driving force of economic growth. Efficiency performance of manufacturing enterprises is evaluated by the cost efficiency measure and its elements, i.e. technical efficiency and allocative efficiency. Then, sources of efficiencies are examined. The last section measures productivity change for manufacturing enterprises pre- and post-global crisis.

## 8.1. Summary and Conclusions of Efficiency Performance

Recognizing the important role of enterprise operation on the macroeconomy, Chapter 5 evaluates efficiency performance of manufacturing firms as the driving force of economic growth. Going further than existing studies on efficiency in Vietnam, the chapter evaluates efficiency performance of manufacturing enterprises through the cost efficiency measurement and its elements, i.e. technical efficiency and allocative efficiency and Chapter 6 examines its sources of efficiency. The two-stage DEA method is applied to meet the objectives. In the first stage, in Chapter 5, the nonparametric method (DEA) is employed to measure input-oriented technical efficiency and cost efficiency under the condition of Variable Returns to Scale (VRS). It is found that input prices are different across firms. Hence, efficiency measurements are calculated using the cost-based production possibility set, which takes account of input quantities and input prices. A New-Tech model, which makes use of the BCC-I model in the cost-based production possibility set is employed to gauge the technical efficiency, while a New-Cost model is applied to gauge the cost efficiency. Input mix allocative efficiency is extracted from the cost efficiency and the technical efficiency.

Keeping in mind that enterprises in different groups tend to use different technologies and different input combinations, but that enterprises in the same group tend to use the same technology and input combination, the metafrontier framework is applied to evaluate efficiency measurements for each individual group and efficiency for the whole sample. The metafrontier is determined for the pooled data, while group frontiers are defined for groups classified by scale, ownership, and sector.

In the second stage of the two-stage DEA method, in Chapter 6, the Tobit model is employed. The estimation is done for the pooled data and some selected groups: Large Enterprises, Small and Medium Enterprises, and Domestic Private Enterprises.

Generally, Vietnamese manufacturing firms are far from efficient. For the whole period 2007-2011, average cost efficiency is 38.9%, average technical efficiency and allocative efficiency is 58.0% and 69.9%, respectively. The result suggests great room for efficiency improvement and reducing production cost. Despite the low efficiency levels, the allocative efficiency improves over time, but at a slower pace.

Analysis of efficiency performance by scale shows that LEs perform better than SMEs in terms of all metafrontier efficiency measures. Larger firms tend to use higher capital-intensive technology and have higher labor productivity and higher productivity of materials and energy. SMEs being unable to obtain economies of scale suffer higher cost to produce one VND of total revenue and pay lower wages to maintain competitiveness than larger counterparts. Since SMEs account for the majority of the total number of Vietnamese enterprises, these findings lead to an implication that the current obstacles SMEs face, i.e. capital shortage, lack of adequate premises, low skill laborers, etc, should be removed. Furthermore, specific attention should be paid to facilitate technology upgrading as well as to enhance productivity of SMEs.

In terms of ownership types, the highest level of technical efficiency and cost efficiency of SOEs result from the preferential treatment they have enjoyed. SOEs, however, bear the lowest technical gap ratio and cost gap ratio, suggesting that if SOEs operate in a level playing field with DPEs and SOEs or without the priorities, their current highest efficiency levels cannot be insured. FIEs are the most allocatively efficient and their meta-production frontier and meta-cost frontier are the closest to the corresponding metafrontiers as most of them are wholly foreign owned, which take advantage of a higher technology level, management skill, business networks. Meanwhile, DPEs lag behind the two ownership types in terms of all efficiency measures. While SOEs and FIEs have received privileges, DPEs, especially small and medium DPEs have not had any of these priorities, but cope with resources constraint, regulation constraint, low technology and machinery, low skilled workers. This result yields a policy implication that the government should provide more support to DPEs as well as making a level playing field for all ownership types.

Considering operation of manufacturing sectors, high technology sectors seem to perform better, but still constitute a small share of the number of firms. Low technology sectors, which make up the largest number of firms, are in the lowest level of efficiencies and technology/cost gap ratios.

Chapter 6 investigates factors driving efficiency performance of manufacturing firms in Vietnam. The Tobit model is employed to reveal determinants of efficiencies, i.e. technical efficiency, allocative efficiency and cost efficiency (or overall efficiency). Explanatory variables include (i) firm characteristics (firm age, firm size, ownership types, location, capital intensity, human capital), (ii) leverage, (iii) concentration degree, (iv) FDI spillovers and finally (v) business environment. Empirical results reveal that:

First, older firms tend to be more allocatively efficient and overall efficient than younger firms as a result of experience and knowledge accumulation. Nevertheless, no significant relation between firm age and technical efficiency is found.

Second, large-sized enterprises perform better than SMEs due to their superior organization, technology knowledge, being more technology intensive and having larger capability in allocating resources. Hence, more attention should be paid to SMEs who account for the largest share of enterprises in Vietnam. The government significantly promoted SMEs development, and made some achievements. However, the effectiveness of those regulations, programs and organizations should be reconsidered seriously in order to strengthen the SMEs sector and to overcome the current phenomenon of the "missing middle" in manufacturing (Truong, 2013).[64]

Third, the lower efficiency level of DPEs compared to SOEs partly reflects DPEs' constraints of resource, information, being vulnerable to market changes, etc. Since 1989 the government's view on the private sector has changed significantly from recognizing the existence of DPEs, issuing laws and regulations and implimenting policies to promote this sector. Nonetheless, the existing gap between policy objectives and implementation prevents the development of DPEs. FIEs recorded a higher allocative efficiency level than SOEs, but no difference of technical efficiency, confirming the conclusion in the previous part that SOEs are not likely to be more efficient than DPEs and FIEs if all ownership types operate in a level playing field.

Fourth, the negative effect of capital intensity on technical efficiency implies the inadequate ability of labor in using new technology or machinery effectively. In addition, human capital positively affects efficiencies. Particularly, the positive relation between the proportion of employees with undergraduate or higher education and allocative efficiency suggests the role of education on improving firm allocative ability.

Fifth, financial leverage is found to lessen efficiencies of manufacturing enterprises, which indicates the existence of agency cost. Efficiency performance of DPEs and SMEs, especially of young firms with less reputation, is recognized to have inverse associations with leverage since the two enterprise types usually suffer higher interests rate.

Sixth, there is a significant and positive relation between concentration degree and technical efficiency, implying that firms operating in a less competitive industry are likely to have little motivation in enhancing their technical efficiency. Conversely, higher competition results in better usage of resources and lower production cost.

[64] The "missing middle" is a term implying the small share of medium sized enterprises.

Seventh, the FDI spillovers introduce positive impacts in terms of technology diffusion, competitive effect, and labor movement on the performance of manufacturing firms in general, and of manufacturing domestic private enterprises. FDI is an important source of investment in Vietnam, but FDI does not really meet the expectation to stimulate performance of the domestic sector. Forward linkage negatively affects technical efficiency and overall efficiency of manufacturing firm. Meanwhile, backward linkage reports insignificant relation to overall efficiency for the pooled sample of manufacturing firms. The weak linkages originate from a weak connection and wide technology gap between MNC affiliates and domestic firms.

Lastly, efforts of local governments in improving the provincial business environment, which have been recorded in the Provincial Competitiveness Index stimulates allocative efficiency and cost efficiency of manufacturing enterprises, especially SMEs and DPEs. In particular, such PCI sub-indices positively influence performance of manufacturing firms as Land access and security of tenure, Transparency and access to information, Time costs and regulatory compliance, Informal charges, Proactivity of provincial leadership, Labor policy, and Legal institutions. Whereas, the index business support services does not present a significant impact.

## 8.2. Summary and Conclusions for Productivity Performance of Manufacturing Enterprises in Vietnam

Productivity performance of enterprises consists of two categories, single factor productivity (labor productivity, capital productivity) and Total Factor Productivity. These productivity measurements are calculated and compared over two periods 2007-2009 and 2009-2011 to investigate the operation of manufacturing firms pre- and post-global crisis. Based on the result in Chapter 5, the Cost Malmquist Productivity Index is calculated as the representative of TFP growth. This productivity index includes the Malmquist Productivity Index, which is popular for the measurement of TFP change. Some conclusions are made through the analyses.

First, in terms of partial productivity, large enterprises registered higher labor productivity and capital productivity than their small and medium counterparts. Since manufacturing firms adjusted their performance to cope with the international and domestic economic situation by reducing firm size, capital and intermediate inputs, almost all manufacturing enterprises achieved a positive but lower growth rate of labor productivity and capital productivity, except small and medium SOEs. FIEs, suffering less effect of the economic crisis, are observed with higher productivity growth than DPEs. SOEs' slowest rate of productivity growth indicates that productivity improvement is not their priority.

Second, by adjusting scale and inputs used, manufacturing enterprises have positive TFP growth over the period 2007-2011, which originates from improvement of allocative efficiency and price effect.

Third, positive TFP growth is attributed to overall efficiency increase and cost-technical efficiency increase.

Fourth, the Malmquist productivity index for manufacturing enterprises as a whole and for groups of firms had a negative growth as a consequence of technical efficiency decline and technical regress. Decrease in technical efficiency, which is caused by decline of pure technical efficiency and scale effect efficiency, implies that manufacturing enterprises as a whole have remained far from their production frontier and optimal scale. It leads to the implication that innovation and technology improvement is necessary for technical efficiency enhancement.

Fifth, productivity improvement does not accompany technological progress.

Sixth, the lowest growth rate of high technology sectors suggests that in economic restructuring, Vietnam should switch to higher value added industries as well as improve its position in the global value chains.

In sum, in spite of many difficulties from the international and domestic sides in both supply and demand, Vietnam's manufacturing enterprises record productivity improvement pre-and post- global economic crisis, in terms of single factor productivity and TFP as a result of their adjustments in operation. However, decrease in Malmquist TFP and technical efficiency combined with technical regress raise a concern of innovation and technology at the national and enterprise levels.

## 8.3. Policy Implications

In this section some policy implications are suggested to improve efficiency and productivity performance of Vietnam's manufacturing enterprises in order to stimulate national productivity and competitiveness.

First, a level playing field must be maintained and promoted by removing special treatments for SOEs, MNC affiliates and connected domestic firms in central and local governments. A new economic growth model should be based on enterprises' effectiveness and contributions rather than preference. Equal opportunities to access credit, land, information, technology and business supports need to be secured for Domestic Private Firms and Small and Medium Enterprises.

Second, the majority of micro and small-sized firms face severe obstacles for future development. To avoid the "missing middle", it is crucial to strengthen these firms' operation by removing their existing obstacles, offering more business support and ensuring the regulatory effectiveness.

Third, most private enterprises were established since the 2000s and they have struggled for survival in the global financial crisis and national economic recession. The government, therefore, should pay more attention to young enterprises not only in promoting business registration but also encouraging their operation.

Fourth, FDI attraction needs to switch from quantity to quality, in terms of technology transfer, and raising the contribution of FDI to the economy. A priority list of sectors for FDI should be set.

Fifth, a better business environment at the national-level and local-level should be made. At the national-level, infrastructure, regulations and labor force bottlenecks need to be removed as soon as possible. The education and vocational training system needs to be reformed in parallel with strengthening interactions between universities, educational organizations and companies. The expenditure for S&T, for R&D and for technicians and researchers force should be increased. At the provincial-level, legal and institutional reforms should be maintained; local government should listen to enterprises and increase the effectiveness of regulation to encourage performance of enterprises.

### 8.4. Scope for Further Research

This section is to point out limitations of this thesis and offer further works to be done. With regard to limitations, data inavailability (number of working hours, sources of investment) lessens the accuracy of results and prevents deeper analysis. In particular, information of working hours will provide better result of labor productivity. [65]Also, if information of sources of investment is available, the price of capital will be more precise.

Some future researches should be done in the scope of enterprise performance. In terms of efficiency performance, along with more international integration of the economy and enterprises, some related variables should be added, for instance, trade activity, protection rate, tariff, etc. Furthermore, since entrepreneur is important in improving firm performance, it is needed to examine entrepreneur characteristics to firm performance. For assessing productivity, a full period since 2001 should be utilized to gauge not only productivity change, but also value of Total Factor Productivity. By doing so, it is expected to reflect more comprehensive efficiency performance and better productivity comparison. Moreover, sources of productivity value and productivity change should be examined. And, finally, further studies should utilize the parametric approach to assess efficiency and productivity performance and examine determinants.

[65] For the quantity of labor, Coelli et al. ( 2005, p. 142) argues that number of hours of labor input is more accurate than other measures (number of persons employed, including full-time and part-time employees; number of full-time equivalent employees and the total wages and salaries bill).

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