2012

The technical efficiency of Thai manufacturing small and medium sized enterprises: a comparison between the pre- and post- financial crisis of 1997

Teerawat Charoenrat
University of Wollongong

THE TECHNICAL EFFICIENCY OF THAI MANUFACTURING SMALL AND MEDIUM SIZED ENTERPRISES: A COMPARISON BETWEEN THE PRE- AND POST- FINANCIAL CRISIS OF 1997

A thesis submitted in fulfilment of the
requirements for the award of the degree

DOCTOR OF PHILOSOPHY

from

UNIVERSITY OF WOLLONGONG

by

TEERAWAT CHAROENRAT

SCHOOL OF ECONOMICS
FACULTY OF COMMERCE
2012

THESIS CERTIFICATION

I, Teerawat CHAROENRAT, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Economics, Faculty of Commerce, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Teerawat CHAROENRAT

13 September 2012

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ADB	Asian Development Bank
AE	Allocative Efficiency
APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
BIBF	Bangkok International Banking Facilities
BOI	Board of Investment
CEPT	Common Effective Preferential Tariff
CES	Constant Elasticity of Substitution
CRS	Constant Returns to Scale
CRSTE	Constant Returns to Scale Technical Efficiency
DEA	Data Envelopment Analysis
DEAP	Data Envelopment Analysis Program
DIP	Department of Industrial Promotion
DMU	Decision-making Unit
DRS	Decreasing Returns to Scale
FDI	Foreign Direct Investment
FTA	Free Trade Agreement
FTPI	Thailand Productivity Institute
GDP	Gross Domestic Product
ICT	Information and Communication Technology
IFCT	Industrial Financial Corporation of Thailand
IIDN	Independently and Identically Distributed Normal
IPOs	Initial Public Offerings
IRS	Increasing Returns to Scale
ISIC	International Standard Industrial Classification
ISMED	Institute for Small and Medium Enterprises Development
ISO	International Standards Organisation
IT	Information Technology
KPI	Key Performance Indicators
LE	Large Enterprise
LIMDEP	Limited Dependent Variable Models

LR	Likelihood Ratio
MAI	Market for Alternative Investment
ME	Medium Enterprise
MLE	Maximum Likelihood Estimate
MOI	The Ministry of Industry
NIRS	Non-increasing Returns to Scale
NPLs	Non-performing Loans
NSO	National Statistical Office
OBM	Original Brand Manufacturers
ODM	Original Design Manufacturers
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturers
OLS	Ordinary Least Squares
ONRCT	Office of National Research Council of Thailand
OSMEP	Office of Small and Medium Enterprises Promotion
OSMRJ	Organisation for Small & Medium Enterprises and Regional Innovation Japan
OTOP	One Tambon One Product
PIM	Perpetual Inventory Method
PPI	Producer Price Index
R&D	Research and Development
ROA	Return on Assets
ROE	Return on Equity
ROS	Return on Sales
SE	Small Enterprise
SFA	Stochastic Frontier Analysis
SICGC	Small Industry Credit Guarantee Corporation
SITC	Standard International Trade Classification
SME Bank	Small and Medium Enterprises Development Bank
SMEs	Small- and Medium-sized Enterprises
TE	Technical efficiency
TFP	Total Factor Productivity
TIG	Agreement on Trade in Goods

TISI	Thai Industrial Standards Institute
TNC	Trans-national Corporation
UNCTAD	United Nations Conference on Trade and Development
VC	Venture Capital
VRS	Variable Returns to Scale
VRSTE	Variable Returns to Scale Technical Efficiency
WTO	World Trade Organisation

LIST OF PAPERS AND PRESENTATIONS

Refereed Journal Articles:

Charoenrat, T, Harvie, C and Amornkitvikai, Y 2012, 'Thai Manufacturing SME Technical Efficiency: Evidence from Firm-level Industrial Census Data', *Journal of Asian Economics* (ERA = A) **(Revised and Resubmitted)**.

Charoenrat, T and Harvie, C 2012, 'Technical Efficiency and Thai Manufacturing Small and Medium Sized Enterprises: A Comparison between the Pre and Post Financial Crisis of 1997', *Journal of Small Business Management* (ERA = A) **(Under Review)**.

Charoenrat, T, Harvie, C and Chowdhury, K 2012, 'Are Thai Manufacturing SMEs Technically Efficient? Evidence from Industrial Census Data', *Economic Modelling,* (ERA = A) **(Under Review)**.

Charoenrat, T, Harvie, C and Amornkitvikai, Y 2012, *Identifying Technical Inefficiency Factors for Thai Manufacturing Small Enterprises*, International Small Business Journal, (ERA = A) **(Under Review)**.

Refereed Conference Articles:

Charoenrat, T, Harvie, C and Naburana, W 2013, *Measuring the Technical Efficiency of Thai Manufacturing SMEs: A Comparison of Parametric and Non-parametric Approaches,* The Cambridge Business & Economics Conference, University of Cambridge, UK, 2-3 July.

Amornkitvikai, Y, Harvie, C and **Charoenrat, T** 2013, *Factors Affecting the Technical Inefficiency of Thai Manufacturing and Exporting Small and Medium Sized Enterprises: A Stochastic Frontier Analysis (SFA)),* The Cambridge Business & Economics Conference, University of Cambridge, UK, 2-3 July.

Charoenrat, T and Harvie, C 2012, *Estimation of Technical Efficiency in Thai Manufacturing SMEs*, the 9th SMEs in a Global Economy Conference 2012: "Rising to the Global Challenge: Entrepreneurship and SME development in Asia, National University of Laos, Vientiane, 9-11 November.

Charoenrat, T and Harvie, C 2012, *Identifying Technical Inefficiency Factors for Thai Small Manufacturing Enterprises,* The 9th SMEs in a Global Economy Conference 2012: "Rising to the Global Challenge: Entrepreneurship and SME development in Asia, National University of Laos, Vientiane, 9-11 November.

Charoenrat, T and Harvie, C 2012, *The Technical Efficiency of Thai Manufacturing SMEs: Evidence From Industrial Census,* the 9th SMEs in a Global Economy Conference 2012: "Rising to the Global Challenge: Entrepreneurship and SME development in Asia, National University of Laos, Vientiane, 9-11 November.

Charoenrat, T and Harvie, C 2012, *Technical Efficiency Performance of Thai Manufacturing Small and Medium Sized Enterprises*, The 41th Australian Conference of Economists, Victoria University, Melbourne, July 8-12.

Charoenrat, T, Harvie, C and Naburana, W 2012, *Determinants of Technical Efficiency in Thai Manufacturing Small and Medium Sized Enterprise,* The Fourteenth Annual International Conference of the Global Business and Technology Association, New York City, New York, U.S.A, 10-14 July.

Charoenrat, T, Harvie, C and Amornkitvikai, Y 2012, *Identifying Technical Inefficiency Factors for Thai Manufacturing Small Enterprises*, The 57th International Council for Small Business World Conference, Wellington, New Zealand, 10-13 June.

Amornkitvikai, Y, Harvie, C and **Charoenrat, T** 2012, *Factors Affecting the Export Participation and Performance of Thai Manufacturing Small and Medium Sized Enterprises (SMEs),* The 57th International Council for Small Business World Conference, Wellington, New Zealand, 10-13 June.

Charoenrat, T and Harvie, C 2011, *Technical Efficiency of Thai Manufacturing SMEs: A Comparative Study of North-eastern Provinces*, The 40th Australian Conference of Economists, Australian National University, Canberra, July 11-14.

Charoenrat, T and Harvie, C 2011, *Identifying Technical Inefficiency Factors of Thai Manufacturing SMEs: A Comparison between the Pre and Post Financial Crisis of 1997*, The 8th SMEs in a Global Economy Conference 2011: "Rising to the Global Challenge: Entrepreneurship and SME development in Asia", Nong Khai, Thailand, 9-11 November.

Charoenrat, T, Harvie, C and Chowdhury, K 2011, *Firm-specific Factors Contributing to the Technical Inefficiency of Thai Manufacturing SMEs: Evidence from Industrial Censuses in 1997 and 2007*, The 8th SMEs in a Global Economy Conference 2011: "Rising to the Global Challenge: Entrepreneurship and SME development in Asia", Nong Khai, Thailand, 9-11 November.

Amornkitvikai, Y, Harvie, C and **Charoenrat, T** 2011, *The Export Participation of Thai Manufacturing SMEs*, The 8th SMEs in a Global Economy Conference 2011: "Rising to the Global Challenge: Entrepreneurship and SME development in Asia", Nong Khai, Thailand, 9-11 November.

Charoenrat, T, Harvie, C and Amornkitvikai, Y 2010, *Technical Efficiency of Thai Manufacturing SMEs: Evidence from a Firm-level Industrial Census*, The 7th SMEs in a Global Economy Conference: Challenges and Prospects, Kuching, Sarawak, Malaysia, 15-17 October.

Amornkitvikai, Y, Harvie, C and **Charoenrat, T** 2010, *Measuring Technical Efficiency: The Case of Thai Manufacturing and Exporting Small and Medium Size Enterprises (SMEs)*, The 7th SMEs in a Global Economy Conference: Challenges and Prospects, Kuching, Sarawak, Malaysia, 15-17 October.

Refereed Working Paper:

Charoenrat, T and Harvie, C 2011, *Technical Efficiency of Thai Manufacturing SMEs: A Comparative Study of North-eastern Provinces*, Working Paper No. 12-03, School of Economics, University of Wollongong, Wollongong.

Seminar Presentations:

Charoenrat, T, Harvie, C and Amornkitvikai, Y 2010, *Technical Efficiency of Thai Manufacturing SMEs: Evidence from a Firm-level Industrial Census*, Seminar Presentation at the Centre for Small Business and Regional Research, Faculty of Commerce, University of Wollongong, Australia, 17 September 2010.

Amornkitvikai, Y, Harvie, C and **Charoenrat, T** 2010, *Measuring Technical Efficiency: The Case of Thai Manufacturing and Exporting Small and Medium Size Enterprises (SMEs)*, Seminar Presentation at the Centre for Small Business and Regional Research, Faculty of Commerce, University of Wollongong, Australia, 17 September 2010.

Amornkitvikai, Y, Harvie, C and **Charoenrat, T** 2010, *Measuring Technical Efficiency: The Case of Thai Manufacturing and Exporting Small and Medium Size Enterprises (SMEs)*, Seminar Presentation at the School of Economics Seminar, Faculty of Commerce, University of Wollongong, Australia, 30 September 2010.

ABSTRACT

Thailand's manufacturing small- and medium-sized enterprises (SMEs) are recognised as making a significant contribution to the nation's business numbers, national employment, exports and output. Despite their obvious importance to the economy, Thai manufacturing SMEs face a number of important disadvantages that act as a barrier to their further development and competitiveness. They also confront intense competition in domestic and foreign markets. It is important to have a clear understanding of their readiness to face the rigours of international competition, including the barriers and specific problems that they face. This thesis is the first empirical study to apply a stochastic frontier production function and technical inefficiency effects model (using the SFA approach) and two-stage DEA approach (utilising a two-limit Tobit model) to estimate and compare the technical efficiency performance of Thai manufacturing SMEs in the pre-(before 1997[1]) and post-(after 2007[2]) Asian financial crisis periods, utilising the most substantive and the most recently available cross-sectional firm-level data from the 1997 and 2007 industrial censuses.

The thesis is the first study to identify important firm-specific factors and explanatory variables contributing to the technical inefficiency (or efficiency) of Thai manufacturing SMEs in the periods 1997 and 2007, covering six categories: by aggregate manufacturing SMEs; by small-sized firms; by medium-sized firms; by domestic market intensity; by export intensity; and by sub-manufacturing sectors classified by the Standard International Trade Classification (SITC) Revision 4. This thesis also identifies key policy priorities for Thai policy makers concerned with enhancing the technical efficiency performance of Thailand's manufacturing SMEs.

The empirical results from the SFA and DEA approaches produced similar results, in that the overall weighted technical efficiency scores in all categories of Thai manufacturing SMEs decreased in the post-crisis (2007) period as compared to the pre-crisis (1997) period. According to the overall weighted technical efficiency scores predicted by SFA and DEA, Thai manufacturing SMEs in both 1997 and 2007

---

[1] Firm-level data in the 1997 industrial census covered the operations of firms from 1st January 1996 to 31st December 1996 (the National Statistical Office of Thailand (NSO), 2010a).

[2] The 2007 industrial census firm-level data covered the operations of firms from 1st January 2006 to 31st December 2006 (the National Statistical Office of Thailand (NSO), 2010b).

operated at a low level of technical efficiency, specifying a high degree of technical inefficiency in their operation. The empirical results from the SFA approach reveal that SME production is heavily labour intensive in both periods with no apparent improvement in firm productivity and innovation. The empirical results from the technical inefficiency effects and a Tobit model indicate that firm size (economies of scale and scope), age (learning by doing), proportion of workforce which is skilled, location in towns and cities and particularly location in Bangkok, type of ownership, whether limited and public limited companies or juristic partnerships, foreign ownership or investment and export activity, are the important firm-specific factors contributing to the technical efficiency of Thai manufacturing SMEs in both 1997 and 2007.

Finally, this thesis concludes that government policy in the post-crisis period have been largely ineffective and should place more attention on creating an enabling environment to foster SME growth, enhance technology and innovation capability, and encourage the development of an environment, infrastructure and facilities conducive to enhancing the business operation of SMEs to enhance their technical efficiency. In addition, key measures to improve the technical efficiency of Thai manufacturing SMEs are: an adequate supply of inputs, easier access to financial services and credit facilities to facilitate firm growth, extensive infrastructural development and training programs for employees, expanded access to skilled labour and improvement in the skills of both the workforce and entrepreneurs, addressing locational and regional capacity inequities, enhancing the effectiveness of SME development programs, encouraging foreign investment for operational synergies and greater export activity to penetrate the world market.

Keywords: Technical Efficiency; Stochastic Frontier Analysis (SFA); Data Envelopment Analysis (DEA); Manufacturing Small and Medium sized Enterprises (SMEs); Thailand

ACKNOWLEDGEMENTS

My PhD thesis would not have been completed without the invaluable guidance, encouragement and assistance of many people and organisations. Therefore, I would like to express my sincere gratitude to them all.

First and foremost, I would like to express my deepest appreciation to my principal supervisor, Associate Prof Charles Harvie, who first introduced me to the thesis topic and directed me throughout my studies with patience, encouragement, constant and constructive criticism and inestimable assistance. His guidance has taught me how to be an independent researcher with a greater vision for future research projects. Charles has a good understanding of my culture, language and characteristics, and without his support it would not have been possible for me to complete my thesis. As Director of the Centre for Small Business & Regional Research (CSBRR), University of Wollongong (UOW), Charles supported me in attending several academic conferences and training courses on efficiency and productivity analysis at the Centre for Efficiency and Productivity Analysis, School of Economics, University of Queensland.

Secondly, I would like to express my special thanks to my co-supervisor, Dr Martin O'Brien, for his valuable support, useful comments and unabated enthusiasm throughout my thesis. Martin demonstrated to me the concept of logical and lateral thinking that will benefit me throughout my academic career. In addition, my thanks goes to Associate Professor Abbas Valadkhani, who taught me how to use research methodology, a skill that helped me complete the empirical analysis of my thesis. Thank you to Dr Khorshed Chowdhury and Dr Cassey Lee for providing me with great inspiration for my research that will benefit me for my whole life.

I would like to thank the following academic staff in the School of Economics, who provided generous assistance, valuable and useful suggestions; Dr Kankesu Jayanthakumaran, Dr Eduardo Pol, Dr Reetu Verma and Dr. Peter Siminski.

To Maree Horne and Helen Harman, a big thank you for your great friendship and kind assistance throughout my thesis, I could not have done it without you both. Thank you to the following administrative staff from the Faculty of Commerce: Brad Braithwaite, Phil Luskan, Lesley Simes, Patricia Hamlet, Carol Borgatti, Robert

Hood, Daryl Trkulja, Jim Longley, Christine O'Brien, Melissa Davies, Lisa Simmons and Kathryn Owen, for your support and assistance during my time at UOW.

My special thank you goes to the Royal Thai Government Scholarship Fund, under the program 'Strategic Scholarships for Frontier Research Network' from the Office of the Higher Education Commission, Thailand, for supporting my PhD degree. I would like to thank UOW for granting me an International Postgraduate Tuition Award in 2012.

My gratitude goes toward a number of staff at the Office of Educational Affairs, at the Royal Thai Embassy in Canberra, Australia, who organised my application process to study at UOW, including three Minister Counsellor's (Education); Phanu Sungkhavon, Thanida Techachokvivat, Kaewta Srisung, Thanapol (Bass) Thamnuvat (Education and Research Officer), and Somchitr Wattanatassi (Administrative and Finance Officer). In addition, I would like to extend my thanks to the National Statistical Office (NSO) of Thailand for granting me permission to utilise the data for this thesis. And my special thank you goes to Professor Chatthip Nartsupha, Faculty of Economics at Chulalongkorn University, Thailand and Associate Professor Tawin Nilbai, Faculty of Economics at Ramkhamhaeng, Thailand, for being my mentor during my PhD thesis.

My special thanks goes to my colleague and friend, Dr Yot Amornkitvikai, for his valuable support assisting me to successfully steer my thesis to its completion. Special appreciation is given to all of my friends and colleagues for their assistance, enjoyment, and encouragement throughout my study: Dr Piyapong (Tom) Sangkaew, Dr Wisuttorn (Dee) Jitaree, Jonathan Halloran, Dr. Viet Le Cong Luyen, Dr Issa Ali and Apiradee Somcheen. My thanks also goes to Leigh Blackmore for his assistance and useful comments on earlier drafts of my thesis.

Finally, my indebted gratitude and love to my family in Thailand; my Father (Teerawut), my Mother (Prapakorn), my older Brother (Ton), my younger Brother (Thinglee), who enabled me to concentrate and complete my degree. Most importantly to my Wife, Wannapa (Mary) who deserves my deepest special gratitude for her love, valuable insight, kind support and forbearance.

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND TO THE RESEARCH

Small- and medium-sized enterprises (SMEs) play a significant role in the economic and social development of many developing economies (Horst *et al.*, 2005; Newby, 2006; Harvie, 2008; Harvie and Lee, 2008; Audretsch *et al.*, 2009; Doern, 2009; Le and Harvie, 2010; Organisation for Economic Co-operation and Development (OECD), 2011). SMEs contribute significantly in terms of business enterprises, employment generation, exports, regional development, economic inclusion and empowerment, and business opportunities (Hallberg, 2000; McMahon, 2001; Biggs, 2002; Kirby and Watson, 2003; Beck et al., 2005; Harvie, 2007; Harvie and Lee, 2008; Organisation for Small & Medium Enterprises and Regional Innovation Japan (OSMRJ), 2008; Audretsch *et al*., 2009; Le, 2010). SMEs are thus commonly seen as being indispensable to the future sustainable development and growth of an economy (Wiboonchutikula, 2002; Horst *et al*., 2005; Ha, 2006; Sahakijpicharn, 2007; Office of Small and Medium Enterprises Promotion (OSMEP), 2009; Le, 2010; OECD, 2011). This is no less so than for the case of Thailand (see Section 3.2 of Chapter 3).

The contribution of SMEs to the Thai economy in terms of business establishments, employment, income and economic growth increased rapidly from 1994 to 2009[3]. Their total number increased from 438,805 enterprises in 1994 to 2,896,106 enterprises in 2009 (see Section 2.4 of Chapter 2). By 2009 they represented over 99 percent of all business establishments in the country, and were particularly dense in the trade and repairs, services and manufacturing sectors. On average they employed more than 7 million workers annually over the period 1994 to 2009, equivalent to more than 73 percent of total employment in the private sector[4], and contributed 37.76 percent of total GDP by 2009[5] (OSMEP (2001-2009)). They

---

[3] Data collection for Thai SMEs only commenced in 1994 and the most updated data collection for SMEs is the year 2009.

[4] In 2009 the manufacturing, services, and trade and repairs sectors contributed 34.23, 35.75, and 30.02 percent of total SME employment (OSMEP, 2009) (see Section 2.4.3 of Chapter 2).

[5] The contribution of SMEs to GDP, at current prices, was approximately 39.0 percent on average of total GDP over the extended period 1999-2009 (OSMEP, 2001-2009) (see Section 2.4.4 of Chapter 2).

are now generally recognised as being the most significant enterprises in accelerating Thai economic growth and development (McMahon, 2001; Dhanani and Scholtès, 2002; Wiboonchutikula, 2002; Horst *et al.*, 2005; Ha, 2006; Newby, 2006; OSMRJ, 2008; OSMEP, 2009). SMEs also play important roles and functions in assisting large enterprises, particularly in the context of regional production networks (Regnier, 2000; Brimble *et al.*, 2002; Mephokee, 2003; OSMEP, 2007a; Tranh *et al.*, 2009; Harvie, 2010; OECD, 2011), being key sources of goods, services, information and knowledge (Regnier, 2000; Huang, 2003; Kirby and Watson, 2003; Buranajarukorn, 2006; OSMEP, 2007b; Audretsch *et al.*, 2009). SMEs also contribute to regional development, poverty alleviation and economic empowerment for minorities and women (McMahon, 2001; Beck *et al.*, 2005; Harvie, 2008; Le, 2010). SMEs are, therefore, the backbone of the Thai economy, contributing greatly to the social and economic development of the country (Brimble *et al.*, 2002; Huang, 2003; Ha, 2006; Sahakijpicharn, 2007; OSMEP, 2009; Charoenrat and Harvie, 2011; Amornkitvikai *et al.*, 2012; Charoenrat and Harvie, 2012; Charoenrat *et al.*, 2012) (see Section 2.4 of Chapter 2).

While SMEs are a major force in Thailand's economy, they face a number of severe barriers to their further development. These include: access to finance, marketing, exporting, information technology (IT), innovation, human resource development, management and/or administration skills, inadequate skilled labour, and government regulations (OSMEP, 2001; Brimble et al., 2002; Harvie and Lee, 2002; OSMEP, 2008; OSMEP, 2009). They also face significant disadvantages (see Section 2.4.7 of Chapter 2). For instance, a large number confront difficulties in gaining access to government funding and credit institutions, because of their limitation in size, lack of fixed assets, and lack of business plans (Sarapaivanich, 2003; Theingi, 2004; OSMEP, 2007b; Doern, 2009; Charoenrat *et al.*, 2010; Charoenrat and Harvie, 2011; OECD, 2011; Charoenrat and Harvie, 2012).

Moreover, most Thai SMEs are family-owned with a traditional style and technology in both production and management, and only a small number utilise IT and business innovation in their business activities (see Section 2.4.7 of Chapter 2). As a consequence, Thai SMEs are experiencing increased difficulty in competing effectively with, for example, SMEs from China and Taiwan, which have more readily adopted IT and innovation as part of their competitiveness strategy

(Mephokee, 2003; OSMEP, 2004; Amornkitvikai *et al.*, 2010; Charoenrat and Harvie, 2011; OECD, 2011; Amornkitvikai *et al.*, 2012; Charoenrat and Harvie, 2012; Charoenrat *et al.*, 2012) (see Section 2.4.7 of Chapter 2).

Despite the obvious significance of SMEs to the Thai economy, there is a dearth of evidence on the performance of Thailand's manufacturing SMEs in terms of their technical efficiency and associated determinants. The issue is an important one, since the economy is at a critical stage in its economic development. As a middle income economy, it can no longer base its future economic growth and development on unskilled low-cost labour. Its firms must become both more innovative, (emphasising knowledge, skill and value-adding activities), and more efficient if they are to compete in an increasingly competitive and integrated regional and global economy. In recognition of this need, the Thai OSMEP formulated the first SME promotion plan from 2002 to 2006. The promotion plan was aimed at enhancing the efficiency and capacity of SMEs, with the over-arching objective of enhancing their international competitiveness and capability (Mephokee, 2003; OSMEP, 2007a; OSMEP, 2007b).

Little research has been conducted on the competitiveness and efficiency of Thai manufacturing SMEs in terms of their technical efficiency, and significant firm-specific factors impacting on this. Also of relevance is the question of whether the performance of the SME sector improved in the wake of the Asian financial crisis of 1997. Subsequent reforms have aimed at putting the economy on a sustainable path to growth and development focusing on: improving the regulatory and supervisory environment of the financial system, improving corporate sector governance and transparency, improving firm competitiveness and performance, embracing foreign ownership and its involvement in the corporate and financial sectors, and developing firm capacity to take advantage of market opportunities arising from regional and global economic integration (OECD, 2011; Amornkitvikai *et al.*, 2012; Charoenrat and Harvie, 2012; Charoenrat *et al.*, 2012). Thus, the primary motivation of this thesis is to identify the performance of Thai manufacturing SMEs in terms of their output and technical efficiency, particularly in the wake of the Asian financial crisis of 1997, and furthermore to investigate firm-specific factors that have influenced this performance.

1.2 THAILAND'S MANUFACTURING SMALL AND MEDIUM SIZED ENTERPRISES AND THE THAI ECONOMY

1.2.1 Definition of Thai Manufacturing SMEs

The most common means of defining an SME are by the number of employees or the level of fixed assets (OSMEP, 2002; OSMEP, 2003; Sahakijpicharn, 2007). The Ministry of Industry (MOI) of Thailand Regulation of 11 September 2002 adopted employment or fixed assets, excluding land, as criteria in defining SMEs (Brimble *et al.*, 2002; Mephokee, 2003; OSMEP, 2003). Hence, an enterprise employing less than or equal to 50 workers, or fixed assets, excluding land, not exceeding THB 50 million (approximately US$1.65 million) in the manufacturing sector is considered a small enterprise. An enterprise employing between 51-200 workers or fixed assets, excluding land, between THB 51-200 million (approximately US$1.68 - 6.6 million) is defined as a medium-sized enterprise. A similar definition is used for SMEs in the services sector; however, the definition is slightly different for SMEs in the wholesale and retail sectors (see Table 2.4 in Chapter 2).

1.2.2 Contribution of Thai Manufacturing SMEs to the Economy

The contribution of Thai manufacturing SMEs to the economy has traditionally been important in terms of number of enterprises, employment, output and exports. This can be shown in Table 1.1. While the contribution of SMEs to total business numbers remained stable at around 99.6 percent over the period 2001-2009, the contribution of manufacturing SMEs to total SMEs and to overall business numbers has experienced a decline. This is particularly noticeable since 2006, where the contribution of manufacturing SMEs to total SMEs fell from around 30.7 percent in 2006 to around 18.89 percent by 2009 (see Section 2.4 of Chapter 2). A similar development is apparent in terms of their contribution to overall businesses. The greatest hiatus of manufacturing SMEs, in terms of significance to overall business numbers, occurred in 1997 before the full effects of the Asian financial crisis began to have an impact. They have not subsequently regained such a level of importance.

In terms of the SME contribution to employment, we can observe from Table 1.1 that for the period after the Asian financial crisis, these enterprises generated around three-quarters of total employment in the economy. Manufacturing SMEs have made an important contribution to this, contributing, with the exception of the years 1994, 1999 and 2003, well over one-third of total employment generated by all SMEs. As with the contribution to business numbers the hiatus of manufacturing SMEs to employment occurred just before the onset of the Asian financial crisis, when they contributed almost 46 percent of total SME employment or 35 percent of total employment in 1997. Subsequently, this contribution has declined, although remaining important at around 38-39 percent of total SME employment or 30 percent of total economy employment over the period 2005-2009[6]. From Table 1.1 it can also be observed that the SME sector contributed around 38-40 percent of GDP, at current prices, over the period 1999-2009, of which manufacturing SMEs contributed between 23-32 percent equivalent to between 9-12 percent of overall GDP during this period. Since 2003 the contribution of manufacturing SMEs to GDP has remained fairly stable at around 11-12 percent (see Section 2.4 of Chapter 2). Consequently, the contribution of manufacturing SMEs to overall GDP continues to remain important.

The Thai authorities do not compile statistics on the exports of SMEs by sector of activity. However, we can make some general observations based upon the data provided in Table 1.1. The overall SME sector contributes around 30 percent of total exports, indicative of a significant decline from a peak of around 45 percent in 2002. It can be reasonably suggested that the bulk of SME exports are in the form of agricultural and manufactured products. This sharp decline in the contribution of SMEs to overall exports is indicative of the increased difficulties being experienced by Thailand's SMEs in international markets, as they struggle to remain competitive in the face of intense competition from rapidly-developing regional economies such as China, India, Vietnam and Indonesia which have much lower labour costs. It is also a reflection of the poor performance of Thai SMEs in upgrading their knowledge and skills, technology, innovation and value-adding activities (Amornkitvikai *et al.*, 2010; OECD, 2011; Amornkitvikai *et al.*, 2012).

[6] Latest figures (for 2009) indicate that manufacturing SMEs contributed 34.23 percent of SME employment, equivalent to 26.77 percent of total employment (OSMEP, 2009) (see Section 2.4.3 of Chapter 2).

Table 1.1: Contribution of Manufacturing SMEs to the Thai Economy, 1994-2009

Enterprises	1994[7]	1997	1999	2002	2003	2004	2005	2006	2007	2008	2009
Business Numbers											
SMEs (% of total firms)	99.20	99.50	99.20	99.60	99.50	99.50	99.50	99.50	99.50	99.70	99.84
Manufacturing SMEs (% of all SMEs)	19.30	36.50	19.00	21.80	18.90	30.70	30.60	30.70	28.80	20.00	18.89
Manufacturing SMEs (% of all firms)	19.10	36.30	18.80	21.70	18.80	30.50	30.40	30.60	28.70	19.90	18.80
SME Employment											
SMEs (% of total employment)	71.20	76.40	79.30	69.00	60.70	75.40	75.50	76.70	76.00	76.20	78.20
Manufacturing SMEs (% of total SME employment)	31.20	45.70	29.20	33.40	24.90	36.50	38.40	39.00	39.30	38.80	34.23
Manufacturing SMEs (% of total employment)	22.20	34.90	23.10	23.10	15.10	27.50	29.00	29.90	29.90	29.60	26.77
GDP of SMEs											
SMEs (% of total GDP)	N/A	N/A	39.40	38.80	38.10	40.00	39.60	38.90	38.20	37.90	37.76
Manufacturing SMEs (% of SME GDP)	N/A	N/A	22.80	25.30	28.80	29.10	29.50	30.30	30.70	32.00	30.40
Manufacturing SMEs (% of total GDP)	N/A	N/A	9.00	9.80	11.00	11.60	11.70	11.80	11.70	12.10	11.48
SME Exports											
SMEs (% of total exports)	N/A	N/A	N/A	45.50	32.10	29.70	29.70	30.20	29.50	31.00	30.56

Source: OSMEP (2001-2009)

1.3 ASIAN FINANCIAL AND ECONOMIC CRISIS OF 1997 AND THAI SMES

The financial crisis in 1997 had a severe impact on the domestic economy, resulting in an economic crisis exemplified by a high unemployment rate, a decline in real income, a significant reduction in domestic demand, private consumption and investment spending and severe contraction in economic growth in 1998 (World Bank, 1993; Nukul's Commission Report, 1998; Regnier, 2000; Phan, 2004; Menkhoff and Suwanaporn, 2007) (see Section 2.3 of Chapter 2). The decline of the country's economic growth was mainly influenced by decreased exports, domestic

[7] There is inadequate data availability for manufacturing SMEs in 1995, 1996, 1998, 2000 and 2001.

expenditure, and investment in fixed assets (Nukul's Commission Report, 1998; OSMEP, 2001). The crisis had marked adverse effects on the SME sector, the most severe of which were substantial declines in sales revenue and tighter liquidity. Retailers and wholesalers encountered higher costs because their imported products cost more with a weaker currency, while product prices experienced a declining trend due to stiff competition (Tapaneeyangkul, 2001). Common responses by SMEs were to cut costs, to impose stricter financial control, to retrench staff, to expand into international markets where possible and to enhance new product development (Regnier, 2000; OSMEP, 2001) (see Section 2.3 of Chapter 2).

After the crisis, GDP growth expanded gradually to 4.4 percent in 1999, and 4.8 percent in 2000 in real terms (Asian Development Bank (ADB), 2010) (see Table 2.10 in Chapter 2), but without the necessary financial and corporate sector reforms, questions over its sustainability remained. Reform measures targeted the supervision and regulation of the financial sector as well as corporate governance; however, SME-related measures appeared to be largely ineffective due to a lack of: R&D and technology transfer, innovation and technology capability, marketing skills, skilled labour, effective government assistance agencies, and access to government funding and credit institutions (Sarapaivanich, 2003; Punyasavatsut, 2007; OSMEP, 2007a; OSMEP, 2008; OSMEP, 2009) (see Section 2.3 of Chapter 2).

SMEs also had internal weaknesses that impeded their export performance, such as a lack of managerial export experience and weak planning systems. SMEs also lacked export knowledge and networks resulting in difficulties finding and accessing new international markets (Chirasirimongkol and Chutimaskul, 2005; OSMEP, 2008; OSMEP, 2009). These factors combined made it difficult for SMEs to benefit from regional market opportunities such as that of the ASEAN free trade agreement, and to effectively compete in domestic markets against more intense foreign competition (see Section 2.4 of Chapter 2). In this context, it is important to identify whether the technical efficiency of domestic manufacturing SMEs improved overall in the post-crisis period, and whether these SMEs are still able to provide an important contribution to the future growth and development of the economy.

1.4 RESEARCH OBJECTIVES AND RESEARCH QUESTIONS

The primary aim of this study is to analyse in detail the competitiveness performance of Thai manufacturing SMEs, as measured by their technical inefficiency. This is an important issue, since these enterprises continue to make an important contribution to output and employment. This thesis is the first empirical study to examine, estimate and compare the technical efficiency performance of Thai manufacturing SMEs in the pre-(before 1997[8]) and post-(after 2007[9]) Asian financial crisis periods and firm-specific factors affecting it. Specifically, this study will:

(1) Empirically estimate the level of technical efficiency of Thai manufacturing SMEs in the periods 1997 and 2007 in six categories: by aggregate manufacturing SMEs; by small-sized firms; by medium-sized firms; by domestic market intensity; by export intensity; and by sub-manufacturing sectors classified by the Standard International Trade Classification (SITC) Revision 4.

(2) Empirically examine firm-specific factors and explanatory variables influencing the technical inefficiency of Thai manufacturing SMEs in 1997 and 2007 for each of the above six categories. Potential firm-specific factors contributing to the technical inefficiency of Thai manufacturing SMEs are drawn from the literature and include: firm size, firm age, intensity of skilled labour, firm location (municipal and non-municipal areas), region of location (i.e., Bangkok, Central and Vicinity, Northern and North-eastern provinces), type of ownership (i.e., individual proprietor, juristic partnership, limited liability, government and state, and co-operative), foreign ownership or investment, exports and government assistance (via the Board of Investment (BOI)); and

(3) Identify appropriate policies to improve the technical efficiency performance of Thailand's manufacturing SMEs.

The following major research questions are addressed in relation to the above main research objectives:

---

[8] Firm-level data in the 1997 industrial census covered the operations of firms from 1st January 1996 to 31st December 1996 (NSO, 2010a).

[9] The 2007 industrial census firm-level data covered the operations of firms from 1st January 2006 to 31st December 2006 (NSO, 2010b).

(1) How do Thai manufacturing SMEs in the pre-(1997) and post-(2007) Asian financial crisis periods perform in terms of technical efficiency?;

(2) How can the overall technical efficiency performance of Thai manufacturing SMEs be improved?; and

(3) What are the firm-specific factors contributing to the technical efficiency of Thai manufacturing SMEs in the pre-(1997) and post-(2007) Asian financial crisis periods?

From the three major research questions above, a number of sub-research questions can be derived and analysed as follows:

(1) How does firm size influence the technical efficiency of Thai manufacturing SMEs?

(2) How does firm age impact upon the technical efficiency of Thai manufacturing SMEs?

(3) How does the employment of skilled labour affect the technical efficiency of Thai manufacturing SMEs?

(4) How important is location (i.e., municipal and Bangkok areas, Central and Vicinity regions, Northern and North-eastern regions) for SME performance?

(5) How do various types of manufacturing SME ownership – individual proprietor, juristic partnership, public and limited company – affect the technical efficiency of Thai manufacturing SMEs?

(6) How does government and state ownership influence the technical efficiency of Thai manufacturing SMEs?

(7) How does cooperative ownership impact upon the technical efficiency of Thai manufacturing SMEs?

(8) How does foreign ownership or investment affect the technical efficiency of Thai manufacturing SMEs?

(9) How does exporting influence the technical efficiency of Thai manufacturing SMEs?

(10) How does government assistance (via the Board of Investment (BOI)) impact upon the technical efficiency of Thai manufacturing SMEs?

(11) How can Thai government policy towards manufacturing SMEs be made to improve the efficiency and competitiveness readiness of Thai manufacturing SMEs?

1.5 CONTRIBUTION AND SIGNIFICANCE OF THE RESEARCH

With respect to the main research objectives, major research questions and sub-research questions, this study will make a significant contribution to the field of Thai manufacturing SMEs as follows:

(1) This thesis is the first empirical study using firm-level data from the 1997 and 2007 industrial censuses conducted by the National Statistical Office of Thailand (NSO) of Thailand to apply data envelopment analysis (DEA) and stochastic frontier analysis (SFA) approaches. Only the study of Arunsawadiwong (2007) utilised aggregate industrial-level data from Thai manufacturing surveys for the period 1990 to 2002, and by doing so found that utilising the SFA approach the overall technical efficiency of the Thai manufacturing sector improved in the post-crisis period. This thesis, using firm-level data, has found that by introducing firm size into the analysis the results can be different. Thus, this is a major contribution of this study;

(2) The thesis is the first empirical study to measure and compare the technical efficiency of Thai manufacturing SMEs in the pre-(1997) and post-(2007) financial crisis of 1997, utilising the most substantive and the most recently available cross-sectional firm-level data from 1997 and 2007 industrial censuses;

(3) The thesis is the first empirical study to examine firm-specific factors and explanatory variables contributing to the technical inefficiency (or efficiency) of Thai manufacturing SMEs in 1997 and 2007 in six categories: by aggregate manufacturing SMEs, by size of manufacturing SMEs (small and medium), by SME export intensity, by domestic market intensity, and by sub-manufacturing sectors classified by SITC Revision 4;

(4) This thesis is the first empirical study to use SFA and a two-stage DEA approach to estimate and compare the technical efficiency performance of Thai manufacturing SMEs in the periods 1997 and 2007, for each of the above six categories;

(5) It will evaluate and analyse the technical efficiency performance of SMEs in the manufacturing sector of Thailand, and how this has changed since the financial and economic crisis of 1997;

(6) The thesis will highlight the role, contribution and significance of SMEs in Thailand's manufacturing sector to the economic development of the Thai economy, and how this contribution could be made even more effective in the future;

(7) It will provide an important insight into the competitiveness readiness of Thai manufacturing SMEs and into key areas of weakness that will need to be tackled to facilitate a more effective participation of Thai manufacturing SMEs in both the domestic and international market place;

(8) It will identify the key barriers, challenges and capacity constraints impacting upon the performance of Thai manufacturing SMEs in terms of technical efficiency;

(9) It will identify key policy priorities for Thai policy makers concerned with enhancing the competitiveness readiness of Thai manufacturing SMEs;

(10) The research findings will provide guidelines for SME policy makers in Thailand to make SME related policies more effective in achieving desired industrial restructuring, employment growth, export growth, regional development, alleviation of poverty, economic growth and effective participation in the increasingly integrated regional and global economies.

1.6 METHODOLOGY

To achieve the research objectives above, this thesis will utilise different methodologies, comprising six steps:

(1) The first step (Chapter 2) is to conduct an overview of the Thai economy, focusing upon the national accounts, growth of output, Gross Domestic Product (GDP), and its key components, per capita GDP, exports and imports, labour force and unemployment rates from 1990 to 2009, which incorporates the period of rapid development of Thailand from 1990 until the financial crisis in 1997. A brief review of the causes of the financial crisis in 1997 is presented and the importance of SMEs to economic recovery identified. It also presents definitions of Thai SMEs by sector, trends in the number classified by size and sector, trends in employment by business

size and sector, and the role, significance and contribution of SMEs to the Thai economy during the period 1994 to 2009.

(2) The second step (Chapter 3) is to conduct a literature review focusing on the important contribution of SMEs to the economy. It provides a review of the literature in regard to the size distribution of firms in the economy and presents the most common performance measures of SMEs, such as profitability, exports, growth and development. It conducts a literature review relating to concepts of efficiency, production frontiers, technical efficiency, scale efficiency, types of returns to scale, and the measurement of efficiency. In addition, it conducts a literature review relating to many empirical studies of the performance of SMEs in terms of technical efficiency and its importance, and presents firm-specific factors impacting upon the technical efficiency of SMEs identified from various studies.

(3) The third step (Chapter 4) is to provide an overview and a detailed discussion of the research methodology used in the estimation of technical efficiency. The two most common approaches of estimating a production frontier and technical efficiency, and predicting the maximum level of output, are the SFA and DEA approaches. It also compares and discusses the difference between non-parametric and parametric approaches, which include the DEA and SFA approaches. These two estimation approaches are compared in terms of their advantages as well as disadvantages. It is suggested that there is no one method that is strictly preferable to any other, and it is quite useful to cross-check the results from both DEA and SFA. The theoretical foundations of the DEA and SFA approaches are represented in this third step.

(4) The fourth step (Chapter 5) is to describe data sources, data classification and to provide a description of key variables to be utilised in the analysis. This step will also provide a detailed discussion of the empirical analysis to be used in this study, specifically the stochastic frontier production function and technical inefficiency effects model using the SFA approach and the two-stage DEA model (a two-limit Tobit model) and firm-specific factors and explanatory variables contributing to the technical efficiency of Thai manufacturing SMEs. This study utilises the 1997 and 2007 industrial censuses data, collected by the NSO of Thailand, concerning enterprises engaged in manufacturing industry activities only.

(5) The fifth step (Chapter 6) is to conduct an empirical analysis of Thai manufacturing SMEs in the pre-(1997) and post-(1997) Asian financial crisis periods. This study applies a stochastic frontier production function and technical inefficiency effects model (SFA) and the first step of the two-stage DEA approach to measure, compare and explain the technical efficiency of Thai manufacturing SMEs in the periods 1997 and 2007.

(6) The sixth step (Chapter 7) is to compare and describe the empirical results from the technical inefficiency effects model (SFA) and the second step of the two-stage DEA approach, to investigate firm-specific factors and explanatory variables influencing the technical inefficiency of Thai manufacturing SMEs in the periods 1997 and 2007 in the above six categories. These categories of manufacturing SMEs were estimated individually, in order to examine whether technical efficiency is positively or negatively related to firm-specific factors. It also provides specific policy implications and recommendations based upon the empirical evidence of the effect of firm-specific factors on the technical efficiency of Thai manufacturing SMEs. These policies and recommendations aim to improve and promote the technical efficiency and competitiveness performance of Thailand's manufacturing SMEs.

(7) The final step (Chapter 8) is to summarise the main empirical results of the thesis in relation to the major research questions and the sub-research questions. It also outlines limitations to the thesis and gives directions for future research possibilities.

In conclusion, the logical use of different methodologies as discussed above is aimed at ensuring that the main research objectives, the major research questions and sub-research questions of this thesis are adequately addressed. By utilising the most substantive and comprehensive dataset for Thai manufacturing SMEs, covering the periods 1997 and 2007, and applying both a parametric approach (SFA) and non-parametric approach (DEA), this thesis provides unique and robust results from which can be derived significant policy implications and recommendations.

1.7 RESEARCH APPROACH

A firm's performance can be measured in terms of economic efficiency, including technical and allocative efficiencies as sub-components (Battese *et al.*, 2004; Coelli *et al.*, 2005; Kontodimopoulos *et al.*, 2010; Amornkitvikai and Harvie, 2011; Charoenrat and Harvie, 2012; Lee, 2013) (see Section 4.2 of Chapter 4). Measuring the technical efficiency[10] of firms in an industry can be undertaken using non-parametric or parametric approaches (Coelli, 1996b; Admassie and Matambalya, 2002; Coelli et al., 2005; Arunsawadiwong, 2007; Zahid and Mokhtar, 2007; McDonald, 2009; Le, 2010; Amornkitvikai, 2011; Lee, 2011; Lee, 2013). Data Envelopment Analysis (DEA) is a non-parametric approach that makes no assumptions concerning the form of the production function. Instead, the best practice function is obtained empirically from observed inputs and outputs. DEA precludes the possibility of evaluating the marginal products and elasticity of substitution of the production technology.

DEA involves the use of linear programming for the construction of an efficiency frontier. It can be implemented without specifying an algebraic form of an association between inputs and outputs. It can also estimate the efficiency frontier without specifying whether the output is a linear, non-linear or other function of inputs (Admassie and Matambalya, 2002; Murillo-Zamorano, 2004; Coelli et al., 2005; Arunsawadiwong, 2007; Assaf, 2007; Zahid and Mokhtar, 2007; Moffat, 2008; Kontodimopoulos et al., 2010; Amornkitvikai, 2011; Lee, 2011; Lee, 2013) (see Section 4.3 of Chapter 4).

Stochastic Frontier Analysis (SFA), on the other hand, is a parametric approach where the form of the production function is assumed to be known or is estimated statistically. SFA also allows other parameters of the production technology to be explored. The advantage of this approach is that hypotheses can be tested with statistical rigour, given that the relationships between inputs and outputs follow known functional forms. When compared to the conventional econometric approach the SFA approach is superior, in that it estimates 'best practice' technology

[10] Technical efficiency refers to a firm's ability to produce the maximum level of output from a given combination of inputs. The output of a firm is the level of production in terms of value added, while inputs are factors of production such as labour and capital. Allocative efficiency is the firm's ability to utilise inputs in optimal proportions given their respective prices (Vu, 2003; Coelli *et al.*, 2005; Zahid and Mokhtar, 2007; Kontodimopoulos *et al.*, 2010; Amornkitvikai, 2011).

upon which the production function concept is based, while the former is based on 'averaging' estimators (Admassie and Matambalya, 2002; Coelli *et al.*, 2005; Arunsawadiwong, 2007; Zahid and Mokhtar, 2007; Amornkitvikai, 2011; Amornkitvikai and Harvie, 2011). Thus, a conventional econometric model may produce results that are fundamentally inconsistent with the definition of the production function (Coelli, 1996b; Admassie and Matambalya, 2002; Coelli *et al.*, 2005; Arunsawadiwong, 2007; Zahid and Mokhtar, 2007; Le, 2010; Amornkitvikai, 2011) (see Section 4.4 of Chapter 4).

However, SFA and DEA have advantages as well as disadvantages. For instance, there is no specific set of criteria by which to select the most relevant method for estimating technical efficiency (Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Seelanatha, 2007; Kontodimopoulos *et al.*, 2010; Amornkitvikai, 2011). There is no technique that is strictly preferable to any other (Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Kontodimopoulos *et al.*, 2010; Amornkitvikai, 2011). Hence, both the SFA and two-stage DEA approaches are applied in this study to estimate and compare the technical efficiency performance of Thai manufacturing SMEs in the periods 1997 and 2007 (see Section 4.2 of Chapter 4).

Focusing on the SFA approach, the maximum likelihood estimates for parameters of the stochastic frontier production function and a technical inefficiency effects model are estimated simultaneously using the computer programme FRONTIER Version 4.1 developed by Coelli (1996a) (see Section 4.4 of Chapter 4). The two-stage DEA approach consists of two steps (Alvarez and Crespi, 2003; Coelli *et al.*, 2005; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011): (1) The first step is to estimate the technical efficiency scores utilising the output-orientated variable returns to scale (VRS) model as analysed by the computer program DEAP Version 2.1 introduced by Coelli (1996b), and (2) In the second-stage DEA, the technical efficiency scores obtained from the first stage DEA are regressed upon explanatory variables or firm-specific factors using ordinary least squares (OLS) regression (see Section 4.3 of Chapter 4).

1.8 DATA AND VARIABLES

Cross-sectional firm-level data from industrial censuses[11] conducted in 1997 and 2007 by the NSO are used in this thesis (see Section 5.2 of Chapter 5). Establishments under the scope of these censuses are those engaged primarily in manufacturing industry (category D International Standard Industrial Classification of All Economic Activities; ISIC: Rev.3). The census uses a Stratified Systematic Sampling methodology. An interview method was employed in the data collection (NSO, 2011a; NSO, 2011b; NSO, 2011c). Importantly, this study only focuses upon manufacturing SMEs. The total sample of manufacturing SMEs in the 1997 and 2007 industrial censuses is 22,685 and 56,441, respectively.

Analysis conducted in this thesis has disaggregated the firms by aggregate manufacturing SMEs, small, medium, domestic market intensity, export intensity and sub-manufacturing sectors classified by SITC: Revision 4. Data extracted for Thai manufacturing SMEs from the 1997 and 2007 censuses are based on that required to estimate Cobb-Douglas and Translog production functions, a technical inefficiency effects model (SFA), and the two-stage DEA approach (see Section 5.3 of Chapter 5).

Key variables extracted include: output value added (Y), labour input (L) and capital input (K). Y is measured as the value of gross output minus intermediate consumption. L is measured as the number of workers in the establishment, including owner or partner, unpaid workers, skilled labour and unskilled labour. The total number of workers is used as the proxy for labour. K is measured as the net value of fixed assets after deducting accumulated depreciation at the end of the year. The net value of fixed assets for each firm in the 1997 and 2007 industrial censuses is utilised as a proxy for capital. The net value of fixed assets is a combination of land, buildings, construction, machinery and equipment, vehicles, office appliances and software.

In addition, the value added (Y) of firms was deflated by the Producer Price Index (PPI) of manufactured products in 1997 and 2007 respectively. The capital (K) of firms was deflated by the PPI of capital equipment in 1997 and 2007 respectively.

[11] These censuses are based upon large samples of firms in the manufacturing industry and are the most comprehensive available for manufacturing SMEs in Thailand (NSO, 2011a, 2011b).

The year 2000 is taken as the base year for these indices (Bureau of Trade and Economic Indices of Thailand, 2010) (see Section 5.3 of Chapter 5).

1.9 RESEARCH SCOPE

This thesis focuses upon the technical efficiency performance of Thai manufacturing SMEs in the pre-(1997) and post-(2007) Asian financial crisis periods. It also empirically examines firm-specific factors contributing to the technical inefficiency (efficiency) of Thai manufacturing SMEs over these two periods. The estimation is performed by aggregate manufacturing SMEs, by size of manufacturing SMEs (small and medium), by domestic market intensity, by export intensity and by sub-manufacturing sectors classified by SITC: Revision 4.

The thesis utilises cross-sectional firm-level data from industrial censuses for 1997 and 2007 compiled by the NSO of Thailand. This study, however, only focuses on Thai manufacturing SMEs. It excludes firms with 201 workers or more in the manufacturing sector which are considered as large enterprises in Thailand. Enterprises in other economic sectors such as, trade, service, wholesale and retail sectors are not considered in this thesis. Thus, the total number of Thai manufacturing SMEs included in the 1997 and 2007 industrial censuses is 22,685 and 56,441 respectively.

1.10 ORGANISATION OF THE THESIS

This thesis is structured and presented in eight chapters as follows:

Chapter 2 presents an overview of the Thai economy, identifying key macroeconomic indicators, including labour force and unemployment rate developments for the period 1990 to 2009. This chapter conducts a brief discussion of the financial crisis of 1997 and causal factors and subsequent outcomes. It conducts a substantive review of the role, contribution and significance of SMEs to the Thai economy, with a particular focus on manufacturing SMEs, from a number of perspectives. These include: the number of SMEs in aggregate, by sector and region; by contribution to total employment in aggregate and by sector; by contribution to GDP in aggregate, by sector and type of economic activity; by contribution to exports and investment. This chapter also explores key barriers facing Thai SMEs and major government SME support policies. Finally, it discusses public-private sector development partnerships.

Chapter 3 reviews the general literature to produce a more detailed understanding of the important contribution of SMEs to an economy. SMEs make a significant contribution to the economy through various perspectives, including economic opportunities, economic empowerment, employment generation, business establishment, entrepreneurship, sustainable local economic development and poverty alleviation.

This chapter provides a review of the literature in regard to the size distribution of firms in the economy. It provides a brief overview of the measurement of efficiency. It presents the concept of efficiency and explains output-orientated technical efficiency measures and describes input and output-oriented technical efficiency measures and types of returns to scale. It also discusses the difference among input and output-orientated measures, and technical and allocative efficiencies from output-orientated measures. In addition, this chapter conducts a literature review of the many empirical studies on the performance of SMEs in terms of technical efficiency and its importance, and presents firm-specific factors impacting upon the technical efficiency of SMEs identified from various studies.

Chapter 4 provides an overview and a detailed discussion of the research methodology used in the estimation of technical efficiency. The two most common approaches of estimating a production frontier and technical efficiency, and predicting the maximum level of output, are the DEA and SFA approaches. This section highlights the difference between the two approaches. It provides an overview of the application of the DEA approach, which can be used to predict scale efficiency, constant returns to scale (CRS) technical efficiency and variable returns to scale (VRS) technical efficiency. It also provides a detailed discussion of the alternative SFA approach, which can also be adopted for predicting a firm's technical efficiency. Finally, this chapter explains technical progress and efficiency improvement in DEA and SFA frontiers.

Chapter 5 describes the data source and data classification and provides a description of key variables to be utilised in the analysis. It outlines key variables for a stochastic frontier production function for the SFA approach, the technical inefficiency effects model, and the first step of the two-stage DEA model. Firm-specific factors and explanatory variables for the model are also explained and discussed in this chapter. Finally, it exhibits the data constructed from the 1997 and 2007 industrial censuses, after removing negative and invalid observed values to be conducted in the empirical analysis of this study.

Chapter 6 conducts an empirical analysis of Thai manufacturing SMEs in the periods 1997 and 2007. This chapter provides a brief review of the analytical framework to be used in this study. It highlights the hypothesis tests to be conducted. The empirical results from SFA and DEA are discussed in this chapter. Finally, this chapter compares and discusses the empirical results between the SFA and DEA approaches.

Chapter 7 compares and describes the empirical results from the technical inefficiency effects model (using the SFA approach) and the second step of the two-stage DEA approach (utilising a two-limit Tobit model) for the robustness of the results. This chapter investigates the statistical significance of various firm-specific factors and explanatory variables influencing the technical inefficiency of Thai manufacturing SMEs in the periods 1997 and 2007 in the above six categories. The empirical results from the technical inefficiency effects model and a two-limit Tobit model for Thai manufacturing SMEs in the periods 1997 and 2007 are discussed in this chapter. Finally, this chapter provides specific policy implications and recommendations based on the empirical evidence for the technical efficiency performance of Thai manufacturing SMEs.

Chapter 8 provides a summary of the key empirical results from this thesis and reports the major findings relating to the major research questions and the sub-research questions identified for this thesis. Finally, limitations of this thesis are outlined and further research possibilities are also suggested in this chapter.

1.11 SUMMARY

This chapter has provided an overview of the overall thesis, emphasising its focus on measuring and explaining the technical efficiency of Thai manufacturing SMEs. It outlined the main research objectives, and described the major research questions and sub-research questions to be examined in this thesis. It highlighted the contributions of the thesis to the existing literature and empirical studies focusing upon key factors influencing the technical efficiency performance of Thai manufacturing SMEs. Such an empirical analysis has not previously been conducted for Thai manufacturing SMEs, and this thesis aims to rectify this gap by: estimating and comparing the level of technical efficiency performance of Thai manufacturing SMEs in the pre- and post-financial crisis periods of 1997 and 2007; 2) examining firm-specific factors and explanatory variables that affect the technical efficiency performance over the two periods; and 3) identifying policies to improve the technical efficiency of Thai manufacturing SMEs.

This chapter explained and discussed a number of methodologies to be used to achieve the research objectives of this thesis. It briefly discussed the definitions of Thai manufacturing SMEs adopted in this thesis and established the scope of the research. Finally, issues identified in this chapter will be described and discussed in more detail in subsequent chapters.

CHAPTER 2

AN OVERVIEW OF THE ROLE, SIGNIFICANCE AND CONTRIBUTION OF SMEs TO THE THAI ECONOMY

2.1 INTRODUCTION

The aim of this chapter is to conduct an overview of the Thai economy and the importance of SMEs within it. It will focus on the growth of output, Gross Domestic Product (GDP) and its key components, per capita GDP, exports and imports, labour force and unemployment rates from 1990 to 2010, a timeframe which incorporates the period of rapid development of Thailand from 1990 until the financial crisis in 1997. The crisis in 1997 had a severe impact on the labour market, resulting in a high unemployment rate and severe contraction in economic growth (World Bank, 1993; Nukul's Commission Report, 1998; Regnier, 2000; Menkhoff and Suwanaporn, 2007). A brief review of the causes of the financial crisis in 1997 is presented and the importance of SMEs to economic recovery identified. SMEs are recognised as making a significant contribution to the social and economic development of Thailand. They also contribute to regional development, national employment, poverty alleviation, and economic empowerment (Tapaneeyangkul, 2001; Brimble *et al.*, 2002; Mephokee, 2003; Sahakijpicharn, 2007; Office of Small and Medium Enterprises Promotion (OSMEP), 2009). In addition, this chapter presents definitions of Thai SMEs by sector, trends in the number classified by size and sector, trends in employment by business size and sector, and the role, significance and contribution of SMEs to the overall Thai economy.

The remainder of this chapter is structured as follows. Section 2.2 conducts an overview of the Thai economy, identifying key macroeconomic indicators, including labour force and unemployment rate development for the period 1990 to 2009. Section 2.3 conducts a brief discussion of the financial crisis of 1997 and causal factors and subsequent outcomes. Section 2.4 conducts a substantive review of the role, contribution and significance of SMEs to the Thai economy from a number of perspectives. These include: the number of SMEs in aggregate, by sector and region; by contribution to total employment in aggregate and by sector; by contribution to GDP in aggregate, by sector and type of economic activity; and by contribution to exports and investment. This section also explores key barriers facing Thai SMEs and major government SME support policies. Section 2.5 discusses public-private sector development partnerships. Section 2.6 provides a summary of the major conclusions from this chapter.

2.2 AN OVERVIEW OF THAILAND'S ECONOMY, 1990-2010

2.2.1 Key Macroeconomic Indicators for the Thai Economy

Table 2.1 presents key macroeconomic indicators for the Thai economy at constant prices for the period 1990 to 2010. The year 1988 is taken as the base year. The average annual growth rate of GDP from 1990 to 1996 was 8.65 percent (Asian Development Bank (ADB), 2011)– remarkably high, until the financial and economic crisis in 1997. The Thai economy was one of the most rapidly-growing economies in the world during the period 1990 to 1996 (World Bank, 1993; Menkhoff and Suwanaporn, 2007). Its strategic location and plentiful natural resources enabled the Thai economy to maximise its trade opportunities. During this period, it emerged as an economically diverse, modern and newly industrialised economy. The growth of the Thai economy can be attributed to two factors (World Bank, 1993; Regnier, 2000; Theingi, 2004; Arunsawadiwong, 2007).

First, Thailand pursued a rational approach to industrialisation. In 1960, it initially used a strategy of import substitution centred mainly on food processing (World Bank, 1993; Nukul's Commission Report, 1998). Thus, Thailand utilised agricultural production to initiate a shift into industrialisation. However, the availability of local cheap labour, combined with abundant natural resources, facilitated Thailand to shift to manufacturing products for export purposes. This led to the rapid expansion of the manufacturing and trade sectors. Second, the Thai economy was aided by huge inflows of Foreign Direct Investment (FDI), which totalled US$8 billion in the period 1987 to 1990[12] (World Bank, 1993; Nukul's Commission Report, 1998; Arunsawadiwong, 2007).

However, the strong growth rate slowed down by 1996 (see Table 2.1) as the Thai economy reached a point where: there was a rapid accumulation of foreign debt, particularly in short-term debt; there were concerns over the ability of the country to service this debt; there were rising current accounts deficits from an increasingly

[12] Due to high returns relative to capital markets in the developed economies.

over-valued real exchange rate; there were infrastructure bottlenecks in the economy in the form of lack of adequate physical infrastructure (particularly in Bangkok) and labour skill shortages; there was unproductive investment in real estate and property development; and a lack of adequate regulatory supervision in the financial sector (World Bank, 1993; Arunsawadiwong, 2007; Menkhoff and Suwanaporn, 2007). In 1997, the growth rate dropped to minus 1.4 percent and to minus 10.5 percent in 1998, as a consequence of the financial and economic crisis. In the aftermath of the crisis, GDP grew by 4.4 and 4.8 percent in 1999 and 2000, respectively. Over the period 2001-2010, the annual average growth rate was 4.36 percent (see Table 2.1). After 2008, the growth rate dramatically declined to minus 2.3 percent in 2009 due to the effects of the global financial and economic crisis in 2008. After the crisis, the growth rate dramatically increased to 7.8 percent in 2010.

Table 2.1: Key Indicators for the Thai Economy, 1990-2010

Items	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
National Accounts at Constant 1988 Market Prices (THB)										
GDP by industrial origin	1,945	2,112	2,283	2,471	2,693	2,942	3,115	3,073	2,750	2,872
Agriculture	264	283	296	255	266	277	289	287	283	289
Mining	31	36	38	41	44	45	53	60	56	61
Manufacturing	541	604	673	782	857	958	1,021	1,036	924	1,033
Electricity, gas, and water	47	52	57	62	69	79	82	87	86	89
Construction	117	133	139	151	172	184	197	146	90	84
Trade	338	363	379	430	471	517	527	511	443	458
Transport and communications	147	158	173	191	213	239	267	280	255	270
Finance	108	114	148	268	301	320	335	313	251	208
Public administration	61	65	66	68	70	77	82	85	92	94
Others	292	305	314	222	230	246	263	269	270	285
Net factor income from abroad	-24	-30	-50	-34	-38	-41	-58	-64	-72	-57
GNI	1,922	2,082	2,233	2,437	2,655	2,901	3,057	3,008	2,678	2,816
Growth of Output, Annual Change (Percentage)										
GDP	11.2	8.6	8.1	8.3	9.3	9.2	5.9	-1.4	-10.5	4.4
Agriculture	-4.7	7.3	4.8	-13.9	4.2	4.0	4.4	-0.7	-1.5	2.3
Industry	16.1	12.1	9.9	14.3	10.2	10.9	6.9	-1.8	-13.0	9.6
Services	12.7	6.1	7.5	9.3	8.9	8.9	5.3	-1.1	-10.0	0.4
Expenditure on GDP at 1988 Market Prices (THB)	1,945	2,112	2,283	2,471	2,693	2,942	3,115	3,073	2,750	2,872
Private consumption	1,111	1,171	1,273	1,380	1,486	1,602	1,694	1,671	1,479	1,543
Government consumption	172	183	194	204	221	233	261	253	263	271
Gross fixed capital formation	760	856	913	998	1111	1236	1323	1051	585	566
Increase in stocks	21	28	18	14	8	43	23	-1	-69	-7
Exports of goods and services	710	817	930	1,051	1,201	1,386	1,310	1,404	1,520	1,657
Less: Imports of goods and services	807	911	993	1,125	1,287	1,544	1,534	1,361	1,066	1,178
Statistical discrepancy	-21	-32	-52	-51	-48	-14	40	55	38	19

Source: ADB (2011)

Table 2.1: (continued) Key Indicators for the Thai Economy, 1990-2010

Items	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
National Accounts at Constant 1988 Market Prices (THB)											
GDP by industrial origin	3,008	3,074	3,237	3,468	3,686	3,851	4,044	4,260	4,361	4,263	4,596
Agriculture	310	320	322	363	354	343	358	371	383	381	382
Mining	64	65	72	77	81	88	91	95	96	95	101
Manufacturing	1,096	1,112	1,191	1,318	1,426	1,500	1,592	1,687	1,754	1,664	1,873
Electricity, gas, and water	98	104	110	115	123	129	136	142	148	149	164
Construction	76	77	81	83	89	94	99	99	95	95	102
Trade	475	470	480	494	516	538	553	592	598	586	611
Transport and communications	290	310	331	341	366	384	405	432	430	421	430
Finance	204	208	224	246	269	286	293	315	328	335	358
Public administration	95	99	105	108	112	119	123	119	121	126	127
Others	299	310	321	323	350	371	395	408	409	412	448
Net factor income from abroad	-20	-25	-31	-190	-228	-244	-201	-195	-178	-211	-201
GNI	2,988	3,048	3,206	3,423	3,634	3,782	3,991	4,048	4,184	4,052	4,395
Growth of Output, Annual Change (Percentage)											
GDP	4.8	2.2	5.3	7.1	6.3	4.6	5.2	4.9	2.5	-2.3[13]	7.8
Agriculture	7.2	3.2	0.7	12.7	-2.4	-3.2	4.4	1.8	3.5	-0.5	-2.2
Industry	5.3	1.7	7.1	9.6	7.9	5.4	5.9	5.7	3.3	-4.2	10
Services	3.7	2.4	4.6	3.5	6.7	5.2	4.2	4.7	1.3	-0.4	4.6
Expenditure on GDP at 1988 Market Prices (THB)	3,008	3,074	3,237	3,468	3,686	3,851	4,044	4,260	4,361	4,263	4,596
Private consumption	1,624	1,691	1,783	1,899	2,017	2,103	2,170	2,208	2,273	2,248	2,360
Government consumption	277	284	286	293	310	352	364	386	405	428	455
Gross fixed capital formation	597	604	644	721	816	907	943	949	952	876	955
Increase in stocks	26	36	34	48	53	68	13	5	59	-99	39
Exports of goods and services	1,947	1,865	2,089	2,237	2,451	2,558	2,776	2,986	3,159	2,759	3,170
Less: Imports of goods and services	1,498	1,415	1,609	1,745	1,978	2,162	2,196	2,303	2,524	1,975	2,416
Statistical discrepancy	35	9	11	15	17	26	25	30	27	26	29

Source: ADB (2011)

2.2.2 Thai Labour Force and Unemployment Rate

Table 2.2 and Figure 2.1 show developments in the Thai labour force during the period 1990-2010. The data used is from ADB, which classifies the number and unemployment rate of the labour force by year. It presents the annual unemployment rate for the period 1990-2010. The average percentage unemployment rate from 1990

[13] In 2009, the Thai economy was severely affected by the global financial and economic crisis that occurred in the second half of 2008.

to 1996 was around 2.37 percent. The unemployment rate fluctuated around this rate until 1997, when, as a consequence of the economic crisis, it subsequently increased to a historically high unemployment rate of 4.4 percent in 1998 (see Table 2.2). After 1998, the unemployment rate steadily declined to 1.0 percent in 2010.

Table 2.2: Thai Labour Force and Unemployment Rate, 1990-2010

(Unit: thousands)

Items	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Labour force	30,820	30,419	31,491	31,716	31,433	31,878	32,123	32,575	32,410	32,719
Employed	29,956	29,220	30,794	30,200	30,164	30,815	30,976	31,522	30,105	30,663
Unemployed	682	939	889	825	821	538	492	488	1,413	1,370
Unemployment rate (%)	2.2	3.1	2.9	2.6	2.6	1.7	1.5	1.5	4.4	4.2

Source: ADB (2011)

Table 2.2: (continued) Thai Labour Force and Unemployment Rate, 1990-2010

(Unit: thousands)

Items	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Labour force	33,224	33,813	34,262	34,902	35,718	36,120	36,429	36,942	37,700	38,427	38,643
Employed	31,293	32,104	33,061	33,841	34,729	35,245	35,686	36,249	37,017	37,705	38,037
Unemployed	1,194	1,124	823	754	739	663	552	508	522	572	402
Unemployment rate (%)	3.6	3.3	2.4	2.2	2.1	1.8	1.5	1.4	1.4	1.5	1

Source: ADB (2011)

Figure 2.1: Unemployment Rate (%), 1990-2010

Source: ADB (2011)

2.3 THE ASIAN FINANCIAL CRISIS IN 1997

Thailand's real GDP increased by approximately 60 times during the period 1960 to 1995, from US$2.83 billion to US$0.17 trillion (Nukul's Commission Report, 1998; Buranajarukorn, 2006; Arunsawadiwong, 2007). The World Development Report in 1997 stated that Thailand was the world's fastest-growing economy during the period 1985 to 1995 (World Bank Report, 1997; Arunsawadiwong, 2007). The average annual growth rate was 7 percent during this period (Tinakorn and Sussangkarn, 1994) until the financial and economic crisis in 1997. This high economic growth rate for Thailand was partly stimulated by increasing worldwide demand for various agricultural products such as rice, sugar cane and cassava (Nukul's Commission Report, 1998; Dhanani and Scholtès, 2002; Phan, 2004). There were a number of other factors that led to the Thai economy achieving a very high growth rate during this period. For example, the depreciation of the US dollar in 1985 made Thai exports more competitive, since the Thai currency[14] was linked to the US currency (Krugman, 2001).

In addition, a rapid increase in foreign direct investment (FDI) by some 600 percent over the period 1987-1990, particularly from Japan, Taiwan and Hong Kong, went mainly into the manufacturing sector (Dhanani and Scholtès, 2002; Phan, 2004; Arunsawadiwong, 2007). These multinational firms selected Thailand as their main production base because of the lower cost of production (Pholphirul, 2005). In addition, numerous domestic and international investors rushed into the Thai stock market because of the relatively high returns, without considering any appropriate risk analysis. Thailand liberalised capital inflows and permitted Thai banks to operate offshore banking facilities. For instance, the Bangkok International Banking Facilities (BIBF) acquired a large amount of US dollar denominated funds for lending to local Thai borrowers in Thai Baht (Nukul's Commission Report, 1998; Pholphirul, 2005; Arunsawadiwong, 2007).

The liberalisation of capital markets, along with the fixed exchange rate of the Thai Baht against a basket of international currencies, created a huge influx of foreign capital and loans into Thailand, especially in the form of short-term loans (Kraipornsak, 2001; Arunsawadiwong, 2007; Menkhoff and Suwanaporn, 2007).

[14] The Thai baht was in fact linked to a basket of currencies in which the US dollar was the dominant currency.

The relatively fixed exchange rate eliminated exchange rate risk for investors. As a consequence, the Thai economy initially experienced a strong growth rate from investment (particularly in the real estate sector) and rapid export growth. The rapid export growth was less than the growth of imports as well as debt service payments in order to generate current account deficits. However, with rising current account deficits, it became increasingly difficult to service the debt, which was predominantly denominated in foreign currency. By mid-1997, the collapse of the financial sector and property price bubble triggered an economic meltdown of Thailand in the second half of this year and during 1998, resulting in the collapse of the Thai currency, which in turn triggered a regional currency contagion and economic downturn in the region. This development resulted in a collapse of domestic demand, private consumption and investment, a decline in real income, a high unemployment rate, excess capacity, and decline in imports (see Table 2.1) (World Bank, 1993; Phan, 2004; Arunsawadiwong, 2007; Menkhoff and Suwanaporn, 2007).

In early June 1997, total foreign reserves fell to US$30 billion from US$39 billion in February 1997, with US$23 billion to be delivered in the forward market over 12 months, leaving net official foreign reserves at a mere US$7 billion. By June 30th net official foreign reserves decreased to US$2.9 billion. Thailand had at this time US$36.5 billion in short term foreign debt, and the current account deficit was running at approximately US$1 billion per month. Furthermore, rising interest rates started to cause adverse effects on the Thai economy, dampening economic activity as well as increasing the cost of funds for existing borrowers. The Thai currency was being battered by speculators into a sharp depreciation. By July 2nd 1997 Thailand abandoned the fixed exchange rate regime. Thereafter, the Thai currency was severely devalued, from around 25 Thai baht per US dollar to its lowest value of 48.80 Thai baht per US dollar in December 1997.

In addition, interest rates increased to an excessive level, causing several firms to default on their outstanding loans. Subsequently, Thai financial institutions suddenly faced problems of massive amounts of outstanding non-performing loans, as well as a sharp decline in demand. The financial market was suddenly plunged into a crisis (Nukul's Commission Report, 1998; Harvie, 2002; Arunsawadiwong, 2007; Pholphirul, 2008). Table 2.3 displays the build-up of Thai foreign debt during the period 1990 to 1996. Total outstanding debt increased from 33.76 percent of GDP in 1990 to 50.93 percent of GDP in 1996.

Table 2.3: Thai Foreign Debt, 1990-1996

Items	1990	1991	1992	1993	1994	1995	1996
Long term debt, % to GDP	21.77	22.52	21.46	21.43	22.28	21.93	27.32
Short term debt, % to GDP	11.99	15.57	17.12	18.62	23.03	27.45	23.61
Total debt, % to GDP	33.76	38.09	38.58	40.05	45.31	49.38	50.93

Source: IMF World Economic Outlook (2009)

The Thai economy began to experience a sharp slowdown in economic growth. The decline of the country's growth rate was due to a slowdown in exports, domestic spending, investment in fixed assets, and overall government expenditure (OSMEP, 2001). Arunsawadiwong (2007) argues that there were five major causes of the crisis in 1997: the slowdown of export[15] growth, mistakes in financial policies, asymmetric information and over-investment, attacks on the currency, and the response to the currency devaluation itself by the authorities. Kraipornsak (2001) states that the weak structure of the Thai economy and poor economic management were the major problems. The crisis had marked adverse effects on Thai SMEs. The most severe effects on SMEs were a huge decline in sales revenue and tighter liquidity. Retailers and wholesalers encountered higher costs because their imported products cost more with a weaker currency, while product prices experienced a declining trend due to stiff competition (OSMEP, 2001; Tapaneeyangkul, 2001). The responses by SMEs were to cut costs, impose stricter financial control, retrench staff, expand into international markets where possible, and enhance new product development (Regnier, 2000; OSMEP, 2001).

However, the financial and economic crisis created some positive aspects for the Thai economy. For example, the currency depreciation made import goods relatively more expensive, reduced the demand for imports, and improved the balance of trade. The improved balance of trade, combined with the low domestic demand, assisted in restraining the inflation rate (Arunsawadiwong, 2007). GDP increased from minus 10.5 percent in 1998 to 4.4 percent in 1999, and macroeconomic indicators confirmed signs of economic recovery (see Table 2.1).

[15] According to Table 2.1, exports declined in 1996 and increased in 1997.

The GDP growth rate was stimulated by domestic demand, particularly in the form of private expenditure, and export expansion during the period 2002 to 2004 (see Table 2.1) (OSMEP, 2002; Phan, 2004).

After the period of the crisis, during 1997-1998, the growth rate started to expand gradually, to 4.4 percent in 1999, and 4.8 percent in 2000 in real terms (see Table 2.1). However, the period of recovery during the years 1999 and 2000 was unstable, and characterised by a rapid increase in the unemployment rate (Pholphirul, 2005). In 2001, the growth rate was highly dependent on the process of reforming the financial sector and restructuring corporate debt in order to improve profitability and investor confidence (Ha, 2006). Nevertheless, the Thai financial sector and economy gradually recovered, and the liquidity of both the commercial and public banks increased (OSMEP, 2002). New jobs were generated and investors' confidence was restored. Exports resumed to a positive growth rate and the number of business establishments increased (Tapaneeyangkul, 2001).

Menkhoff and Suwanaporn (2007) states that the resolution of Thailand's financial crisis of 1997 was successful, and the Thai government provided measures to resolve problems in the financial sector. First, the Thai government stabilised the financial sector by guaranteeing most deposits of the existing banks. This measure was aimed at isolating the non-performing loans (NPLs) of financial institutions, with the support of bad debt resolution mechanisms (Asset Management Corporation) and a recapitalisation of financial institutions. The second measure involved closure of bankrupt financial institutions, resulting in a radically reduced number of financial institutions. The number of important branches of financial institutions decreased radically from 91 to 7. Hence, there were less financial institutions than before the crisis, but these financial institutions became bigger (in terms of assets) because they merged with other financial institutions (Menkhoff and Suwanaporn, 2007).

Finally, the government encouraged foreign banks to participate actively in the Thai financial sector in an attempt to stabilise it, and to promote technological upgrading (Okuda and Rungsomboon, 2006). Accordingly, Thailand's financial system and the capital market improved. The government established specialised financial institutions which served as the government's arm for economic and social development as well as policy implementation agencies, in an attempt to provide financial assistance to specific sectors of the economy, such as housing credits, credits to SMEs, and export-import credits. Necessary corollary institutions were established and broad access to financial services was addressed (Menkhoff and Suwanaporn, 2007).

In 2001, Thai specialised financial institutions, such as the industrial financial corporation of Thailand (IFCT) and SME development bank of Thailand, provided loans for SMEs worth US$2.96 billion. The small industry credit guarantee corporation (SICGC) provided a total of US$78.31 million of guaranteed loans for SMEs. The SMEs and people's financial advisory centre (SFAC) assisted SMEs with financial consulting services (OSMEP, 2002). Moreover, to assist SMEs in mobilising funds, the government established the market for alternative investment (MAI) or New Stock Market. The intention of this market is to provide SME entrepreneurs with access to long term loans through sales of securities to the public. In addition to the development of the new stock market, the government established two funds in accord with its measures to support private sector investment, including the SME Venture Capital Fund and Thailand Recovery Fund. Both funds were aimed at mobilising financial resources for SMEs (Tapaneeyangkul, 2001; OSMEP, 2002; Mephokee, 2003).

2.4 AN OVERVIEW OF THAI SMALL AND MEDIUM SIZED ENTERPRISES

SMEs are the backbone of the Thai economy, and contribute significantly to the country's social and economic development. (Brimble *et al.*, 2002; Mephokee, 2003; Sahakijpicharn, 2007). They represent 99 percent of business establishments in the country, and employ more than 7 million workers, accounting for 73 percent of total employment during the period 1994 to 2009. SME production accounted for 37.8 percent of GDP in 2009. Furthermore, Thai SMEs serve as a solid foundation for industrial development in which their products are used by large firms in industries such as semi-products or materials. In addition, SMEs are key components for linking all important units of industry together, and filling gaps in industrial clusters which may not be completed by large enterprises alone (Regnier, 2000).

2.4.1 Definition of Thailand's Small and Medium sized Enterprises

The two most common means of defining an SME are: the number of employees or the level of fixed assets (Brimble *et al.*, 2002; OSMEP, 2003; Sahakijpicharn, 2007). The Ministry of Industry (MOI) regulation of 11 September 2002 adopted employment or fixed assets, excluding land, as criteria in defining SMEs. The criteria change, however, according to sector. Hence, Thai SMEs are classified into four business sectors[16] (see Table 2.4) (Brimble et al., 2002; OSMEP, 2002; Mephokee, 2003; OSMEP, 2003):

2.4.1.1 Manufacturing Sector

An enterprise employing less than 50 workers or fixed assets, excluding land, not exceeding THB 50 million in the manufacturing sector is considered a small enterprise. An enterprise employing between 51-200 workers or fixed assets, excluding land, worth between THB 50-200 million is defined as a medium-sized enterprise.

2.4.1.2 Wholesale Sector

A small enterprise is defined as having less than 25 workers or fixed assets, excluding land, not exceeding THB 50 million. An enterprise employing 26-50 workers or fixed assets, excluding land, worth between THB 50-100 million, is defined as a medium-sized enterprise.

2.4.1.3 Retail Sector

An enterprise employing less than 15 workers or fixed assets, excluding land, not exceeding THB 30 million is defined as a small enterprise. A medium-sized enterprise is defined as employing 16-30 workers or fixed assets, excluding land, worth between THB 30-60 million.

2.4.1.4 Service sector

A small enterprise is considered as employing less than 50 workers or having fixed assets, excluding land, not exceeding THB 50 million in value. An enterprise

---

[16] Micro enterprises are not defined separately from a small enterprise.

employing between 51-200 workers or fixed assets, excluding land, worth between THB 50-200 million is defined as a medium-sized enterprise.

Table 2.4: Summary: Definitions of Thai SMEs by Sector

Sectors	Number of Employees (Workers)	Fixed Assets (THB, Million)
1. Manufacturing		
1.1 Small Enterprises	≤ 50	≤ 50
1.2 Medium Enterprises	51-200	51-200
2. Wholesale		
2.1 Small Enterprises	≤ 25	≤ 50
2.2 Medium Enterprises	26-50	51-100
3. Retail		
3.1 Small Enterprises	≤ 15	≤ 30
3.2 Medium Enterprises	16-30	31-60
4. Service		
4.1 Small Enterprises	≤ 50	≤ 50
4.2 Medium Enterprises	51-200	51-200

Source: OSMEP (2003) and Mephokee (2003)

2.4.2 Number of Thai Small and Medium sized Enterprises

The data utilised in this subsection is from the OSMEP of Thailand, covering the period 1994[17] to 2009. Table 2.5 presents the number and percentage of SMEs[18] in overall enterprises during this period. It can be observed that SMEs constituted more than 99 percent of total enterprises. This confirms that SMEs are crucial to the development of the Thai economy. Figure 2.2 displays trends of SMEs and all enterprises by size from 1994 to 2009. Unfortunately, there is inadequate data availability for SMEs in 1995, 1996, 1998, 2000 and 2001. In 1994, the total number of all types of enterprises was 442,444 enterprises. SMEs totalled 438,805, representing 99.18 percent of overall enterprises, while large enterprises (LE) accounted for 3,639 firms, representing 0.82 percent of all enterprises. In 1999, the total number of SMEs decreased to 524,960 enterprises, arising from the financial

[17] Data collection of Thai SMEs started in 1994.

[18] The number of Thai SMEs is calculated from the employee size in each of the four business sectors.

crisis in 1997 (see Table 2.5). This is a substantial reduction. It is important to note that the data collection on Thai SMEs was poor and this could also account for the high variability in SME numbers from year to year.

The total number of SMEs, however, increased to 1,639,427 in 2002. The total number of SMEs increased rapidly from 2002 to 2004 and stabilised after 2005. In 2006, the total number of SMEs was 2,274,525 enterprises, or 99.45 percent of all enterprises (see Table 2.5). In 2009, the total number of SMEs was 2,896,106 enterprises, representing 99.84 percent of all enterprises. Government promotion policy[19] was the main factor for the increasing number of Thai SMEs during this period (OSMEP, 2005; Sahakijpicharn, 2007).

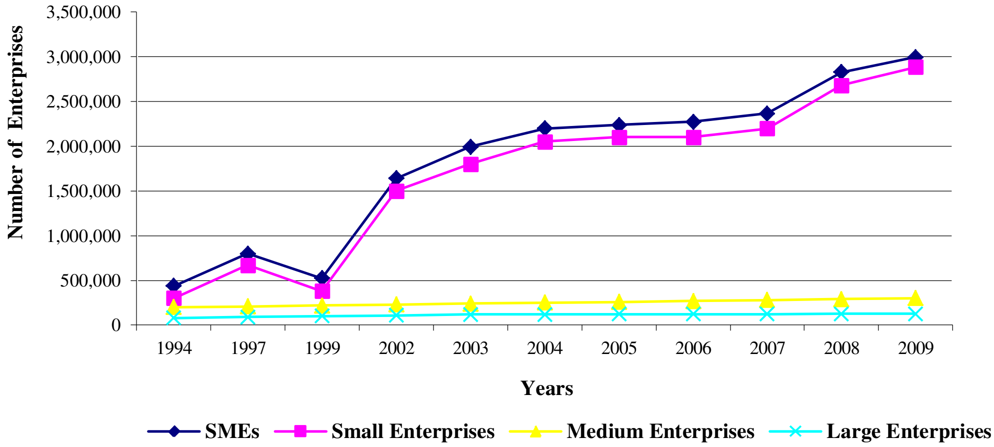
Table 2.5: Number and percentage of SMEs and Enterprises by Size, 1994-2009

Enterprises	1994	1997	1999	2002	2003	2004	2005	2006	2007	2008	2009
SMEs	438,805	799,033	524,960	1,639,427	1,995,929	2,199,595	2,239,280	2,274,525	2,359,312	2,827,633	2,896,106
Small Enterprises	432,967	767,766	515,664	1,630,015	1,989,394	2,189,966	2,229,353	2,264,734	2,347,531	2,815,560	2,884,041
Medium Enterprises	5,838	11,267	9,296	9,412	6,535	9,629	9,927	9,791	11,781	12,073	12,065
Large Enterprise	3,639	4,168	4,351	6,103	10,599	4,323	4,444	4,292	4,324	4,586	4,653
Other Enterprises	N/A	N/A	N/A	N/A	N/A	5,989	5,994	8,240	6,915	4,158	N/A
Total	**442,444**	**803,201**	**529,311**	**1,645,530**	**2,006,528**	**2,209,907**	**2,249,718**	**2,287,057**	**2,377,466**	**2,836,377**	**2,900,759**
Percentage of SMEs (%)											
SMEs	99.18	99.48	99.18	99.63	99.47	99.53	99.54	99.45	99.53	99.69	99.84
Small Enterprises	97.86	95.59	97.42	99.06	99.15	99.1	99.09	99.02	98.74	99.27	99.42
Medium Enterprises	1.32	1.4	1.76	0.57	0.33	0.44	0.44	0.43	0.5	0.43	0.42
Large Enterprise	0.82	0.52	0.82	0.37	0.53	0.2	0.2	0.19	0.18	0.16	0.16
Other Enterprises	N/A	N/A	N/A	N/A	N/A	0.27	0.27	0.36	0.29	0.15	N/A
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Sources: OSMEP (2001-2009)

[19] The volatility in SME numbers is likely to be also due to the way in which the National Statistical Office (NSO) of Thailand collected data on SMEs during the period 1994 to 2009.

Figure 2.2: Trends in SMEs, Classified by Size, 1994-2009



Sources: OSMEP (2001-2009)

Table 2.6 presents the number and percentage of SMEs classified by sector during 1994 to 2005. In 1997, the largest number of SMEs was in the manufacturing sector, which had 291,456 SMEs or 36.46 percent of all SMEs. The retail sector was the second highest, with 277,997 SMEs or 34.79 percent of all SMEs. The service sector and the wholesale sector had 204,232 and 25,348 SMEs, respectively, accounting for 25.56 percent and 3.17 percent of all SMEs, respectively. Sevilla and Soonthornthada (2000) emphasises that SME policy in Thailand paid more attention to the manufacturing sector, because Japanese investment mainly concentrated in this sector. By 1999, however, the total number of SMEs decreased to 524,960 enterprises as a consequence of the financial crisis in 1997. The number of SMEs in the manufacturing and service sectors contracted to 99,568 and 96,083, respectively.

From Table 2.6, it can be observed that the manufacturing and service sectors were most severely affected by the crisis. However, the total number of SMEs increased rapidly to 1,639,427 in 2002. Most SMEs were in the retail sector in 2002, totalling 732,593 or 44.69 percent of overall SMEs, followed by the service sector with a total of 500,970 or 30.56 percent of all SMEs. The manufacturing sector accounted for 356,806 SMEs or 21.76 percent of all SMEs in 2002. The wholesale sector recorded 49,058 SMEs or 2.99 percent of the total (see Table 2.6).

In 2004, the major contribution of SMEs[20] changed from the retail sector to that of the services and manufacturing sectors. The reasons for this change are discussed in more detail below. The number of SMEs in the retail sector declined due to increased competition from giant discount stores in Thailand such as Tesco Lotus, Carrefour, and Big C (OSMEP, 2002; Sahakijpicharn, 2007). However, in 2003, the Office of the Board of Investment of Thailand promoted 675 projects involving SMEs, the total value of which amounted to US$3,960 million (OSMEP, 2002; Mephokee, 2003).Of these projects, 573 involved Thai manufacturing SMEs in such areas as raw steel, machines, car spare parts, mining, ceramics, electronic and electronic appliances, paper and plastic products, services and utilities (Sahakijpicharn, 2007).

As a consequence of these projects, there was a dramatic increase in the number of SMEs in the manufacturing and service sectors (see Table 2.6). In 2005, manufacturing remained the most SME dense sector, accounting for 684,815 SMEs or 30.58 percent of total SMEs. Theingi (2004) states that the growth of the Thai manufacturing sector (such as in computers, automotive and auto parts, home appliances and electronics), directly relied upon export growth. The manufacturing sector became the leading sector in the Thai economy. The service sector was the second most SME-dense sector, accounting for 577,663 SMEs or 25.80 percent of all SMEs in 2005. The retail sector came a close third, with 563,366 SMEs, representing 25.16 percent of all SMEs in 2005. The wholesale sector accounted for 188,830 SMEs or 8.43 percent of all SMEs in 2005.

In 2006, it can be noted that the major contribution of SMEs changed from the manufacturing and service sectors to the trade[21] and repairs sector. The number of SMEs in the trade and repairs sector was 918,028 enterprises or 40.36 percent of total SMEs in 2006. The manufacturing sector accounted for 698,651 SMEs or 28.83 percent of all SMEs in 2006. The service sector recorded 636,626 SMEs, representing 27.99 percent of total SMEs in 2006. Finally, in 2009, the largest number of SMEs was in the trade and repairs sector, representing 1,371,488 SMEs or

[20] The database of SMEs in 2003 indicated that there were some SMEs which were unidentified in terms of business sectors. This may have contributed to the volatility of SME numbers after 2003 (OSMEP, 2003).

[21] There is confusion in the definition of Thai SMEs in terms of the trade sector (Sevilla and Soonthornthada, 2000). In 2006 the OSMEP redefined the trade and repair sectors to include the wholesale and retail sectors (OSMEP, 2006).

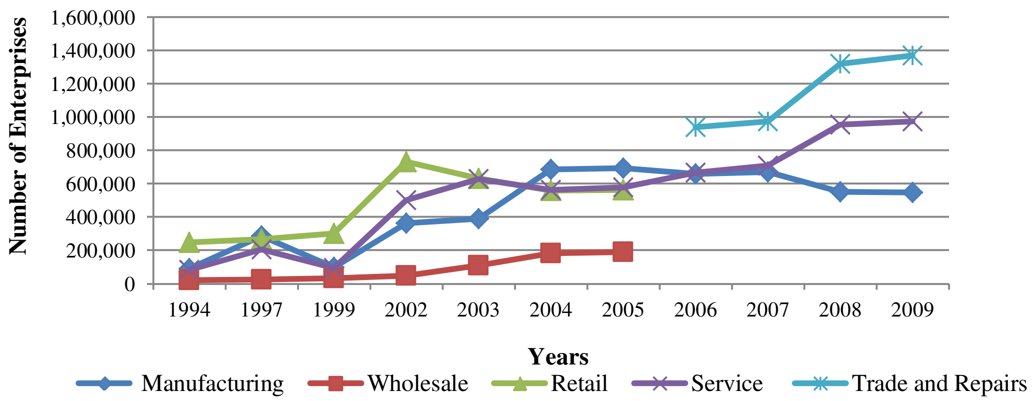
47.36 percent of all SMEs. The service sector was the second highest with 975,552 SMEs or 33.68 percent of all SMEs. The manufacturing sector had 547,052 SMEs, which accounted for 18.89 percent of all SMEs (see Table 2.6). Punyasavatsut (2007) acknowledges that Thai manufacturing SMEs were not ready to face the rigours of international competition in international markets arising from the country's increased opening to foreign trade/investment and economic integration, and more intense competition from lower labour cost in other countries. From 2006, the trend of SMEs numbers in the manufacturing sector decreased gradually, while the trend in the trade and repairs sector increased rapidly in the period 2006 to 2009 (see Figure 2.3).

Table 2.6: Number and Percentage of SMEs Classified by Sector, 1994-2009

Sectors	1994	1997	1999	2002	2003	2004	2005	2006	2007	2008	2009
Manufacturing	84,541	291,456	99,568	356,806	378,031	674,129	684,815	698,651	680,270	564,706	547,052
Wholesale	21,821	25,348	31,833	49,058	109,524	180,926	188,830	N/A	N/A	N/A	N/A
Retail	249,094	277,997	297,476	732,593	634,179	558,496	563,366	N/A	N/A	N/A	N/A
Service	83,349	204,232	96,083	500,970	627,772	561,797	577,663	636,626	709,841	946,812	975,552
Trade and Repairs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	918,028	953,248	1,311,714	1,371,488
Other enterprises	N/A	N/A	N/A	N/A	246,423	224,247	224,606	21,220	15,953	4,401	2,014
Total	**438,805**	**799,033**	**524,960**	**1,639,427**	**1,995,929**	**2,199,595**	**2,239,280**	**2,274,525**	**2,359,312**	**2,827,633**	**2,896,106**
Percentage of SMEs (%)											
Manufacturing	19.27	36.48	18.97	21.76	18.94	30.65	30.58	30.72	28.83	19.97	18.89
Wholesale	4.97	3.17	6.06	2.99	5.49	8.23	8.43	N/A	N/A	N/A	N/A
Retail	56.77	34.79	56.67	44.69	31.77	25.39	25.16	N/A	N/A	N/A	N/A
Service	18.99	25.56	18.3	30.56	31.45	25.54	25.8	27.99	30.09	33.48	33.68
Trade and Repairs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	40.36	40.4	46.39	47.36
Other enterprises	N/A	N/A	N/A	N/A	12.35	10.19	10.03	0.93	0.68	0.16	0.07
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Sources: OSMEP (2001-2009)

Figure 2.3: Trends in SMEs, classified by Sector, 1994-2009



Sources: OSMEP (2001-2009)

In terms of the regional distribution of SMEs, it can be observed from Table 2.7 that Bangkok and vicinity areas contained the highest number of SMEs over the period 1994 to 2008, accounting for around 30 percent of total SMEs on average. Bangkok and regions in its vicinity are recognised as the major economic centre and contain many of Thailand's large businesses (OSMEP, 2008). The second-highest number of SMEs can be found in the North-eastern area, having 514,498 SMEs equivalent to 27.41 percent of all SMEs on average during 1994 to 2008. The North-eastern region contains 17 of the 76 provinces of Thailand, and has the highest population in the country. In 1994 the number of SMEs in Bangkok and vicinity regions was 119,609 enterprises or 27.26 percent of all SMEs. The North-eastern area had 111,712 SMEs, representing 25.46 percent of total SMEs, while the central region had 82,673 SMEs or 18.84 percent of all SMEs.

In 2008, Bangkok-and-vicinity areas had 868,715 SMEs, equivalent to 30.72 percent of all SMEs, an increase of 140,197 SMEs over the previous year. The North-eastern region was second with 769,503 SMEs in 2008, representing 27.21 percent of all SMEs, an increase of 80,488 SMEs from 2007. The Northern region had 479,154 SMEs in 2008, or 16.95 percent of total SMEs, an increase of 79,028 SMEs over 2007. The Central region had 298,548 SMEs or 10.56 percent of all SMEs, an increase of 99,928 SMEs from 2007. The Southern region had 228,547 SMEs in 2008 or 8.8 percent of all SMEs, an increase of 27,091 SMEs from 2007. The Eastern region had the lowest number of SMEs, accounting for 178,659 SMEs in

2008, or 6.32 percent of total SMEs, an increase of 39,734 SMEs from 2007. Finally, the remaining 4,507 enterprises are not specified by region. It is important to note that the OSMEP did not specify the number of SMEs classified by region in 2009.

Table 2.7: Number and Percentage of SMEs Classified by Region, 1994-2008

Regions	1994	1997	1999	2002	2003	2004	2005	2006	2007	2008
Bangkok and Vicinity	119,609	N/A	157,730	517,827	611,535	660,389	674,838	692,922	728,518	868,715
Central	82,673	N/A	85,795	202,411	203,585	186,516	190,061	195,970	198,620	298,548
Northern	81,168	N/A	76,640	298,124	300,490	386,232	387,585	395,611	400,126	479,154
North-Eastern	111,712	N/A	121,940	514,245	524,515	623,682	625,402	650,469	689,015	769,503
Southern	36,539	N/A	70,442	29,015	246,951	213,699	215,588	197,394	201,456	228,547
Eastern	5,304	N/A	10,459	76,658	107,753	125,338	129,210	137,825	138,925	178,659
Unspecified[22]	1,800	N/A	1,954	1,147	1,100	3,739	16,596	4,334	2,652	4,507
Total	**438,805**	**N/A**	**524,960**	**1,639,427**	**1,995,929**	**2,199,595**	**2,239,280**	**2,274,525**	**2,359,312**	**2,827,633**
Percentage of SMEs (%)										
Bangkok and Vicinity	27.26	N/A	30.05	31.59	30.64	30.02	30.14	30.46	30.88	30.72
Central	18.84	N/A	16.34	12.35	10.20	8.48	8.49	8.62	8.42	10.56
Northern	18.50	N/A	14.60	18.18	15.06	17.56	17.31	17.39	16.96	16.95
North-Eastern	25.46	N/A	23.23	31.37	26.28	28.35	27.93	28.60	29.20	27.21
Southern	8.33	N/A	13.42	1.77	12.37	9.72	9.63	8.68	8.54	8.08
Eastern	1.21	N/A	1.99	4.68	5.40	5.70	5.77	6.06	5.89	6.32
Unspecified	0.41	N/A	0.37	0.07	0.06	0.17	0.74	0.19	0.11	0.16
Total	**100**	**N/A**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Sources: OSMEP (2001-2008)

2.4.3 Employment by Small and Medium Sized Enterprises

Table 2.8 presents total employment and employment by enterprise size from 1994 to 2008**.** SMEs can be seen to play a pivotal role in creating jobs in the Thai economy. They contributed more than 73 percent on average of overall employment over the period 1994-2009. However, SMEs have a higher bankruptcy rate. In 1994, a total of 7,367,500 workers were employed by all types of enterprises. SMEs employed 5,243,500 workers or 71.17 percent of overall employment. Small sized enterprises employed 4,700,000 workers or 63.79 percent of overall employment. Medium-sized enterprises employed 543,500 workers, representing 7.38 percent of overall

[22] In 2009 the OSMEP did not identify unspecified enterprises by region.

employment. Employment in large enterprise was 2,124,000 or 28.83 percent of total employment.

In 2004, the total number employed by SMEs increased rapidly to 8,863,607, equivalent to 75.43 percent of all employment, an increase of 3,296,742[23] workers over the previous year. This reflects the unreliability of the data being generated by the Thai authorities. Small enterprises employed 7,454,493 workers or 63.44 percent of all employment, an increase of 2,442,277 workers from 2003. Medium enterprises employed 1,409,114 workers or 11.99 percent of total employment, an increase of 854,465 workers from 2003. This represented a dramatic increase in employment in the SME sector. This fluctuation in the number and percentage of SME employment is likely to be due to an improvement in statistical collection methods (OSMEP, 2003; Sahakijpicharn, 2007).

From Figure 2.4 it can be seen that the trend in employment by medium enterprises was a rapid increase after 2004. The reason for this is that many small enterprises became medium enterprises in terms of number of employees. Firms of all sizes expanded their classification from small enterprises to medium and large enterprises (Wiboonchutikula, 2002; OSMEP, 2004). After 2004 the total numbers employed by SMEs gradually increased and continued rising to 9,701,354 workers by 2009. The total number employed by all enterprises was 12,405,597 in 2009, with the SME contribution equivalent to 78.20 percent of the total. There were 2,704,243 workers employed in large-sized enterprises, 21.80 percent of the total. While important, the SME employment contribution is noticeably less than that of the SME contribution to total business numbers.

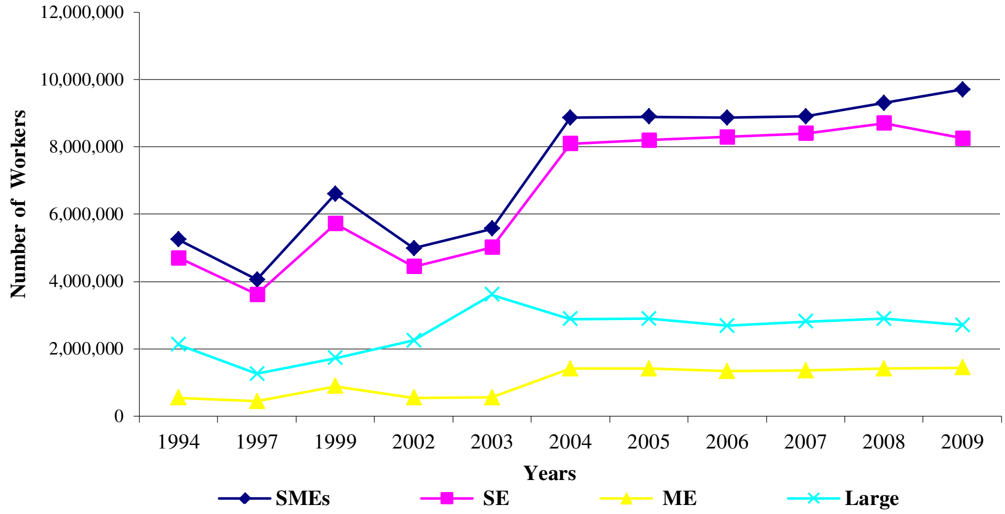
[23] The total number employed by all enterprises in the period 1994 to 2003 is not complete, because some enterprises did not report numbers employed. For this reason the numbers employed by all enterprises may be underestimated during this period (OSMEP, 2003).

Table 2.8: Number and percentage of SME Employment and Enterprises by Size, 1994-2008

Enterprises	1994	1997	1999	2002	2003	2004	2005	2006	2007	2008	2009
SMEs	5,243,500	4,057,595	6,605,300	4,990,217	5,566,865	8,863,607	8,896,164	8,863,334	8,900,567	9,125,916	9,701,354
Small Enterprises	4,700,000	3,619,670	5,718,600	4,444,532	5,012,216	7,454,493	7,482,561	7,524,936	7,550,269	7,715,458	8,262,128
Medium Enterprises	543,500	437,925	886,700	545,685	554,649	1,409,114	1,413,603	1,338,398	1,350,298	1,410,458	1,439,226
Large Enterprise	2,124,000	1,255,775	1,727,300	2,243,805	3,605,887	2,887,261	2,894,932	2,687,938	2,810,767	2,891,756	2,704,243
Total	7,367,500	5,313,370	8,332,600	7,234,022	9,172,752	12,000,000	12,000,000	11,551,272	11,711,334	12,000,000	12,405,597
Percentage of SMEs (%)											
SMEs	71.17	76.37	79.27	68.98	60.69	75.43	75.45	76.73	76	76.23	78.2
Small Enterprises	63.79	68.12	68.63	61.44	54.64	63.44	63.46	65.14	64.5	64.2	66.6
Medium Enterprises	7.38	8.24	10.64	7.54	6.05	11.99	11.99	11.59	11.52	11.73	11.6
Large Enterprise	28.83	23.63	20.73	31.02	39.31	24.57	24.55	23.27	24	24.07	21.8
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Sources: OSMEP (2001-2009)

Figure 2.4: Trends in Employment by Business Size, 1994-2009



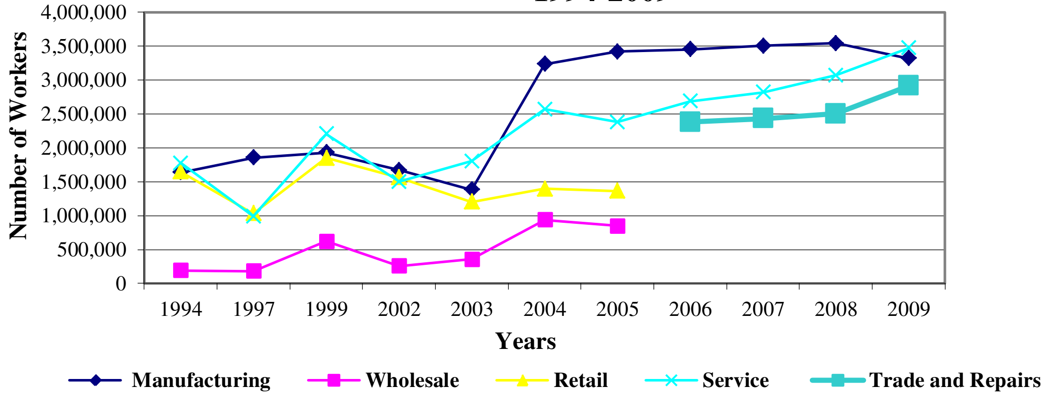
Sources: OSMEP (2001-2009)

Table 2.9: SME Employment by Number and Percentage, Classified by Sector, 1994-2009

Sectors	1994	1997	1999	2002	2003	2004	2005	2006[24]	2007	2008	2009
Manufacturing	1,636,700	1,852,691	1,928,300	1,668,303	1,383,343	3,233,484[25]	3,420,120	3,452,699	3,501,167	3,541,587	3,320,409
Wholesale	190,226	183,063	623,460	256,643	355,630	935,702	846,162	N/A	N/A	N/A	N/A
Retail	1,644,274	1,033,116	1,848,240	1,563,221	1,200,070	1,395,029	1,365,054	N/A	N/A	N/A	N/A
Service	1,772,300	988,725	2,205,300	1,502,050	1,803,012	2,567,485	2,378,657	2,687,284	2,819,684	3,066,933	3,467,763
Trade and Repairs[26]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,376,968	2,431,432	2,501,941	2,912,678
Unspecified[27]	N/A	N/A	N/A	N/A	824,810	731,907	886,171	346,383	148,284	15,455	N/A
Total	**5,243,500**	**4,057,595**	**6,605,300**	**4,990,217**	**5,566,865**	**8,863,607**	**8,896,164**	**8,863,334**	**8,900,567**	**9,125,916**	**9,700,850**
Percentage of SMEs (%)											
Manufacturing	31.21	45.66	29.19	33.43	24.85	36.48	38.44	38.95	39.33	38.8	34.23
Wholesale	3.62	4.51	9.44	5.14	6.39	10.56	9.51	N/A	N/A	N/A	N/A
Retail	31.35	25.46	27.98	31.33	21.56	15.74	15.34	N/A	N/A	N/A	N/A
Service	33.8	24.37	33.39	30.1	32.39	28.97	26.74	30.31	31.68	33.6	35.75
Trade and Repairs	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.81	27.31	27.42	30.02
Unspecified	N/A	N/A	N/A	N/A	14.82	8.26	9.96	3.9	1.67	0.18	N/A
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Sources: OSMEP (2001-2008)

Figure 2.5: Trends in SME Employment, Classified by Sector, 1994-2009



Sources: OSMEP (2001-2009)

---

[24] In 2006, the trade and repair sector included the wholesale and retail sectors (the OSMEP, 2006).

[25] The total numbers employed in the manufacturing sector in the period 1994 to 2003 are not complete, due to many manufacturing firms not reporting numbers employed. As a result, the number employed by the manufacturing sector during this period may be underestimated. In addition, the total numbers employed in this sector increased rapidly because of high domestic and foreign demand for Thai manufactured goods and a weak exchange rate (OSMEP, 2004).

[26] The trade and repairs sector was introduced as a new classification in 2006 and included the wholesale and retail sectors.

[27] The OSMEP did not identify unspecified enterprises by sector.

Table 2.9 displays employment by SMEs classified by sector, during 1994 to 2009. In 1994, employment by SMEs was highest in the service sector, which employed 1,772,300 persons, or 33.8 percent of total employment by SMEs. The second-ranked sector was retail which accounted for 1,644,274 persons, or 31.35 percent of total SME employment. The manufacturing and wholesale sectors employed 1,636,700 and 190,226 or 31.21 percent and 3.62 percent of overall SME employment in 1994, respectively. In 1999, total employment in the service sector was the highest with 2,205,300 workers, or 33.39 percent of total SME employment. The manufacturing sector ranked second at 1,928,300 workers, or 29.19 percent of total SME employment. The total numbers employed in the manufacturing and service sectors gradually increased after 1999, due to assistance from government support programs. These programs encouraged the establishment of new enterprises in the manufacturing and service sectors, and assisted in increasing the number of SMEs and numbers employed, particularly in the manufacturing sector (OSMEP, 2003; Sahakijpicharn, 2007)

As a result of Thai government support programs such as the product development program, the promotion of innovative SMEs, and the program for scientific and technological innovation (OSMEP, 2002), the total numbers employed in the manufacturing sector increased from 1,668,303 persons in 2002 to 3,320,409 persons in 2009. In 2002 the textile and garment industries played an important role in the Thai economy. They represented one of the highest sources of export earnings in 2002, accounting for more than US$2.9 billion. This sector also created the greatest employment opportunity in the manufacturing sector, totalling 800,000 workers in 2002 (OSMEP, 2003).

In 2001, Thailand joined the World Trade Organisation (WTO). The benefits of being a member of the WTO were perceived to be: 1) a better trade environment because of the improvement in the regulations that members of the WTO must strictly follow; 2) the regulations of the WTO assisting Thailand to achieve improved fairness from international trade (Jackson, 2001; Thanapornpun, 2008) by improving trading conditions for imports, exports, product quality, country of origin, product dumping, subsidising and protection of intellectual property. These regulations enabled Thailand to gain access to international markets, such as Europe and North-America, on equal terms to that of other developing WTO members; and 3)

Thailand's ability to now utilise trade regulations to investigate member country operations. If a member does not follow the regulations of the WTO, then Thailand can report it to the WTO (OSMEP, 2002; Sahakijpicharn, 2007). Thai SMEs could now more easily expand their business operations into global markets.

In 2004, the number employed in the manufacturing sector grew rapidly[28] to 3,233,484 workers or 36.48 percent of total SME employment, an increase of 1,850,141 workers from 2003. Service SMEs employed 2,567,485 workers or 28.97 percent of total SME employment. The retail and wholesale sectors employed 1,395,029 and 935,702 or 15.74 percent and 10.56 percent of overall SME employment in 2004, respectively. According to the OSMEP (2004), manufacturing and services SMEs were more labour-intensive than those in the retail and wholesale sectors. They had an average number employed of 4 workers for small enterprises and 200 and 109 workers for medium-sized enterprises in the manufacturing and service sectors, respectively.

On the other hand, the retail sector had an average number employed of two workers for small enterprises and 54 workers for medium sized enterprises (Sahakijpicharn, 2007). From Table 2.9 it can be seen that the share of manufacturing employment in total SME employment increased rapidly from 24.85 percent in 2003 to 36.48 percent in 2004. After 2004, the trend in manufacturing employment remained moderately stable until 2008. This may be due to the poor efficiency and performance of manufacturers as shown in a later chapter, and hence poor competitiveness. In 2009, the share of manufacturing employment declined to 34.23 percent of total SME employment. On the other hand, the share of service employment increased gradually over the period 2005 to 2009. In 2009, employment by SMEs was highest in the service sector, which employed 3,467,763 persons or 35.75 percent of total employment by SMEs. The second-ranked sector was manufacturing which accounted for 3,320,409 persons, or 34.23 percent of total SME employment. The trade and repairs sector employed 2,912,678 or 30.02 percent of overall SME employment in 2009.

---

[28] The total numbers employed in the Manufacturing Sector in the period 1994 to 2003 are not complete due to many manufacturing firms not reporting numbers employed. As a result, the number employed by the manufacturing sector during this period may be underestimated. In addition, the total numbers employed in this sector increased rapidly because of high domestic and foreign demand for Thai manufactured goods and a weak exchange rate (OSMEP, 2004).

2.4.4 The Role, Significance and Contribution of SMEs to Thailand's GDP

Table 2.10 displays the structure of Thailand's Gross Domestic Product (GDP) during the period 1999 to 2009. It indicates that the non-agricultural Sector was the main source of Thai GDP over this period, although this share has been declining since 2001. Large enterprises in the non-agriculture sector contributed an average 43.03 percent of total GDP over this eleven-year period. The contribution of SMEs to GDP, at current prices, was approximately 38.84 percent of total GDP over the period 1999-2009. In 1999, SMEs in all sectors generated products and services about 39.1 percent of overall GDP. When categorising this GDP by small enterprises (SE) and medium enterprises (ME), GDP by SEs accounted for 20.9 percent of the total and MEs accounted for 18.2 percent of the total. While the SME share of overall GDP during 1999 to 2006 was 38.95 percent on average, there has been a continuous decline in this share since 2001. In 2009, Thai SMEs contributed around 37.76 percent to overall GDP. In terms of contribution to GDP, SEs contributed 25.41 percent of total GDP while MEs contributed 12.35 percent of total GDP in 2009.

Table 2.10 also shows the real growth rate of SME output during the period 1999 to 2009. The average annual real growth rate of SME output over the period 1999-2009 was approximately 3.91 percent. Comparing[29] the average growth rate between 1999 and 2009 classified by size of enterprise (small and medium), it is found that the growth rate of SEs declined while the growth rate of MEs increased. The average real growth rate of SEs and MEs during the period 1999-2009 was around 3.60 percent and 4.34 percent, respectively, while the average real growth rate of LEs was 4.47 percent. However, the real growth rate of SME output in 2009 was minus 2.40 percent arising from the global financial and economic crisis in 2008. In addition, the fastest growth has been by LEs, which explains why their share of GDP has increased[30]. Hence, SMEs are still under-performing relative to LEs, in terms of contribution to GDP. However, it may be difficult to state this unambiguously. The size distribution of enterprises in an economy depends on a

---

[29] The average growth rate of SE output is quite different from ME output at current prices during 1999-2009. This may be due to misreporting arising at the data entry stages.

[30] The average real growth rate of LEs increased rapidly due to reform measures after the financial crisis of 1997 (OSMEP, 2008).

number of factors, such as economies of scale and scope, transaction costs, resources, sector competitiveness and concentration and stage of economic development (Hallberg, 2000; Biggs, 2002; OECD, 2005). However, if SMEs are being inhibited due to market failures, this is an important policy issue that needs to be addressed.

Table 2.10: Gross Domestic Product (GDP) Classified by Size of Enterprise, 1999-2009

Items	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Gross Domestic Product (GDP) at Current Price (Thai Million Baht)											
Agriculture	435,507	444,143	468,456	510,877	579,460	654,810	706,285	836,077	967,091	1,054,175	1,052,564
Non-agriculture	4,201,572	4,479,120	4,665,380	4,940,977	5,359,602	5,848,677	6,397,943	6,980,397	7,501,542	8,050,783	7,998,151
Large Enterprises	1,870,484	1,980,488	2,070,598	2,213,656	2,449,551	2,954,382	3,260,301	3,589,655	3,881,340	4,214,807	4,154,278
SMEs	1,811,905	1,946,224	2,020,128	2,115,316	2,263,574	2,598,657	2,816,641	3,041,895	3,236,634	3,446,589	3,417,861
SE	969,263	1,043,419	1,084,295	1,136,947	1,210,217	1,761,455	1,901,333	2,043,460	2,170,069	2,295,711	2,300,196
ME	842,642	902,825	935,833	978,369	1,053,357	837,202	915,307	998,435	1,066,564	1,150,877	1,117,665
Other Enterprises	519,183	552,387	574,654	612,005	646,477	295,638	321,001	348,846	383,567	389,387	425,384
Total GDP	**4,637,079**	**4,923,263**	**5,133,836**	**5,451,854**	**5,939,062**	**6,503,487**	**7,104,228**	**7,816,474**	**8,468,633**	**9,104,959**	**9,050,715**
Gross Domestic Product (GDP) at Current Price (Percentage)											
Agriculture	9.4	9	9.1	9.4	9.8	10.1	9.9	10.7	11.4	11.6	11.6
Non-agriculture	90.6	91	90.9	90.6	90.2	89.9	90.1	89.3	88.6	88.4	88.4
Large Enterprises	40.3	40.2	40.3	40.6	41.2	45.4	45.9	45.9	45.8	46.3	45.9
SMEs	39.1	39.5	39.4	38.8	38.1	40	39.6	38.9	38.2	37.9	37.8
SE	20.9	21.2	21.1	20.9	20.4	27.1	26.8	26.1	25.6	25.2	25.4
ME	18.2	18.3	18.2	18	17.7	12.9	12.9	12.8	12.6	12.6	12.3
Other Enterprises	11.2	11.2	11.2	11.2	10.9	4.5	4.5	4.5	4.5	4.3	4.7
Total GDP	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Real GDP Growth Rate at Constant Price (Percentage)											
Agriculture	2.3	7.2	3.5	3	6.8	-2.4	-1.9	3.8	2.6	5	0.5
Non-agriculture	4.7	4.5	2	5.7	6.7	7.4	5.2	5.2	5.4	2.4	-2.4
Large Enterprises	2.1	4.6	2.8	6.7	8.2	7.4	5.6	5.4	6	2.9	-2.5
SMEs	4.6	4.3	1.7	4.5	5.5	7.6	4.9	5.5	4.9	1.9	-2.40[31]
SE	2.1	4.6	1.9	4.5	5	6.9	4.7	5.4	4.7	1.7	-1.9
ME	7.4	4.1	1.6	4.5	6.1	9.1	5.2	5.5	5.3	2.3	-3.4
Other Enterprises	4	4.6	2.8	5.1	5	3.2	3.9	0	2.2	-1.1	N/A
GDP	**4.4**	**4.8**	**2.2**	**5.3**	**7.1**	**6.3**	**4.6**	**5.2**	**4.9**	**2.5**	**-2.3**

Sources: OSMEP (2001-2009) and Sahakijpicharn (2007)

Table 2.11 presents the GDP of SMEs classified by economic activity during the period 1999 to 2009. The GDP of the private services sector played the most important role in the country's economy, with an average value of about 31.55 percent of total SME output during 1999 to 2009. The second sector was that of the

[31] In 2009, the real output growth rate of SMEs was badly affected by the global financial and economic crisis in 2008.

trade and maintenance sectors, which accounted for approximately 31.46 percent of overall SME GDP. The third ranked sector was the manufacturing sector which accounted for about 28.68 percent of total SME GDP. The construction sector was fourth with around THB 161,662 million, representing 6.19 percent of total SME GDP. The mining sector had approximately 1.87 percent of total SME output. Finally, the electric, gas and water supply sectors had about 0.6 percent of overall SME GDP in 1999-2009.

By 2009 private services contributed the highest SME GDP, accounting for 32 percent of total SME GDP. The second highest sector was that of manufacturing, contributing 30.40 percent of overall SME GDP. The third ranked was the trade and maintenance sectors with 29.9 percent of total SME GDP. The construction and mining sectors accounted for 5.9 percent and 1.6 percent of total SME GDP, respectively. Finally, the electric, gas and water supply sectors recorded 0.3 percent of overall SME GDP in 2009 (see Table 2.11).

From Table 2.11 the average real output growth of SMEs at constant prices was around 4.12 percent during 1999 to 2004. In 2005, the SME GDP growth rate decreased to 4.9 percent compared to 7.6 percent in 2004. The reduced growth rate was influenced by the Tsunami disaster in 2004, an increase in the oil price, and by political uncertainty and violence in the south of Thailand (OSMEP, 2005; Sahakijpicharn, 2007). Average real output growth of SMEs was 4.3 percent during the period 2005-2008. During this period, the highest SME growth rate was found in the manufacturing sector, with an average annual growth rate of 5.3 percent over the period 2005-2008. The second highest average annual growth rate was in the electric, gas and water supply sectors, representing 4.85 percent during the period 2005-2008.

The SME growth rate in the mining sector ranked third, with a 4.75 percent average annual growth rate over the period 2005-2008. The fourth ranked was in private services, which achieved an average annual growth rate of 3.95 percent over the period 2005-2008. The average annual growth rate of SMEs in the trade and maintenance, and construction sectors were 3.92 and 1.73 percent, respectively over the period 2005-2008. In 2009[32] the real SME GDP growth rate was negative in the manufacturing, trade and maintenance sectors (see Table 2.11).

---

[32] The OSMEP did not provide all information on the real GDP growth rate of SMEs by economic activities in 2009.

Table 2.11: GDP of SMEs in Aggregate and Classified by Economic Activity, 1999-2009

Items	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
GDP of SMEs by Economic Activities at Current Price (Thai Million Baht)											
SMEs	1,811,905	1,946,224	2,020,128	2,115,316	2,263,574	2,598,657	2,816,641	3,041,895	3,236,634	3,446,589	3,417,861
Mining	44,389	57,263	61,928	66,960	26,921	31,636	40,159	46,545	49,902	57,073	54,686
Manufacturing	412,995	469,673	495,964	534,534	682,640	755,130	830,247	921,924	992,617	1,101,480	1,039,030
Construction	122,142	110,431	113,093	120,835	146,830	164,043	184,051	197,448	205,471	212,283	201,654
Trade and Maintenance	676,642	717,509	725,271	734,680	722,551	783,347	841,407	889,518	937,861	981,979	1,021,940
Private Services	534,038	561,848	590,345	623,117	781,905	857,892	913,893	975,561	1,043,155	1,085,581	1,093,715
Electric, Gas and Water Supply	21,699	29,520	33,527	35,190	6,262	6,610	6,882	7,900	7,628	8,190	10,254
Share of GDP SMEs by Economic Activities at Current Price (Percentage)											
SMEs	39.1	39.5	39.4	38.8	38.1	40	39.6	38.9	38.2	37.9	37.76
Mining	2.5	2.9	3.1	3.2	1.1	1.2	1.4	1.5	1.5	1.7	1.6
Manufacturing	22.8	24.1	24.6	25.3	28.8	29.1	29.5	30.3	30.7	32	30.4
Construction	6.7	5.7	5.6	5.7	6.2	6.3	6.5	6.5	6.3	6.2	5.9
Trade and Maintenance	37.3	36.9	35.8	34.6	30.5	30.1	29.9	29.2	29	28.5	29.9
Private Services	29.5	28.9	29.2	29.5	33	33	32.4	32.2	32.2	31.5	32
Electric, Gas and Water Supply	1.2	1.5	1.7	1.7	0.3	0.3	0.2	0.3	0.2	0.2	0.3
GDP Growth Rate of SMEs at Constant Price (Percentage)											
SMEs	4.6	4.3	1.7	4.5	5.5	7.6	4.9	5.5	4.9	1.9	-2.4
Mining	1	1.2	1.2	1.2	-4.6	9.5	9	4.2	3.5	2.3	N/A
Manufacturing	8.9	9.5	9.7	10.2	11.3	10.1	5.2	5.9	6.2	3.9	-5.1
Construction	2.6	2.2	2.2	2.2	0.8	5.5	5.7	4.3	1.6	-4.7	N/A
Trade and Maintenance	14.6	14.6	14.1	13.5	1.7	4.5	4.4	3.9	5.5	1.9	-2.1
Private Services	11.5	11.4	4.4	4.1	2.3	8.3	4.7	6.5	3.7	0.9	N/A
Electric, Gas and Water Supply	0.5	0.6	0.7	0.7	0.4	1.7	5.3	4.8	5	4.3	N/A

Sources: OSMEP (2001-2009)

2.4.5 The Role of Small and Medium sized Enterprises in Exporting, 2000-2009

Table 2.12 presents the value and percentage of exports classified by size of enterprise during the period 2000 to 2009. The average value of exports by LEs was 66.98 percent of overall exports over the period 2000 to 2009, while the average value of exports by SMEs was 33.02 percent of total exports. In 2000, the value of exports by LEs was 61.52 percent of total exports, while the export value of SMEs totalled 38.48 percent of overall exports by value. The contribution by value of SMEs remained steady until 2002, thereafter experiencing a sharp increase due to high demand for manufactured products from Japan, USA and ASEAN, particularly for plastic products, electronic products, computer parts, vehicle and automotive parts (Dhanani and Scholtès, 2002; OSMEP, 2003). After 2002, the change in the export value of SMEs may also have been caused by Thailand's free trade agreements with ASEAN, ASEAN-China FTA, ASEAN-India FTA, ASEAN-South Korea FTA, ASEAN-Australia-New Zealand FTA, Thailand-Australia FTA, Thailand-Peru FTA and Thailand-South Korea FTA, which all came into effect after 2002[33] (Chirathivat, 2007; Sally, 2007).

In 2003, the export value of SMEs accounted for 45.52 percent of total exports (see Table 2.12). The ASEAN market was the most important export market for Thai SMEs. Table 2.13 indicates that the total value of exports by SMEs to ASEAN was about 20.79 percent of the total export value of SMEs in 2003. A possible explanation for this is the ASEAN Free Trade Agreement (AFTA), which came into force in 1992. According to Sally (2007), Thailand has been the most active member of ASEAN in seeking bilateral free trade agreements and closer economic integration in ASEAN and the region more generally since the Asian financial and economic crisis (Chirathivat, 2007; Sally, 2007). Thailand[34] benefited from the Common Effective Preferential Tariff (CEPT) scheme (ASEAN Secretariat, 2002). Some 95.55 percent of products in ASEAN have tariff rates of between zero to five percent regarding the Common Effective Preferential Tariff (CEPT) Inclusion List (IL), while 99.71 percent of products of the original six members (Brunei Darussalam, Indonesia, Malaysia, the Philippines, Singapore and Thailand) have a 0 - 5 percent tariff range (ASEAN Secretariat, 2009).

By 2009, the value of exports by SMEs was 30.56[35] percent of total exports (see Table 2.12). Table 2.13 shows that the major export markets for Thai SMEs in this year were ASEAN, the EU, Japan, USA, Hong Kong, China, Switzerland and Australia, respectively. The largest export market for Thai SMEs was still ASEAN, which accounted for 22 percent of the total export value of SMEs in 2009. The EU market was now the second largest export market, representing 14.50 percent of overall SME export value. The third ranked was the Japanese market, which

---

[33] Thailand has been very active in establishing bilateral FTAs, and regional trade agreements in the Asia-Pacific region. Establishing bilateral FTAs has become the major trade policy priority in Thailand (Chirathivat, 2007; Sally, 2007).

[34] Six members of ASEAN (Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore, and Thailand) agreed to reduce tariff rates for imported goods on the inclusion list (IL) from member countries to zero to five percent by 2003 (by 2006 for Vietnam; by 2008 for Laos and Myanmar; and by 2010 for Cambodia), and a zero tariff rate was expected to be applied by 2010 (by 2015 for all new members) (ASEAN Secretariat, 2002, 2009).

[35] The percentage share of SME exports by value in total exports declined sharply in 2009, because of a strong Thai baht and a lack of international competitiveness (OSMEP, 2009).

amounted to 9.71 percent of the total export value of SMEs. The USA[36] market ranked fourth, representing 9.25 percent of total SME export value. The fifth ranked was the Hong Kong market, which accounted for 9.01 percent of overall SME export value. The value of exports to the Chinese market for Thai SMEs was 8.41 percent of the total export value of SMEs in 2009, representing an increase from 2008. ASEAN signed an Agreement on Trade in Goods (TIG) under the Framework Agreement on Comprehensive Economic Cooperation[37] with China in November 2004 (OSMEP, 2009; The Association of Southeast Asian Nations (ASEAN), 2011), providing impetus for this growth in trade with China.

The export value of the Swiss and Australian markets for Thai SMEs were 5.7 percent and 4.89 percent of the total export value of SMEs, respectively, in 2009. Finally, the remaining 1.48 percent of total SME export value was not specified by country in 2009 (see Table 2.13). From Figure 2.6 it can be observed that the trend in SME exports indicates only a gradual increase during the period 2000-2009. The possible reason for this is that Thai SMEs face specific barriers or proactive problems relative to large enterprises, experience inefficiencies, poor quality products and a lack of competitiveness. This could be due to non-tariff barriers to trade (e.g. logistics, labelling, warehousing etc.). This problem is a typical problem faced by SMEs in other countries. Consequently, this study is of particular importance as it will shed light on the source of these inefficiencies.

Table 2.12: Value and Percentage of Exports Classified by Size of Enterprise, 2000-2009

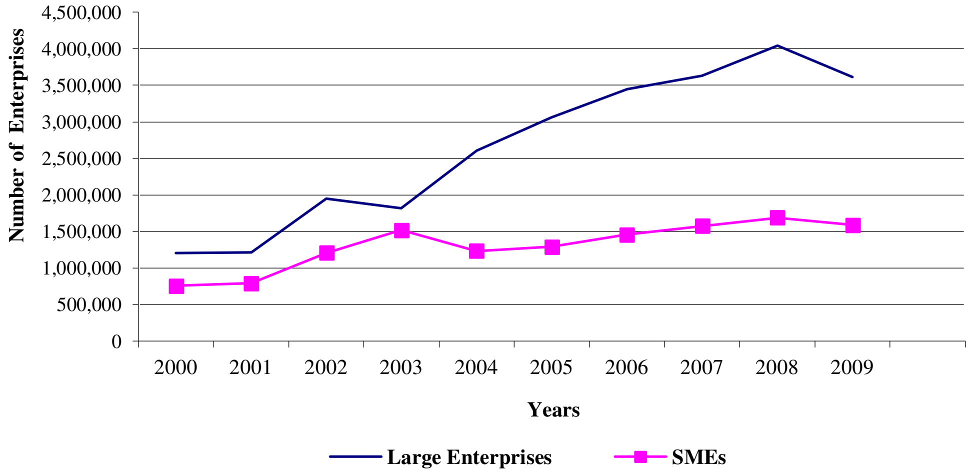
Enterprises	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Exports (Thai Million Baht)										
Large Enterprises	1,208,000	1,217,000	1,954,000	1,816,000	2,611,085	3,060,290	3,448,181	3,634,414	4,042,799	3,610,713
SMEs	755,500	793,760	1,209,303	1,516,971	1,235,139	1,291,858	1,456,083	1,575,971	1,691,145	1,589,200
Total	**1,963,500**	**2,010,760**	**3,163,303**	**3,332,971**	**3,846,224**	**4,352,148**	**4,904,264**	**5,210,385**	**5,733,944**	**5,199,912**
Percentage of Exports (%)										
Large Enterprises	61.52	60.52	61.77	54.48	67.89	70.32	70.30	69.75	70.50	69.44
SMEs	38.48	39.48	38.23	45.52	32.11	29.68	29.70	30.24	29.50	30.56
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Sources: OSMEP (2001-2009)

36 A bilateral Free Trade Agreement (FTA) between Thailand and the US has been postponed since 2006, due to Thai political unrest (OSMEP, 2008).

37 The economic benefits to Thailand of the ASEAN-China FTA are that Thailand and China enforced a bilateral tax reduction for agricultural products, such as vegetables, fruits tobacco, coffee, live animals and animal products in October 2004 under the ASEAN-China early harvest program.

Figure 2.6: Trends in SME Exports, Classified by Size, 1994-2009



Sources: OSMEP (2001-2009)

Table 2.13: Value and Percent of SME Exports Classified by Countries, 2003-2009

Countries	2003	2005	2006	2007	2008	2009
SME Exports (Thai Million Baht)						
ASEAN	315,442	269,944	302,959	363,706	361,032	349,624
EU	44,498	186,648	201,368	222,422	228,434	230,434
USA	205,028	220,585	221,130	188,927	181,435	147,001
Japan	281,986	151,576	159,231	160,766	181,798	154,311
China	89,363	102,736	138,921	120,688	113,976	133,652
Hong Kong	90,573	64,801	66,612	98,672	124,565	143,982
Middle East	N/A	72,367	88,509	97,359	103,464	N/A
Australia	17,668	29,143	47,978	48,842	68,222	77,712
South Asia	N/A	35,761	39,824	45,550	48,432	N/A
Switzerland	N/A	12,234	15,368	26,631	46,230	90,584
Republic of Korea	13,755	23,235	23,516	26,120	39,916	N/A
Taiwan	N/A	26,803	26,419	29,609	30,779	N/A
South Africa	N/A	10,621	11,492	12,665	15,674	N/A
Canada	N/A	14,727	15,697	15,722	15,521	N/A
Unspecified Countries	458,658	70,676	97,058	118,294	131,669	261,900
Total	**1,516,971**	**1,291,858**	**1,456,083**	**1,575,971**	**1,691,145**	**1,589,200**
Percentage of Total SME Exports (%)						
ASEAN	20.79	20.90	20.81	23.08	21.35	22.00
EU	2.93	14.45	13.83	14.11	13.51	14.50
USA	13.52	17.08	15.19	11.99	10.73	9.25
Japan	18.59	11.73	10.94	10.20	10.75	9.71
China	5.89	7.95	9.54	7.66	6.74	8.41
Hong Kong	5.97	5.02	4.57	6.26	7.37	9.06
Middle East	N/A	5.60	6.08	6.18	6.12	N/A
Australia	1.16	2.26	3.30	3.10	4.03	4.89
South Asia	N/A	2.77	2.73	2.89	2.86	N/A
Switzerland	N/A	0.95	1.06	1.69	2.73	5.70
Republic of Korea	0.91	1.80	1.62	1.66	2.36	N/A
Taiwan	N/A	2.07	1.81	1.88	1.82	N/A
South Africa	N/A	0.82	0.79	0.80	0.93	N/A
Canada	N/A	1.14	1.08	1.00	0.92	N/A
Unspecified Countries	30.24	5.47	6.67	7.51	7.79	16.48
Total	**100**	**100**	**100**	**100**	**100**	**100**

Sources: OSMEP (2003-2009)

2.4.6 Investment Promotion for SMEs

Table 2.14 displays the number of projects and the investment value for SMEs receiving investment promotion from the Office of the Board of Investment of Thailand (BOI) during the period 2002 to 2006. According to the BOI's announcement No.6/2002: policies and criteria for SME investment promotion of Thailand, the Office of BOI established policies to promote Thai SMEs consistent with the government's SME development strategy (OSMEP, 2003; Organisation for Small & Medium Enterprises and Regional Innovation Japan (OSMRJ), 2008; Punyasavatsut, 2010). In 2002, the Office of the BOI granted investment promotion projects[38] to 573 SMEs with a total investment value of THB 91,582 million. Medium-sized enterprises received 264 investment promotion projects from the BOI, the total value of which was THB 66,640 million, or 72.76 percent of total investment value, while small enterprises obtained 309 investment promotion projects worth THB 24,942 million, or 27.23 percent of total investment value. In 2006, the BOI approved 582 investment projects[39] for SMEs, amounting to THB 30,319 million. Small enterprises received 442 investment projects with a total investment value of THB 18,885 million, representing 62.65 percent of total investment value. Large enterprises acquired 139 investment projects, worth THB 11,294 million or 37.48 percent of overall investment value. The total amount of approved projects by SMEs decreased in 2006, a decrease of THB 61,443 million compared to 2002.

[38] The criteria for the allocation of these investment funds are as follows: (1) registered capital SMEs should hold at least 51 percent in the Thai capital stock, (2) SMEs should be approved as the manufacturer of product of the "One Tambon One Product" (OTOP) project and should be the manufacturer that meets the criteria for the community product manufacturing, and (3) SMEs should obtain the agreement from the SME Promotion Expert Committee.

[39] Investment project incentives include the enhancement of tax and duty privileges and relaxation of government regulations (OSMEP, 2003; OSMRJ, 2008).

Table 2.14: Number of Projects and Investment Value: SMEs Receiving Investment Promotion from the Office of the BOI, 2002-2006

Items	2002	2003	2004	2005	2006
Number of Projects					
Small Enterprises	309	353	429	493	442
Medium Enterprises	264	322	167	135	139
Total SMEs	**573**	**675**	**596**	**628**	**582**
Investment Value (Thai Million Baht)					
Small Enterprises	24,942	36,444	26,669	25,361	18,885
Medium Enterprises	66,640	117,943	16,522	12,863	11,294
Total SMEs	**91,582**	**154,387**	**43,191**	**38,224**	**30,139**
Percentage of Investment Value					
Small Enterprises	27.23	23.60	61.74	66.34	62.65
Medium Enterprises	72.76	76.39	38.50	33.65	37.48
Total SMEs	**100**	**100**	**100**	**100**	**100**

Sources: OSMEP (2001-2006)

2.4.7 Key Barriers to Growth and Development

While SMEs represent a major component of the Thai economy in terms of employment, business establishments and GDP, they face a number of severe problems that act as a barrier to their further growth and development. These include: a lack of management and/or administration skills; limited marketing skills; lack of technology and related skills; inadequate skilled labour; limited access to information and promotion from Thai government agencies; and difficulty in gaining access to government funding and finance from lending institutions (Sarapaivanich, 2003; Punyasavatsut, 2007). In addition, SME failures can arise from a lack of experience, insufficient capital invested by the owner, an over-reliance on external funds and poor record-keeping (Brooks *et al.*, 1990). According to Gregory, Harvie and Lee (2002), SMEs have to build their capacity through strengthening and improving their cooperation and integration with both domestic and overseas enterprises, participate in production networks and become embedded in knowledge networks, with the aim of maintaining competitiveness worldwide and enhancing their knowledge and technology. A number of these barriers are now discussed in more detail.

2.4.7.1 Finance

There is considerable evidence to support the contention that SMEs face many barriers in accessing finance, mainly related to their limited resources, opaqueness in business operation and perceived risk by lenders (Oum *et al.*, 2011, p42). Harvie (2011, p18) also emphasises that access to finance is the most critical factor influencing the competitive readiness of SMEs. This in turn determines their ability to fully exploit and participate in the global market, take advantage of business opportunities stemming from regional economic integration, and participate in regional production networks (Tranh *et al.*, 2009; Oum *et al.*, 2011).

In the context of Thailand, a large number of SMEs face difficulties in accessing formal sources of funding due to limitations related to their characteristics such as small size, lack of fixed assets, a lack of systematic accounting and lack of a business plan (OSMEP, 2007a; OSMRJ, 2008; OSMEP, 2009). A lack of access to capital causes them to encounter high financial costs and high failure rates (OSMEP, 2003; Sarapaivanich, 2003). They have also been unable to obtain capital through the Thai stock market and raise funds from banks and financial institutions (OSMEP, 2003; Theingi, 2004) (Theingi, 2004). This lack of interaction with financial markets and institutions has caused several problems for SMEs. For example, a lack of efficiency, usage of out dated technology, poor innovation, inadequate funds for investment and a lack of integration into domestic and international value adding production networks (Brimble *et al.*, 2002; OECD, 2005; OSMRJ, 2008).

2.4.7.2 Marketing

The role of marketing is one of the most important factors that can influence SMEs' success and prosperity (Simpson and Taylor, 2002; Rose *et al.*, 2006). Thai SMEs primarily remain in the domestic market because of intense competition in worldwide markets, their involvement in primarily low-skill low-value-adding activities, as well as from the existence of tariff and non-tariff barriers in overseas markets. These factors add disproportionately to their costs. Most SMEs are not well-prepared for both domestic and international markets. The major reason for this is that they lack knowledge and know-how as to how to increase the value-added content of their products; distribution channels; and market penetration. As a result, the marketing efforts of SMEs are frequently not fully competitive in both domestic and international markets. In the domestic market, Thai SMEs face intense competition from large enterprises and from imported products, such as from the modern trade discount and convenience stores (OSMEP, 2007b; Punyasavatsut, 2010; OECD, 2011).

2.4.7.3 Exports

Thai SMEs have internal barriers that impede their export performance, such as a lack of managerial export experience and weak planning systems. SMEs lack export knowledge and have poor networking that leads to difficulties in finding new international markets (Chirasirimongkol and Chutimaskul, 2005). SMEs utilise less formal market research on international market opportunities. Thai SMEs confront greater challenges in international markets than large-sized enterprises, because they have to compete with several big companies' products and they lack access to market information (OSMEP, 2004; Theingi, 2004). The changing marketing environment has increased competition in both domestic and international markets, requiring Thai SMEs to improve their performance in order for them to survive in the global marketplace (OSMEP, 2003). With respect to product quality and technological advances, Thai SMEs are unable to compete with SMEs in other countries such as Italy, Japan, Taiwan due to being heavily involved in labour-intensive, low-skill, low-value-adding activities using out of date technology (OSMEP, 2007a; OSMEP, 2007b; Tambunan, 2008).

2.4.7.4 Information Technology (IT)

Thai SMEs also lack the ability to access and utilise information technology and to adopt e-commerce. Most SMEs still utilise a traditional style of business operation, rather than use IT. The majority of SME entrepreneurs and employees have low education and skills, and lack the understanding of how to utilise IT effectively in their business (Lertwongsatien and Wongpinunwatana, 2003). Hence, application of IT to SMEs is difficult and beyond their capacity to utilise efficiently, despite Thai government agencies having provided technological support to assist SMEs, such as with the Software Park project in 1997. As a consequence, only a small number of

SMEs received any benefit from this project, because Thai government agencies provided insufficient information about the IT project. Many were not aware of the benefits from IT services provided by government agencies (OSMEP, 2009; Tippakoon, 2009). In contrast, large enterprises have continued to develop and enhance their utilisation of information technology. They have applied IT to their administration and production process. For instance, the management of their supply chains, commodity inventories and e-commerce systems. The benefit of IT to large enterprises is to simplify their process of work, save production costs, and expand customer reach.

2.4.7.5 Innovation

Innovation[40] is related to creative thinking, improvement and innovative usage of technology to increase the economic value of products and services (Cooke, 2001). Innovation is also important in the knowledge or so-called "new economy". According to Intarakamnerd *et al*. (2002), the innovation system in Thailand is not well-organised in many areas, such as in the macro-environment, innovation infrastructure, R&D and technology capabilities. Innovation was not explicitly emphasised in the Thai National Economic and Social Plan. Thus, SMEs in Thailand pay insufficient attention to innovation. This is as a consequence of the low level of education of employees in the SME sector that contributes to a lack of creative activity. In addition, the educational system itself is one of the problems, because in Thailand emphasis is placed on rote learning or memorising in class and not learning through creative thinking. Baker and Rudd (2001) emphasises that creative thinking is the process of creating something new or a new idea.

Varatorn (2005) points out that brainstorming is one kind of creative thinking in schools. Teaching students to think creatively must therefore be the priority of schools today (Baker and Rudd, 2001). The absence of appropriate innovation among Thai SME entrepreneurs is a critical issue that leads to low product quality and production, and is an issue that needs to be addressed by the Thai government (Brimble et al., 2002; OSMEP, 2003). In terms of technology and quality control, SMEs are producing goods below export-quality standards, such as ISO, making it

[40] Innovation usually involves product, process and organisational innovations. SMEs usually focus on product innovations as these are less resource-intensive.

difficult for them to participate in the supply chains of multinational companies and international markets more generally (Brimble et al., 2002). Although the Thai government established an innovation development fund in 2000 in order to support entrepreneurs and employees, to date this fund has not been successful in terms of patents, product designs, trademarks, certification mark and local Thai wisdom (culture, art and knowledge in the community) (OSMEP, 2003).

2.4.7.6 Human Resource Development

Human resources are a vital issue for SME development, particularly in the knowledge- and skill-intensive "new economy" today. The government of Thailand has supported the educational system by allocating a large amount of funds through successive budgets. However, the average education of Thai workers is low and almost 70 percent of the workforce in SMEs has only primary education or lower. The labour force in SMEs consists of largely unskilled labour. These workers have limitations and difficulties in learning and training, and knowledge acquisition and application. That part of the labour force which is more highly educated, such as at the secondary school or diploma levels, have a greater ability to learn and understand compared to workers who only have a primary education (OSMEP, 2001; OSMEP, 2007b). Entrepreneurship skill is another problem facing Thai SMEs. The traditional style of running a business may be productive for the domestic market, but it may not be effective for the international market (Mephokee, 2003). Furthermore, most Thai SMEs are family businesses, and informal, which limits their business and market expansion. They have limited capabilities in raising and managing finance, conducting market research, business administration, and analysis of domestic and international markets (Theingi, 2004).

2.4.7.7 Government Regulation

Another reason for the weakness of SMEs relates to the Thai government. The government has, until quite recently, not paid much attention to SMEs. Government agencies are not well-prepared to play an effective role in assisting SMEs (Mephokee, 2003; Sahakijpicharn, 2007; OSMEP, 2007a). For example, the government should play the major role in providing necessary information for the

SME sector. It should also encourage networking between SMEs for their mutual benefit and should launch necessary measures to protect SMEs from unfair competition and international trade barriers (OSMEP, 2003). Corruption in Thai government agencies and in corporate governance is the main reason for the lack of effectiveness of support. SMEs face various problems from the Thai government such as the lack of transparency of government agencies, an inadequate legal and regulatory framework, inconsistent SME promotion plans and confusion in the structure of government agencies and their support (Sahakijpicharn, 2007; OSMEP, 2007b).

2.4.8 Government Policies to Support SMEs

The basic law and first SME Promotion Act were declared in 2000. The first SME promotion plan from 2002 to 2006 provided a strategic direction for developing SMEs. The objective of the plan was to develop more entrepreneurs and facilitate SMEs in meeting international quality standards. This plan aimed to improve the efficiency and capacity of SME operators with the objective of enhancing their international competitiveness (Mephokee, 2003; OSMEP, 2003; Punyasavatsut, 2007).

The targets of the first SME promotion plan were as follows (OSMEP, 2003): (1) expanding the growth of SMEs with the aim of increasing their contribution to GDP by 50 percent in 2006, (2) increasing employment by SMEs at an average of 180,000 people annually, (3) boosting the value of SME exports by 6 percent per year or approximately THB 436.5 billion by the end of 2006, (4) increasing the amount of new entrepreneurs by 50,000 per year, (5) enhancing and promoting target groups of SMEs, including those operating in food processing, fashion industries, automotive parts and electrical and electronic components, and (6) targeting groups for capability enhancement and promotion, such as enterprises with existing high potential (tourism, downstream businesses, design and construction), enterprises with good business track, and those in the professional services sectors (engineering, architecture, accounting and law) and the entertainment business.

Furthermore, the first SME promotion plan included the following seven strategies (Mephokee, 2003; OSMEP, 2003; Punyasavatsut, 2007): (1) managerial and technological upgrading, (2) human resource development, (3) expanding both domestic and international markets, (4) strengthening financial capabilities, (5) improving the business environment, (6) developing microenterprises and grassroots community businesses, and (7) establishing comprehensive linkages between enterprises and promoting the potential of community enterprises[41].

There were three major policies from the first SME Promotion Act: (1) investment promotion, (2) financial assistance, and (3) technical and management consultation. Investment promotion for SMEs is in association with the Board of Investment (BOI) of Thailand.

In 2006 the BOI approved 582 SME investment projects with a total value of THB 30,139 million (OSMEP, 2007a). Arising from this policy of financial assistance towards SMEs, the Small and Medium Enterprises Development Bank of Thailand (SME Bank) was established in 2002, aimed at assisting SMEs to secure funding, to prepare business plans and to provide guidance on business operations (OSMEP, 2003; Punyasavatsut, 2007). In addition, the SME Bank provided business counselling and training programs to resolve various problems and facilitate further development of SMEs. In 2003, the government provided THB 5 billion of venture capital funds for SMEs in order to establish joint ventures through SME projects (Mephokee, 2003; OSMEP, 2004).

Table 2.15 presents the results of the first SME promotion plan for 2002 - 2006. The goals of this plan were not fully realised, because the SME promotion plan was not implemented in unity and lacked a powerful driving force from the policy level to the operational level. There were also limitations in terms of the budget, knowledge, expertise of government agencies and insufficient government assistance both qualitatively and quantitatively. As a result, Thai SMEs lacked marketing capabilities, lacked consumer and environmental accountability, possessed low skilled labour and poor management, and lacked good governance (OSMEP, 2007b). The SME plan was not successful as confirmed by the empirical results in chapter 6, suggested that technical efficiency of SMEs declined in 2007. It will be essential for SME policy makers to focus on this problem if a major improvement in technical efficiency is to be achieved.

[41] Community enterprises are different from cooperatives in Thailand.

Table 2.15: Results of the First SME Promotion Plan for 2002-2006

Targets of the plan	Results	Problems and Limitations from the government point of view
1. GDP share of SMEs to reach 50% in 2006	• 38.9% per year on average	• The GDP of SMEs in the manufacturing and service sectors increased gradually, while the trade sector decreased.
2. Increasing employment by SMEs at an average of 180,000 people annually	• Employment increased by about 354,533 workers per year during 2000-2006.	• SMEs are labour intensive enterprises. • Inadequate skilled labour. • Job opportunities and working environment were insufficient for SMEs.
3. Boosting the value of SME exports by 6% per year	• 9% per year	• Most SME exports were in primary and labour intensive products. • Lack of product differentiation. • Weak marketing infrastructure.
4. Increasing new entrepreneurs by 50,000 per year	• 44,551 entrepreneurs per year	• New SMEs required government support due to market failures and policy biases.
5. Enhancing and promoting target groups of SMEs, such as enterprises with existing high potential and good record. Increasing groups[42] of SMEs by 10% per year and to reach 6,300 groups in 2006	1,602 groups per year	• SMEs needed to focus upon knowledge and quality. • SMEs required a strong integration of business networking.

Sources: OSMEP (2007b)

The second SME promotion plan for 2007 to 2011 was formulated by the OSMEP, and is employed as the second master plan for SMEs aimed at providing further guidelines for SME development and an indicative plan (OSMEP, 2007a; OSMEP, 2007b). This promotion has a vision to facilitate SMEs to develop their business with continuity, strength, and sustainability in the key areas of skill and knowledge. The objective and key performance indicators (KPI) of this plan are the following: (1) increasing the value of SMEs' contribution to GDP continuously to reach 42 percent of total GDP by 2011, (2) ensuring that SME output growth should be not less than the growth rate of their total exports, and (3) expanding the total factor productivity of SMEs to be not less than 3 percent per year, while increasing

[42] SMEs that have a 3-5 five star OTOP rating.

total factor productivity of targeted sectors and labour productivity of all SMEs at not less than 5 percent per annum.

The SME promotion plan for the period 2007 to 2011 consisted of six strategies and associated objectives (OSMEP, 2007a; OSMEP, 2007b):

(1) Strategy on creating and developing entrepreneurs

This strategy aimed at creating a conducive environment to increase the number of new entrepreneurs and support entrepreneurs to enhance their performance, as well as create business value in order to compete in niche markets. The objectives of this strategy are: to create entrepreneurial enthusiasm, spirit, and good governance; to inspire and encourage people into entrepreneurship; to enhance technology and innovation capability; to build business opportunities; to provide knowledge of marketing; and to improve the quality and competency of SME employees.

(2) Strategy on increasing the productivity of SMEs and enhancing innovation competency in the manufacturing sector

This strategy aimed at increasing value added, product differentiation, and the competitiveness of SMEs, particularly in industrial products. It also aimed at reforming the structure of production of SMEs from being original equipment manufacturers (OEM) to being original design manufacturers (ODM), and eventually being original brand manufacturers (OBM). The objectives are to support business alliances and SME clusters, to promote technological infrastructure, to enhance quality standards and the capability of SMEs to meet market demands.

(3) Strategy on increasing efficiency of the trade sector

This strategy aimed at increasing business efficiency corresponding to trends in modern consumer behaviour, and decreasing the undesirable impact from high competition with modern mega-sized trading businesses and changing business environment. The objectives of this strategy are: to strengthen the competitiveness of SMEs in the wholesale and retail sectors by promoting the utilisation of information and communication technology (ICT) to enhance business efficiency; to support and improve administration and the regulatory systems of the wholesale and retail sectors to ensure fair trade competition.

(4) Strategy of creating higher value added in the services sector

This strategy aimed to promote knowledge, the Thai culture, Thai wisdom, technology, and information technology among SMEs in the service sector, in order to create increased value added and to support linkages between SME service providers and large enterprises. The key objectives are: to develop human resources in the services sector; to support networks of supply chains and clusters of high potential service subsectors; to encourage implementation of the plan to enhance the efficiency, productivity and quality standard of service products.

(5) Strategy on promoting SMEs in the regions and localities

This strategy intended to support the creation of networks and connections involving SMEs in the regions of Thailand and to employ technology to develop their capability and business management is seen as important. Family networks can be leveraged by regional SMEs and community enterprises in order to enhance the value and quality of products and services (Sevilla and Soonthornthada, 2000; Tapaneeyangkul, 2001). The objectives of this strategy are: to promote clusters and value-adding chains involving local SMEs; to support the development of infrastructure in order to provide services to SMEs; to promote the local community and local products; and to build networks of SMEs in the regions by encouraging cooperation among regional SMEs.

(6) Strategy of enabling factors conducive to business operation

This strategy is focussed on developing the environment, infrastructure and facilities conducive to enhancing the business operation of SMEs in order to enhance their productivity and competitiveness and furthermore to promote SMEs to adjust into a strong knowledge-based business operation. The objectives of this are: to promote the use of technology and innovation in SMEs; to improve the knowledge and skills of SME personnel; to provide and develop information management and database management systems for SMEs; to support SMEs in financial matters to avoid management risks and financial problems; and to promote efficiency in logistics management and in marketing facilities.

Table 2.16: Summary of the Second SME Promotion Plan[43] for 2007-2011

The strategies of the plan	Direction	The objectives of the strategies
1. Strategy on creating and developing entrepreneurs	• Creating a conducive environment to increase the number of new entrepreneurs • Create business value in order to compete in niche markets	• To create entrepreneurial enthusiasm, spirit, and good governance • To enhance technology and innovation capability
2. Strategy on increasing productivity of SMEs and enhancing innovation competency in the manufacturing sector	• Increasing value added, differentiation, and competitiveness of SMEs, particularly in industrial products	• To support business alliances and SME clusters • To enhance quality standards and the capability of SMEs to meet market demands.
3. Strategy on increasing efficiency of the trade sector	• Increase business efficiency corresponding to trends in modern consumer behaviour	• Promoting the utilisation of information and communication technology (ICT) to enhance business efficiency
4. Strategy of creating higher value added in the services sector	• Promoting knowledge, the Thai culture, Thai wisdom, technology, and information technology among the service sector aimed at creating value added	• To develop human resources in the services sector • To support networks of supply chains and clusters of high potential service subsectors,
5. Strategy on promoting SMEs in the regions and localities	• Supporting the creation of networks and connections involving SMEs in the regions of Thailand • Employing technology to develop their capability and business management	• To promote clusters and value adding chains involving local SMEs • To promote the local community and local products, and to build networks of SMEs in the regions
6. Strategy of enabling factors conducive to business operation	• Developing the environment, infrastructure and facilities conducive to enhancing the business operation of SMEs in order to enhance their productivity	• To improve the knowledge and skills of SME personnel • Provide financial assistance to avoid management risks and financial problems, to promote efficiency in logistics management and in marketing facilities.

Sources: OSMEP (2007b)

[43] Most of these measures are consistent with the recommendations in chapter 7 of this thesis. That is, the results from the thesis confirm the need for many of these policies.

2.4.9 Government Agency Support

This section provides a review of the literature on Thai government agency support. It proceeds as follows: (1) Ministry of Industry and the Promotion of SMEs, (2) Department of Industrial Promotion (DIP), (3) Office of Small and Medium Enterprises Promotion (OSMEP), (4) Institute for Small and Medium Enterprises Development (ISMED), (5) SME Development Bank of Thailand (SME Bank), (6) Thailand Productivity Institute (FTPI), and (7) The Thai Industrial Standards Institute (TISI).

2.4.9.1 Ministry of Industry and the Promotion of SMEs

The Ministry of Industry is the crucial government agency that is directly involved with the development of Thai SMEs. The first law of Promotion of SMEs was proposed and declared by the Ministry of Industry in 2000 (Mephokee, 2003). The law comprises two main components, as follows:

(1) Establishment of the OSMEP, to be responsible to the Executive Board of OSMEP. This office is the coordination unit that facilitates major operational plans for SME promotion throughout all levels of Thai government agencies, state independent promotion units, and relevant private organisations. In addition, the OSMEP is responsible for the management and administration of the SME promotion funds.

(2) Provision of SME promotion funds to set up new SMEs and provision of loans for the improvement and expansion of existing SMEs, R&D projects, technical and financial consultation, seminars and workshops.

2.4.9.2 Department of Industrial Promotion (DIP)

The Department of Industrial Promotion (DIP) is a sub-department of the Ministry of Industry. The DIP plays the lead role in the promotion and development of SMEs and follows the guidelines of the Ministry of Industry and the National plan in elaborating its own policies to promote SMEs. The DIP has direct responsibility to encourage the establishment of all essential industries, to enhance the efficiency of industries, to promote regional industrialisation, to encourage the dispersal of urban industries to rural areas, to invest in SMEs, to establish industrial networks, to promote investment in the industrial sectors and to enhance the competitiveness of industries and SMEs (Yuwaboon, 2004). Furthermore, the mission of the DIP is to support the creation of industrial entrepreneurs and develop entrepreneurship, to encourage the competitiveness of industrial businesses, to create and improve industrial promotion, and to create and develop industrial business service provider networks (Department of Industrial Promotion of Thailand, 2009).

2.4.9.3 The OSMEP

The OSMEP was established under the Small and Medium Enterprises Promotion Act in 2000. OSMEP is a legal entity and a government organisation that operates as an independent agency, not as a public organisation. OSMEP is the central planning office that coordinates and facilitates the operational plans of all government agencies in promoting Thai SMEs (Yuwaboon, 2004). OSMEP has the responsibility to promote SMEs (Punyasavatsut, 2007), by such means as (1) formulating an SMEs promotion master plan and promotional policies, (2) organising the action plan for SME promotion, (3) serving as the SME information centre and central organisation for conducting research and studies on Thai SMEs, (4) developing information systems and networks to assist the operation of SMEs, and (5) administering venture capital (VC) funds for SMEs. In addition, OSMEP is a service centre for SMEs and provides various services such as counselling on financial sources, marketing and management. Furthermore, the top priority of OSMEP is to promote SMEs to the world market, such as participating and maintaining good relations with APEC, US Chamber of Commerce, ADB, and World Bank (OSMEP, 2002; Mephokee, 2003).

2.4.9.4 Institute for Small and Medium Enterprises Development (ISMED)

ISMED is a foundation controlled by the Ministry of Industry and Thammasat University. The aims of ISMED are to develop entrepreneurial SMEs, to create new entrepreneurs, and to develop human resource management in SMEs and to cooperate with several government organisations, (for instance the Department of Industrial Promotion, Thammasat University and local universities throughout the country) (Mephokee, 2003; Yuwaboon, 2004; Thassanabanjong *et al.*, 2009). ISMED is the crucial knowledge source that can support SMEs in various directions such as with training, consulting, research implementation and information servicing (Yuwaboon, 2004).

In addition, ISMED creates a training network for SMEs throughout the country, such as the SME development centre at Chiangmai University in the northern region, the research and training centre at Khon Kaen University in the North-eastern region, and the Faculty of Business Administration at Songkhlanakarin University in the southern region (Mephokee, 2003). Moreover, ISMED plays the most significant role in certifying people who are capable of business diagnosis and analysis (Yuwaboon, 2004; Thassanabanjong et al., 2009).

2.4.9.5 SME Development Bank of Thailand (SME Bank)

The SME Bank is the leading bank in providing quality services for the support and development of SMEs in the drive towards sustainable economic growth (The Small and Medium Enterprise Development Bank of Thailand, 2009). The aims of this bank are: to promote and assist SMEs in their establishment, operation and expansion; to improve their businesses through the provision of loans, guarantees, and venture capital; to support, reinforce and enhance SME competitiveness; to create financial services that are responsive to the needs of SMEs; to develop a network of strategic SME alliances with the public and private sectors; and to encourage new entrepreneurs.

From a business perspective, the SME bank aims to expand customers in all regions by emphasising business and strategic clusters. From a financial perspective, the SME bank is responsible for increasing income channels and expanding high return businesses. However, increasing business returns are usually associated with higher risk. The SME bank provides several financial services for SMEs, such as general credit, packing credit, joint venturing and letter of guarantee. The SME bank also contributes general loans with a minimum credit line of US$1,280 and maximum US$2.6 million, with a repayment period not greater than 15 years (Mephokee, 2003; The Small and Medium Enterprise Development Bank of Thailand, 2009).

2.4.9.6 Thailand Productivity Institute (FTPI)

The Thailand Productivity Institute was established in 1994, and is an independent organisation under the Ministry of Industry. FTPI acts as a representative of Thailand in the Asian Productivity Organisation (APO) and is responsible for coordinating between domestic and international productivity organisations. FTPI is responsible for offering suitable policies on productivity and is providing necessary techniques to improve productivity. FTPI also serves as a centre for up-to-date information and expertise on productivity, to assist Thailand become competitive in the global market (Thailand Productivity Institute, 2009). The mission of this institute is to use highly-skilled, knowledgeable, and experienced staff to promote increased productivity in all regions. The FTPI provides various services to all business sectors in order to enhance their productivity – for instance, training and consulting services in productivity management, measurement and analysis for productivity, production management, quality standard systems, productivity improvement, competitiveness clusters, human resource management, business management, and research implementation in fields focusing upon quality and productivity (Yuwaboon, 2004; Thailand Productivity Institute, 2009).

2.4.9.7 Thai Industrial Standards Institute (TISI)

The Thai Industrial Standards Institute (TISI) was established in 1969 as the national standards body of Thailand under the Ministry of Industry. The policies of this institute are to undertake national standardisation activities and community product standards with commitment to the promotion and development of Thai industry, to maximise benefits for entrepreneurs and consumers throughout the country. The TISI has the following objectives: (1) consumer protection, (2) environmental protection and natural resource preservation, (3) industrial development to be competitive in the global market place, and (4) ensuring fair trade and eliminating trade barriers caused by standardisation measures. The mission of the TISI includes such aims as: to increase national standards and monitor the quality of products and services to ensure conformity with requirements and international practices; to develop community product standards and provide a certification service, to support and develop national standardisation activities; to cooperate with international standardisation organisations at both the bilateral and multilateral levels; to provide information on standardisation; and to establish the national single network of standardisation (Thai Industrial Standards Institute, 2009).

For government agency support, it can be concluded that Thai SMEs generally experience poor assistance from government agencies. The SME promotion plan has been under government consideration since 2002. Government agencies are not well-equipped to be able to plan an effective role in an attempt to promote and improve the quality of SMEs both qualitatively and quantitatively (OSMEP, 2007a; OSMEP, 2007b). Government agencies are not well-integrated to support Thai SMEs in accordance with the SME promotion plan. The weak system of corporate governance and infamous corruption in Thai government agencies are the main factors which result in inefficient assistance from government agencies (Brimble et al., 2002; Sahakijpicharn, 2007). However, there are some further issues that need to be addressed. For instance, the Thai government should improve coordination at the national and sub-national levels, the procedure and structure of government agencies and should develop the qualifications of human resources in the public sector. It should also revise government transparency, and ensure an adequate legal and regulatory framework (Sahakijpicharn, 2007; OSMEP, 2008).

2.5 PUBLIC-PRIVATE SECTOR DEVELOPMENT PARTNERSHIP

The Thai government has provided a wide variety of promotion programs to support SMEs (Hallberg, 2000; Harvie and Lee, 2005b), but the results from the first SME promotion plan for 2002-2006 indicated that the development of SMEs has been less than satisfactory (OSMEP, 2007b). Hallberg (2000) suggests that an SME development strategy should focus more on a private sector development strategy, because government polices to support SMEs may be underprovided in distorted and segmented markets. The public sector plays an important role in sustaining an equitable pattern of economic, social and SME development (Asasen *et al.*, 2003). The government should provide policies concerning a durable collaboration between public and private sectors, such as the promotion of SME growth and integration, cross-border linkages and on-going learning and innovation. A public and private partnership program should apply to the provision of SME development services and is equally applicable in other contexts (Asasen et al., 2003; Hussain *et al.*, 2009).

Traditional SME promotion strategies rely heavily upon the direct and subsidised provision of financial and non-financial services to SMEs (Hallberg, 2000). It is recommended that the Thai government should play a crucial role in promoting market-completing interventions and the elimination of policy biases, and these include (Hallberg, 2000; Asasen et al., 2003; Harvie and Lee, 2005a; Hussain et al., 2009):

(1) The government should place more emphasis on bureaucratic fragmentation and conflict in the provision of SME support. It should target policies aimed at eliminating specific market failures, rationalising the number of government agencies that provide incentives and services for SME development.

(2) It should focus more on developing performance and impact indicators for promotion plans with budgetary allocations tied to these, and increase cost recovery for publicly provided or subsidised services.

(3) The government should give more emphasis to the provision of business development services that can help SMEs with training programs (development of a business plan) and network promotion, and privatise service providers when financially sustainable.

(4) The government should focus more on creating an enabling environment for fostering SME growth and focus upon developing markets for SME-relevant services rather than substituting for them.

(5) It should focus on developing business support services, implementing a competition policy that opens access to markets and creates a level playing field for SMEs and all firms in the domestic market.

(6) It should focus more upon enabling greater access by SMEs to government projects and reducing policy biases against all SMEs and tackling SME access to financial services.

(7) Government policies should place more focus on the encouragement of innovative information provision and encourage public and private partnerships at the local level to improve the business environment for SMEs, with continual monitoring and assessing of existing policy measures and enhancing the effectiveness of their delivery.

(8) It should expand the coverage and the impact of government programs by utilising the private sector to distribute services, and focus on scarce public resources in an attempt to facilitate market transactions and invest in public goods.

(9) The government should emphasise market failures that can create cost disadvantages for SMEs. Market failures obstruct SMEs from accessing markets and hinder the development of markets for various financial and non-financial services that are suitable for SMEs.

(10) It should improve transactional efficiency in financial, product and input markets by facilitating access to information and developing instruments to avoid management risks.

(11) The government should reconsider public policies and regulations that impede SMEs or produce fixed costs that create comparative disadvantages for SMEs such as compliance costs.

(12) It should improve public goods investment, including that in infrastructure, information, communications and transportation as well as education, information technology (IT) and innovation.

(13) The government should promote a partnership between government and private sectors in an attempt to foster SME growth.

2.6 SUMMARY

SMEs are recognised as the most significant enterprises for accelerating Thai economic development. They also play a significant role in encouraging income stability, economic growth, and employment generation (Regnier, 2000; Tapaneeyangkul, 2001; Brimble et al., 2002; Harvie, 2002b; Mephokee, 2003; Harvie and Lee, 2005a; Harvie, 2007; Sahakijpicharn, 2007; Harvie, 2008; OSMEP, 2009). SMEs also contribute to regional development, poverty alleviation and economic empowerment for minorities and women (Harvie, 2008). The contribution of SMEs to the Thai economy in terms of business numbers, employment, income and economic growth increased from 1994 to 2009. In addition, SMEs are key sources of supply of goods, services, information, and knowledge for large enterprises (Buranajarukorn, 2006; Sahakijpicharn, 2007). They play a pivotal role in the production of export goods (Tapaneeyangkul, 2001; Ha, 2006).

The Asian financial crisis in 1997 had a negative impact on the Thai domestic economy, resulting in an economic crisis exemplified by a high unemployment rate, a huge decline in real income, a significant reduction in domestic demand, private consumption and investment spending and severe contraction in economic growth in 1998 (World Bank, 1993; Nukul's Commission Report, 1998; Regnier, 2000; Phan, 2004; Menkhoff and Suwanaporn, 2007). The crisis had marked adverse effects on Thai SMEs. The most severe effects on SMEs were a huge decline in sales revenue and tighter liquidity. The most significant responses by SMEs were to cut costs, retrench staff, and enhance new product development and to seek out alternative markets (Regnier, 2000; OSMEP, 2001; Tapaneeyangkul, 2001).

In 2009, Thai SMEs accounted for more than 99 percent of total enterprises. The trade and repairs sectors had the largest number of enterprises, accounting for 47.36 percent of all SMEs. Second was the services sector, representing 33.68 percent of all SMEs. The manufacturing sector was third, contributing 18.89 percent of total SMEs. From a regional perspective, around 30 percent of SMEs were concentrated in Bangkok-and-vicinity areas during 1994 to 2008. In terms of national employment, SMEs contributed more than 74 percent of total employment in the private sector from 1994 to 2009. In 2009 the services, manufacturing, and trade and repairs sectors contributed 35.75, 34.23, and 30.02 percent of total employment. SMEs contributed around 37.80 percent of total GDP in 2009. SMEs are, therefore, the backbone of the Thai economy, and contribute greatly to the social and economic development of the country (Mephokee, 2003; Sahakijpicharn, 2007).

While SMEs represent the main element of Thailand's economy, they face a number of severe problems that act as key barriers to their further development. These include access to finance, marketing, export markets, information technology (IT), innovation, human resource development, management and/or administration skills, inadequate skilled labour, and bureaucratic government regulations (Brimble et al., 2002; Harvie and Lee, 2002; OSMEP, 2003). Thai SMEs face important disadvantages compared to large enterprises. For instance, a large number of SMEs confront difficulties in gaining access to government funding and lending institutions due to market failures and policy biases, and their limitation in size, opaqueness in business operation, lack of fixed assets, and lack of business plans (Sarapaivanich, 2003; Theingi, 2004; OSMEP, 2007a).

Moreover, most SMEs are owned and run by a family that employs a traditional style and technology in both production and management. Information technology (IT) usage and innovative activity are widely utilised as measures of competitiveness. However, only a small number of Thai SMEs use IT. As a consequence, Thai SMEs are unable to compete effectively with other SME competitors, particularly from China, Taiwan and Vietnam (Mephokee, 2003; OSMEP, 2007b).

The Thai government has attempted to solve this problem by establishing several agencies, organisations and policies to support SMEs, such as the first SME promotion plan from 2002 to 2006, the second SME promotion plan from 2007 to 2011, the Department of Industrial Promotion (DIP), the OSMEP, the Institute for Small and Medium Enterprises Development (ISMED), and the SME Development Bank of Thailand (SME Bank). However, the results have been disappointing, as will be confirmed in chapter 6.The majority of SMEs have not been able to achieve benefits from these agencies and policies in the way that they should. Furthermore, some policies are not suitable to the needs of SMEs (Mephokee, 2003; OSMEP, 2007b).

It is suggested that Government agencies should play a more effective role in assisting and promoting SMEs performance to enable them to be more competitive in the domestic and international market place. The Thai government should reconsider public policies and regulations that hinder SMEs and should give more emphasis to bureaucratic fragmentation and conflict in the provision of SME assistance (Hallberg, 2000; Harvie and Lee, 2005b). It should promote a partnership between government and the private sector in order to enhance SME growth (Hallberg, 2000; Hussain et al., 2009). The government should play an important role in promoting market-oriented SME interventions for improving SME development and the elimination of policy biases (Hallberg, 2000; Asasen et al., 2003; Harvie and Lee, 2005a; Hussain et al., 2009).

Having presented an overview of the Thai economy, the financial crisis in 1997, and the role and contribution of SMEs to the Thai economy in this chapter, this thesis has contributed to filling a gap in the existing literature. Finally, the following chapter will focus upon a literature review of the contribution of SMEs to an economy in general, including such factors as creating economic opportunities, engendering economic empowerment, generating employment, new business establishments and poverty alleviation. It will also explore and discuss the concepts of SME performance measures, efficiency measures and technical efficiency.

CHAPTER 3
SMES, THEIR ECONOMIC CONTRIBUTION, RESPONSE TO GLOBALISATION AND PERFORMANCE MEASUREMENT: A LITERATURE REVIEW

3.1 INTRODUCTION

This chapter further elaborates upon the important contribution and role of SMEs in an economy and in the process of globalisation, by drawing upon key contributions in the literature. It discusses the contribution of SMEs to economic growth in terms of creating jobs, acting as a seedbed for innovation and entrepreneurship, contributing to economic development and reducing poverty in developing countries. SMEs make a significant contribution to the economy through various perspectives, including economic opportunities, economic empowerment, employment, business establishments, entrepreneurship, sustainable local economic development and poverty alleviation (Hallberg, 2000; McMahon, 2001; Biggs, 2002; Kirby and Watson, 2003; Beck *et al.*, 2005; Harvie, 2007; Harvie and Lee, 2008; Audretsch *et al.*, 2009; Le, 2010).

They play an important role in creating a substantial proportion of employment and newly-generated jobs in both developed and developing economies (Hallberg, 2000; Biggs, 2002; Beck *et al.*, 2005; Harvie and Lee, 2005a; Le, 2010). SMEs are recognised as an important seedbed for innovation and entrepreneurship, and provide the foundation for the long-run growth of an economy and for the transition towards larger firms (Biggs, 2002; Luetkenhorst, 2005; Wang *et al.*, 2007; Audretsch *et al.*, 2009; Le, 2010). This chapter provides a review of the literature in regard to the size distribution of firms in an economy. The size distribution of firms can be determined by factors such as market size, consumption patterns, degree of market competition, resource endowments, technology, institutions, economies of scale, stage of economic development and transaction costs (Ace and Audretsch, 1990; Hallberg, 2000; McMahon, 2001; Biggs, 2002; Beck *et al.*, 2005; Harvie and Lee, 2008; Audretsch *et al.*, 2009; Yang and Chen, 2009; Le, 2010). This chapter also reviews the principle competitive strategies of SMEs in the era of globalisation. These include forming alliances, networking and clustering, subcontracting, participating in value chains and creating and participating in niche markets.

This chapter also presents the most common performance measures of SMEs such as profitability, exports and growth (Rosa and Scott, 1999; Regnier, 2000; Nguyen, 2001; Liedholm, 2002; Bartlett, 2004; Chen *et al.*, 2007; Serrasqueiro, 2008; Tambunan, 2008b; Park *et al.*, 2009). These measures characterise the most significant indicators of performance for growing or surviving SMEs and are simple measures of SME success (Storey, 1994; Hallberg, 2000; McMahon, 2001; Mambula, 2002; Beck et al., 2005; Pasanen, 2007; Tambunan, 2008a). From an economic perspective, however, a preferred and more robust measure of SME performance is in terms of technical efficiency.

The chapter proceeds as follows. In section 3.2 the key role of SMEs in an economy is discussed. In section 3.3 factors contributing to the size distribution of firms are identified. Section 3.4 discusses the changing role of, and responses by, SMEs to the process of globalisation. Section 3.5 discusses various measures of SME performance. Section 3.6 provides a brief overview of the measurement of firm efficiency. The first subsection presents the concept of efficiency from both input- and output-oriented perspectives. Finally, Section 3.7 presents a summary of the main conclusions from this chapter.

3.2 SMEs IN AN ECONOMY – IMPORTANCE, ROLE AND CONTRIBUTION

A number of contributions in the literature highlight that SMEs make a significant contribution to the economy in terms of number of business establishments, employment, income, exports, poverty alleviation, sustainable local economic development, entrepreneurship, innovation and economic empowerment (Hallberg, 2000; McMahon, 2001; Biggs, 2002; Kirby and Watson, 2003; Beck *et al.*, 2005; Harvie, 2007; Harvie and Lee, 2008; Audretsch *et al.*, 2009; Le, 2010). Biggs (2002) emphasises that SMEs contain specific advantages that offer unique contributions to the economy. For example, SMEs create a substantial proportion of employment and newly-generated jobs, which are the key to poverty reduction in developing economies.

Furthermore, jobs created by SMEs are likely to have a lower cost than large enterprises. SMEs have the potential to play a critical role in alleviating economic and social problems in the rural sector, including that of poverty, urban-rural income inequality and rural out-migration (Beck *et al.*, 2005; Coulson-Thomas, 2007; Harvie and Lee, 2008; Tippakoon, 2009). SMEs tend to reduce rural-urban migration (Liedholm, 2002; Tippakoon, 2009; Le, 2010). For example, small firms in the rural sector provided millions of jobs in China in the 1980s and early 1990s during the country's reform period and transition to a market-oriented economy (Kirby and Watson, 2003; Le, 2010).

SMEs play an important role in reducing a number of poverty elements, such as insecurity, powerlessness and social inequality (Macqueen, 2005; Harvie, 2008; Le, 2010). Furthermore, Le (2010) specifies that SMEs significantly contribute to local and regional economic development by satisfying local demand due to a good understanding of these markets. They can assist in industrialisation, absorbing surplus labour, increasing labour productivity, increasing rural real incomes, savings and investment, improving technology, expanding the pool of entrepreneurs and enhancing a more equitable distribution of income (Hu, 2000; Coulson-Thomas, 2007; Harvie and Lee, 2008; Le, 2010).

Hallberg (2000) also mentions that the desire of many governments to promote SMEs is commonly based upon encouraging the participation of certain ethnic groups or ethnic minorities such as women in traditional societies. Harvie and Lee (2005a) posits that SMEs can increase social inclusion in the economy, such as women, ethnic minorities and the poor. SMEs can provide new opportunities for those in rural areas and in isolated localities. In addition, Luetkenhorst (2005) acknowledges that SMEs can promote social cohesion by reducing gaps and disparities, and increase the gains of economic growth to broader population segments. Cheah and Cheah (2005) demonstrates that SMEs serve as the main force promoting upward social mobility by increasing employment and assisting people in low productivity occupations.

However, many studies are sceptical about the potential contribution of SMEs to the economy (Hallberg, 2000; Sarapaivanich, 2003; Harvie and Lee, 2005a; Baier, 2008; Saleh and Ndubisi, 2008; Doern, 2009; Le, 2010). For instance, Harvie and Lee (2008) expresses that the relatively small size of SMEs can act as a major disadvantage across key operational and strategic dimensions that inhibits the potential role that they play in the economy. SMEs face a lack of purchasing power in the acquisition of resource inputs or of economies of scale in the production process, and an inability to take advantage of market opportunities that need large production quantities, homogenous standards and regular supply (Harvie and Lee, 2008, p3). Thus, SMEs may face a number of severe problems that act as barriers to their further development. These barriers include (Mephokee, 2003; Sarapaivanich, 2003; Baier, 2008; Harvie, 2008; Saleh and Ndubisi, 2008; Tambunan, 2008a):

(1) A lack of management and/or administration skills and limitation of marketing skills and lack of efficiency

(2) Lack of technology and innovation skills and poor competitiveness and entrepreneurial skills

(3) A lack of international competitiveness and lack of integration in domestic and international markets

(4) Difficulties in obtaining funds from the government and financial institutions. Financial institutions usually charge higher interest rates on loans to SMEs because of a lack of financial transparency and good bookkeeping (Harvie *et al.*, 2011).

(5) A lack of human capital is the most important challenge facing SMEs. It is very expensive for SMEs to acquire and utilise skilled labour professionals.

(6) SMEs face a lack of access to technology and ICT that hampers their efficient and productive business operations.

(7) SMEs face a low level of research and development expenditures.

(8) Manufacturing SMEs usually rely upon one person or the owner-manager to make decisions.

(9) A lack of financial support because of the high risk involved in their activities.

(10) Manufacturing SMEs depend on external sources of advice and assistance.

3.2.1 Job Creation

SMEs can be seen to play a significant role in creating jobs in both developed and developing economies (Hallberg, 2000; Biggs, 2002; Beck *et al.*, 2005; Harvie and Lee, 2005a; Le, 2010). They employ a large share of the workforce, typically more than large enterprises in many developing countries (North and Smallbone, 1995b; Hall, 2002; Harvie, 2007; Saleh and Ndubisi, 2008). The total job creation of SMEs is considerably higher than that of large firms, because SMEs present high 'birth-rates'. However, they also have equally high 'death rates' (Hallberg, 2000; Pasanen, 2007)[44]. Cheah and Cheah (2005) also reveals that SMEs represent almost the only employment opportunity available to a large proportion of the population. Hallberg (2000) emphasises that micro-enterprises and small-scale enterprises represent the majority of firms and a large share of employment in most developing countries[45] (Liedholm, 2002; Harvie and Lee, 2005a; Le, 2010). However, it is important to discuss the issue of the quality of jobs generated. It is often argued that large firms generate more full-time, highly-skilled and highly-trained workers than SMEs. Large firms offer much higher wages than SMEs and their workforce is more productive than that employed by SMEs (Biggs, 2002; Le, 2010; Punyasavatsut, 2010). So, the quality of jobs created by size of enterprise is a contentious issue in both developed and developing countries.

In addition to creating jobs in developing economies, SMEs play a pivotal role in the evolution of a dynamic private sector (Hallberg, 2000; Hall, 2002; Cheah and Cheah, 2005; Harvie, 2007). Harvie and Lee (2005a) argues that SMEs in East Asia employ around 70 percent of the private sector workforce and 30 percent of the total workforce. SMEs have played an important role in almost all net job creation in China, Malaysia, Thailand, Vietnam and Indonesia, since the early 1990s. In Indonesia, Thailand and China, large enterprises have been net job destroyers as they downsized in this period. This phenomenon also occurred in Europe and the USA (Hall, 2002; Harvie and Lee, 2005a; Punyasavatsut, 2010).

Hall (2002) also acknowledges that SMEs contributed to more than 95 percent of all enterprises in East Asia and employed around 70 percent of overall employment over the period 1998 to 2000. Indonesian SMEs contributed the highest share of SME employment at 88 percent of total employment in the period 1998 to 2000, whereas Australian SMEs had the lowest proportion of employment, at 50 percent of all employment. Hence, it can be seen that SMEs in East Asia are economically and politically significant (Hallberg, 2000; Hall, 2002; Harvie and Lee, 2008; Punyasavatsut, 2010).

---

[44] Hence the SME sector is subject to considerable 'churning'.

[45] Most of which are in the informal sector.

Focusing on SME employment in developed economies, SMEs in the USA tended to contribute to net new jobs which was about proportional to their share of the USA workforce during the period 1978 to 1980 (Biggs, 2002; Horst *et al.*, 2005; Le, 2010). Birch (1981) states that large enterprises were no longer the main source and providers of new jobs for the USA. There have been subsequent doubts about the techniques and conclusions of Birch's study, due to its focus upon gross job creation and inclusion of SMEs owned by large enterprises, as well as other flaws in the empirical analysis (Biggs, 2002; Horst *et al.*, 2005; Le, 2010). Yet, the view of Birch represented a major shift from the conventional wisdom that larger enterprises provided the majority of jobs in the USA (Biggs, 2002; Horst *et al.*, 2005; Le, 2010). In 1994, SMEs employing less than 500 workers accounted for 50 percent of private sector employment in the USA labour force (Acs, 2003; Le, 2010).

Kirby and Watson (2003) reveals that new businesses in the UK created about 2.3 million jobs during the period 1995 to 1999, and around 85 percent of jobs were mainly provided by micro-enterprises and SMEs. In OECD countries, the average proportion of SME employment in the manufacturing sector was around 60 percent in 2002 (OECD, 2005; Le, 2010). The OECD study also showed that Korea had the highest proportion of SME employment at 87 percent. Even though industrial conglomerates dominate the Korean economy, SMEs were the main providers of jobs in 2002. Korean SMEs represented 99 percent of total business establishments in the country. It can be stated that SMEs are the back bone of the Korean economy (Gregory *et al.*, 2002; OECD, 2005; Park *et al.*, 2009; Le, 2010). In 2002, the lowest share of SMEs in the manufacturing sector was the Slovak Republic at 40 percent. The reason for this may be the legacy of central planning, which was dominated by large state-owned enterprises (OECD, 2005; Audretsch *et al.*, 2009; Le, 2010).

Despite their obvious importance in terms of job creation, one issue that needs to be discussed, as identified previously, is the quality of jobs generated by SMEs. A number of studies have shown that larger enterprises tend to offer much higher wages than SMEs in both developed and developing economies (Hallberg, 2000; Biggs, 2002; Cheah and Cheah, 2005; Harvie, 2007). In developed economies the wage differential between large enterprises and SMEs for similar job categories is likely to be as much as 35 percent, while the wage differential in developing economies is found to be as large as 50 percent (North and Smallbone, 1995b; Hallberg, 2000; Biggs, 2002; Kirby and Watson, 2003; Le, 2010). Large enterprises offer better jobs in terms of fringe benefits, wages, pension plans, health insurance and opportunities for skill enhancement (Hallberg, 2000; Biggs, 2002; Hall, 2002; Harvie and Lee, 2008). They have better working conditions than SMEs, particularly in comparison to those in the informal sector in developing countries where there are unsafe working conditions. The jobs created by large enterprises are more secure than jobs generated by SMEs, due to the fact that lay-off rates in large enterprises are much lower than SMEs (Biggs, 2002; Liedholm, 2002; Acs, 2003; Le, 2010).

Focusing on differences in labour productivity by size of firm, SMEs can invariably make a positive contribution to aggregate labour productivity growth (Biesebroeck, 2005; Park *et al.*, 2009; Le, 2010). This is reflected in the movement of labour from the low-productivity agriculture sector to non-farm small firms. It can also be observed that SMEs in developing economies appear not to locate in those industries where they would be at a substantial cost disadvantage relative to larger incumbents. Small non-farm firms can raise labour productivity by absorbing surplus farm labour to manufacturing production. The real incomes and savings from non-farm employment can then be reinvested in local markets. Hence, labour is moved to higher productivity non-farm employment while rural-urban migration is reduced. SMEs serve the needs of local communities and are a source of revenue for local governments (Tybout, 2000; Li and Hu, 2002; Park *et al.*, 2009; Le, 2010).

3.2.2 The Seedbed Role for Innovation and Entrepreneurship

SMEs are considered a significant seedbed for innovation and entrepreneurship, providing the foundation for the transition towards large firms and the long-run growth of the economy (Luetkenhorst, 2005; Wang *et al.*, 2007; Audretsch *et al.*, 2009; Le, 2010). They play an important role by being the breeding ground for new and large firms. They are likely to promote new products due to flexibility, affordability and proximity to the market (Wang *et al.*, 2007; Audretsch *et al.*, 2009; Le, 2010). Even though SMEs have limited resources for R&D investment, they are capable of innovating and producing new technology and new production (Wang *et al.*, 2007; Suprapto *et al.*, 2009). For instance, Peacock (2004) found that Australian SMEs contributed around 54 percent of overall important technological innovations, despite their share of R&D investment representing just 20 percent of total technological innovation expenditures.

With respect to entrepreneurship, a number of studies have specified that an entrepreneur is an innovator who can bring about change through new products, new processes, and new management techniques (Horst *et al.*, 2005; OECD, 2005; Cooper and Dunkelberg, 2006). SMEs are most innovative in the development of new products (Schumpeter, 1942; Audretsch and Thurik, 1998; Audretsch *et al.*, 2009). The Schumpeterian entrepreneur plays an important role in creative destruction in the short run but large enterprises would have the innovation advantage over SMEs, and the role of SMEs would diminish, and maybe even disappear, in the long run due to innovation itself becoming reduced to routine. However, SMEs can provide a better incubator environment for fostering the growth of entrepreneurial desires and learning than larger firms (Biggs, 2002; Langlois, 2003; Le, 2010).

SMEs are less management-intensive than large enterprises, and they are more flexible than large enterprises to adapt to changes in market circumstances due to being less bureaucratic organisations (Audretsch and Thurik, 1998; Le, 2010). Entrepreneurs can learn from managing SMEs through the acquisition of relevant experience. Several studies suggest that managing SMEs is less difficult than for large firms (Schumpeter, 1942; Audretsch and Thurik, 1998; Langlois, 2003; Le, 2010). From this point of view, SMEs may be more effective than large enterprises in terms of disseminating managerial ability and becoming more familiar with technology and machinery. However, a counterargument is that SMEs may not be such a good breeding ground for entrepreneurship because their managerial and entrepreneurial skill is poor at the executive level (Knight, 2000; Biggs, 2002; Krasniqi, 2007; Le, 2010).

3.3 THE SIZE DISTRIBUTION OF FIRMS IN AN ECONOMY

The role and contribution of SMEs is, therefore, important from a number of perspectives. However, a number of questions remain. What determines the number of SMEs and, more generally, the size distribution of firms in an economy? Should government attempt to influence this distribution or leave this to the market? A review of the industrial organisation literature indicates that there is no optimal or ideal size distribution of enterprises, but an equilibrium size structure can be determined by factors such as market size, consumption patterns, degree of market competition and segmentation, resource endowments, stage of economic development, technology-driven economies of scale, institutions, transaction costs, taxation and laws (Hallberg, 2000; Biggs, 2002; Le, 2010). Some factors determining firm size are natural, in the sense that they are not amenable to policy interventions.

Other factors, however, such as taxation, transaction costs, and degree of market completion can be influenced by policy makers (Hallberg, 2000; Biggs, 2002; OECD, 2005). For example, in the formerly centrally-planned economies of Eastern Europe, government policy stifled private enterprises and subsidised large state-owned enterprise. This led to the size distribution of enterprises becoming heavily skewed toward large enterprises. It resulted in SMEs facing a high level of bureaucracy from government agencies, low levels of research and development expenditures and a lack of technology and innovation skills, which impeded SME growth in the post-communist era (Ace and Audretsch, 1990; Biggs, 2002; Audretsch *et al.*, 2009). Consequently, government measures to deliberately influence the size distribution of firms is fraught with danger and may be potentially damaging to the growth, resource allocation and technical efficiency of the economy.

In developing economies in the past government policy[46] has deliberately tipped the balance of resource allocation in favour of large enterprises, state or foreign owned, resulting in dualism of the size distribution of firms, The economy is dominated by a small number of large enterprises and a large number of small informal enterprise with a resulting "missing middle"[47] (Tybout, 2000; Biggs, 2002; Le, 2010). Tybout (2000) indicates that a heavy industry import substitution policy in developing countries created an incentive for inefficient industrialisation and protected the monopoly position of large foreign and domestic enterprises. High taxes and over regulation kept many firms small and informal, and cut off the growth and development of the private sector and SMEs (Biggs, 2002; OECD, 2005; Pasanen, 2007).

[46] Due to much more limited resources, developing economy governments did not have the funds or the support infrastructure to pursue an SME oriented policy. Instead, they tended to focus on attracting large foreign firms to invest in the country or to focus upon large state owned enterprises.

[47] A term used to describe a lack of medium sized formal enterprises.

The following section discusses factors that can determine the size of an individual firm and the size distribution of firms in the economy. These include: (1) economies of scale, (2) transaction costs, (3) market structure, and (4) stage of economic development.

3.3.1 Economies of Scale

Many studies find that SMEs often produce at a low level of output, resulting in a small share of industry or market output, which weakens the attainment of scale economies (Hallberg, 2000; McMahon, 2001; Biggs, 2002; Beck *et al.*, 2005; Harvie and Lee, 2008; Le, 2010). However, the industry itself may be characterised by weak economies of scale (Hallberg, 2000; Bigsten *et al.*, 2002; Dhanani and Scholtès, 2002; Le, 2010). But in certain sectors, technology may lead to limited economies of scale and small firm size may be optimal. This basically argues for the market to determine optimal firm size (Biesebroeck, 2005; Park *et al.*, 2009; Le, 2010).

With respect to economies of scale and minimum efficient scale, the size of a firm can be determined by the effectiveness of an organisation in decision-making and implementation (Hallberg, 2000; Sahakijpicharn, 2007; Park *et al.*, 2009). For instance, the ability of the firm in terms of risk-taking and loss of control from expansion of firm size, can affect a firm's willingness to expand its size (Biesebroeck, 2005; Sahakijpicharn, 2007; Le, 2010). Firm size can also be determined by technological change. Many studies have argued that the nature of technological change from the Industrial Revolution up until the 20th century was to raise the minimum efficient scale of most manufacturing firms (Cheah and Cheah, 2005; Sahakijpicharn, 2007; Yang and Chen, 2009; Le, 2010).

Yet, in the late 20th century, innovations such as the introduction of new materials like plastics, and the increasing utilisation of computers and general purpose machines, have the opposite implication. However, changes in information and communications technology (ICT) can improve organisational efficiency and increase efficient organisation. Thus, the size distribution of the firm can be determined by a combination of efficient firm size, market size and the product composition of production in an economy (Hallberg, 2000; Biesebroeck, 2005; Sahakijpicharn, 2007; Park *et al.*, 2009).

A number of studies have indicated that there are important reasons for the co-existence of SMEs with large enterprises in the economy (Cheah and Cheah, 2005; Yang and Chen, 2009; Le, 2010). For instance, all firms are different in accessing scarce factors of production, including entrepreneurial skills, know-how and physical resources. Firms can increase endowments and diminish returns. They may face a technological trade-off between efficiency – the cost of generating a given set of output and flexibility – and the cost of adjusting the output that can give rise to the size distribution of firms. In addition, it is believed that SMEs and large enterprises are the same except for the difference in adjustment. If it is costly to adjust firm size, firms will stagger their expansion overtime. However, large enterprises have had more time to adjust themselves to previous expansions in terms of demand and reduction in cost (Biggs, 2002; Yang and Chen, 2009; Le, 2010, p88).

3.3.2 Transaction Costs

In economic theory, firms can be observed to be an alternative to the market place, and as an instrument of allocating resources and structuring transactions (Coase, 1937; Ace and Audretsch, 1990; Audretsch and Thurik, 1998). It can be argued that transactions for which the market cost is high will result in such transactions being withdrawn from the market and internalised by the firm. This explains the existence of firms and why they may increase or decrease in size (You, 1995; Hallberg, 2000; Audretsch *et al.*, 2009; Le, 2010). Many studies have emphasised that the nature and size of transaction costs can change over time For instance, the availability of new ICT and the emergence of E-commerce have significantly provided SMEs with lower costs of transacting with suppliers and customers (Hallberg, 2000; Sahakijpicharn, 2007; Le, 2010). This has enabled many SMEs to participate in wider markets and link with other enterprises.

You (1995) and Le (2010) specifies that transaction costs can influence both entry and firm size, thus explaining the existence and growth of firms. The efficient firms' size will grow when they have organisational technology and innovation which reduces the costs of internal transactions relative to market transactions. However, inflexibilities and conflicts in labour relations can lead enterprises to vertically disintegrate the size of their labour force. The difficulty of specifying all types of goods exchanged and the small amount of bargaining can encourage integration and enlargement of firm size, such as through mergers (You, 1995; Biesebroeck, 2005; Sahakijpicharn, 2007; Park *et al.*, 2009; Le, 2010). However, a reduction in fixed asset specificity due to flexible manufacturing technology may cause vertical disintegration in the manufacturing sector.

In developing economies, where transaction costs are an important factor in setting up a formal firm, many firms decide to stay small and informal; small firms are not able and are unwilling to grow (Tybout, 2000; Biesebroeck, 2005; Le, 2010). Furthermore, it is suggested that the shift in economic activities away from large enterprises and toward SMEs can increase economic welfare as start-up enterprises can change the fundamentals of the economy. SMEs can grow in the face of intense competition from large enterprises by becoming part of a value chain, and a larger social community, such as an industrial cluster and by occupying market niches (Acs, 2003; Audretsch *et al.*, 2009; Park *et al.*, 2009; Le, 2010).

3.3.3 Market Structure

It can be argued that the size distribution of firms represents the distribution of market power, segmentation and distortions in both input and output markets (Hart and Oulton, 1996; Hallberg, 2000; Biesebroeck, 2005; Pasanen, 2007). SMEs can obtain an advantage from some of these issues. For example, SMEs can be legally exempted from labour market policies, including minimum wages and social benefits. This permits SMEs to employ labour more cheaply than large firms. SMEs can benefit from small size, flexibility and proximity to the local market enabling them to be responsive to adjusting market conditions. They can also provide possibilities for promoting empowerment, security, and economic opportunity (Biggs, 2002; Cheah and Cheah, 2005; Rose *et al.*, 2006; Harvie and Lee, 2008).

SMEs can exist in imperfectly competitive markets due to cost differentials from scale differences (Ace and Audretsch, 1990; Audretsch and Thurik, 1998; Le, 2010). You (1995) and Biesebroeck (2005) points out that product differentiation is the major component in competition for market share. Firm size serving different market segments varies due to the differences in technologies, innovations and the size of demand across segments of markets (You, 1995; Park *et al.*, 2009; Le, 2010). Thus, it is important to emphasise that firms generating mass-consumption goods will be much larger than firms producing specialised goods

A number of studies argue that SMEs and large enterprises have different advantages in their own right (Smallbone *et al.*, 1995; You, 1995; Kirby and Watson, 2003; Yang and Chen, 2009; Le, 2010). SMEs tend to have the advantage of flexibility over large enterprises due to their ability to respond quickly to changes. They have the flexibility to adjust and diversify their activities in order to become more efficient. With respect to flexibility, SMEs can focus upon meeting the specialised requirements of customers and they can create product differentiation. SMEs can add dynamism to business activities, which can improve economic performance. They are likely to have a cost advantage relative to large enterprises because they may be exempted from labour market policies and pay lower wages and salaries than large enterprises (Biggs, 2002; Yang and Chen, 2009; Le, 2010).

Although SMEs and large enterprises are likely to operate in different market segments, they co-exist in the economy. SMEs purchase their supplies from large enterprises, and then sell their goods to customers and large firms. Thus, collaboration between SMEs and large enterprises is of importance in the economy. For example, SMEs can be utilised as sub-contractors by large firms in order to reduce the cost of production and provide greater flexibility (Biggs, 2002; Yang and Chen, 2009; Le, 2010). There is also the issue of deliberately engineered market segmentation by large firms who use their dominant position in the marketplace. There may be natural segments in a market for small and large firms to occupy, but market segments could be created through the market dominance of large firms themselves (Coulson-Thomas, 2007; Sahakijpicharn, 2007; Le, 2010).

3.3.4 Stage of Economic Development

For a long period of time the conventional wisdom from many studies has been that SMEs do not play a significant role in an economy, and their role diminishes as an economy develops (Snodgrass and Biggs, 1995; You, 1995; Hallberg, 2000; Le, 2010). The size distribution of enterprises was seen as changing over time with economic development and the development of industrial production (Hallberg, 2000; Sahakijpicharn, 2007), with average firm size steadily increasing. This occurred as the share of agriculture, based around small rural farmers, in GDP steadily decreased, with an offsetting growth in industrial production based around the factory system increasing average plant size as countries developed (Snodgrass and Biggs, 1995; Hallberg, 2000; Le, 2010). There are three stages of industrial growth in the manufacturing sector. These include: (1) the first stage is dominated by household manufacturing, (2) the second stage is the emergence of small shops and factories that replace household manufacturing, (3) the final stage is predominantly occupied by large-scale production displacing the remaining household manufacturing facilities, and a large share of shop and small factory production (Anderson, 1982; Snodgrass and Biggs, 1995; You, 1995; Le, 2010).

Hallberg (2000) and Le (2010) argue that low-income economies are characterised by a missing middle with a large number of micro- and small-sized enterprises existing together with a few large-sized enterprises. Some enterprises are state-owned enterprises and some are foreign-invested enterprises. This occurs from the protective barriers that encourage capital intensive import-substituting production. However, this framework is not in line with the comparative advantage of low-income countries which appear to be in labour-intensive light manufacturing dominated by SMEs. Thus, it is argued that not until countries reach middle-income status will medium-sized enterprises start to account for a relatively larger share of production and employment (Hallberg, 2000; Le, 2010).

Furthermore, the rise of large enterprises in the last century under the industrialisation process has not diminished the significance of SMEs (Rondinelli and Kasarda, 1992; Hallberg, 2000; Le, 2010). As discussed above, SMEs have been recognised to be playing an increasingly important role in developed countries such as the UK and USA since the 1970s. The process of de-industrialisation in post-industrial society and expansion of the service sector has resulted in a decline in average firm size, more entrepreneurial activity and a rise in the share of SMEs in an economy (You, 1995; Sahakijpicharn, 2007; Le, 2010).

Technological developments have resulted in discontinuities in the production process, proving opportunities for SMEs in the value chains of trans-national corporations (TNCs). Thus, parts of the production process can be sub-contracted to SMEs. At the same time the service sector is commonly characterised by lower scales economies and the demand for services appear to be more customised, dedicated and specialised and highly suitable for SMEs (You, 1995; Le, 2010). In developing economies the traditional decrease in the role and importance of

SMEs has changed under the process of globalisation. The reason for this is that increased global outsourcing and marketing by large firms has presented many business opportunities for SMEs to participate in their supply chains This has occurred in a number of East Asian economies, where product fragmentation and outsourcing has happened to a substantial extent (Harvie and Lee, 2005a; Le, 2010).

A number of studies have also emphasised that the stylised pattern of development does not hold true in many countries (Hallberg, 2000; Luetkenhorst, 2005; Tambunan, 2008a; Le, 2010). Iqbal and Urata (2002) and Le (2010) describe that SMEs in East Asia have either held their own or become more important when measured by their share of value added and employment during 1975 to 1995. In Taiwan, the size distribution of enterprises has remained quite constant in the last three decades even as the structure of production changed from labour-intensive manufacturing to high-tech computer industries (Hallberg, 2000; Hu, 2000; Le, 2010). Japanese SMEs continue to flourish even when the economy reached a high-income position. The share of Japanese SMEs in the total number of firms and employment has remained more or less relatively constant over the past twenty years (Burki, 1996; Yamawaki, 2002; Le, 2010).

Nevertheless, within the Japanese SME sector, there has been an obvious shift away from micro enterprises (1-4 workers) to medium enterprises. The share of micro enterprises decreased from 72 percent of the total to 62 percent, with the most rapid decline happening in the last ten years when the overall economy stagnated (Kawai and Urata, 2002). Weeks (2002) and Le (2010) describe that manufacturing SMEs appeared to decline in number during the early stages of economic development, but this was reversed when countries reached middle income status.

3.4 SMEs AND GLOBALISATION

The onset of globalisation and expanded regional economic integration in the world has intensified the competitive pressures on SMEs in both domestic and international markets, and required a reconfiguration of the international model of business in which SMEs are playing a crucial role (OECD, 2000; Woods, 2001; Harvie, 2008, 2010). Despite their perceived weaknesses related to their relatively small size and limited resources the Asian region retains a dynamic, entrepreneurial and increasingly internationalised SME sector. SMEs have not been swept away with the process of globalisation and regional integration, but, rather, their role and contribution has evolved as they attempt to retain a competitive position in the domestic and global marketplace. This has involved the adoption of effective business strategies in response to global competition, as well as meeting the needs of the new economy with its emphasis on knowledge, skill and innovation as key sources of competitiveness. Those enterprises most able to respond flexibly and adaptively to rapidly changing regional and global markets will be the most successful. A critical issue is how best to ensure that they fully participate in the business opportunities that will present themselves, including participation in global and regional value chains (Kaplinksy and Readman, 2001; Lim and Kimura, 2009; Harvie, 2010; Harvie *et al.*, 2010).

This section starts with a brief discussion of barriers affecting SMEs when entering the global marketplace. It also reviews different strategies adopted by SMEs in an attempt to participate and retain a competitive position in both domestic and international markets.

3.4.1 Barriers to SME Access to International Markets

It can be argued that to be able to compete and be successful in both the domestic and global economies requires firms to be big. SMEs are believed to be at a disadvantage over large enterprises in the international markets. The key barriers for small enterprises to participate in the global market are inherently different from those faced by large enterprises (Hart and Oulton, 1996; Thurik, 2008; Doern, 2009; Le, 2010). For most SMEs, high fixed costs create the most important barrier in the internationalisation process. The costs of learning about foreign environments are relatively large for SMEs. These comprise the costs of communicating at long distances, negotiating with national governments, the costs of doing market analysis abroad, purchasing legal consulting services, adaptation of products to foreign markets, and the costs of setting up and maintaining foreign distribution and marketing networks (Thurik, 2008; Audretsch *et al.*, 2009; Le, 2010; OECD, 2011).

In addition, a key barrier for SMEs is accessing information about international markets. A lack of business information, knowledge, experience and technological capability in the global marketplace constitutes the main challenge to small enterprises. According to OECD (2008), three out of the four most serious barriers to SME access to international markets are related to understanding foreign markets. SMEs have difficulty in specifying foreign business opportunities, they have limited information to locate and analyse markets and an inability to contact potential foreign customers (Le, 2010). These barriers can be overcome through learning by doing and accumulated knowledge by SMEs as well as support from industry or government associations of the home and host countries through various channels, such as professional business matching services or trade fairs (OECD, 2008; Hayakawa *et al.*, 2010; Le, 2010).

In addition, long distance communication with foreign markets makes it harder for SMEs to enter international markets. SMEs tend to find it more difficult to communicate over long distances (Berger and Udell, 2004; Le, 2010; Adlung and Soprana, 2012). Nevertheless, advances in information and communication technology (ICT) have reduced the importance of long-distance substantially. It has also decreased the cost of transmitting information across geographic/physical space to virtually zero (Le, 2010; Audretsch *et al.*, 2012). Even though communicating over a long distance is not an important issue these days, managing complex relationships at a long distance remains a substantial barrier to SMEs. Hence, studies have found that most SMEs appear to move initially into markets that are either psychologically or geographically close (OECD, 2008; Le, 2010; Audretsch *et al.*, 2012). For instance, more than 50 percent of Australian internationalised SMEs operate in New Zealand and East Asia, while most European SMEs carry out activities in other countries in Europe (Le, 2010; OECD, 2011; Audretsch *et al.*, 2012).

Furthermore, SMEs confront business environment barriers in their internationalisation endeavours. They have to deal with regulatory requirements on product quality standards. Intellectual property (IP) rights protection is one of the important problems for SMEs in international markets. SMEs find it costly to internationalise when they deal with countries that have a weak enforcement mechanism. The globalised market also means fiercer competition for SMEs with the presence of foreign enterprises (OECD, 2008; Le, 2010; Audretsch *et al.*, 2012). The OECD (2005) indicates that many obstacles to SME internationalisation could originate at the level of the national economy, institutions and general infrastructure - related to issues of competition policy, legislative and regulatory frameworks, research and education policies. This is intensified by the fact that SMEs are quite weak in negotiating with national governments compared to large firms (OECD, 2005; Le, 2010; Wilson, 2012).

Importantly, barriers to international markets are not the same for all SMEs. The nature and scope of barriers are different for SMEs in different economies. They vary depending upon the market, the product and the level of management of enterprises (OECD, 2008; Le, 2010; Audretsch *et al.*, 2012; Wilson, 2012). Many of the above barriers facing SMEs may overlap due to their lack of resources. Resources are the most important factor for SMEs to expand into the global marketplace. For example, SMEs that do internationalise appear to be larger, more capital rich, more productive and profitable and tend to have a higher export ratio that SMEs in general (OECD, 2008; Le, 2010; Audretsch *et al.*, 2012).

Despite facing many barriers to enter international markets, globalisation has created a number of opportunities for SMEs, as follows: (1) it opens opportunities for outward expansion and growth for some SMEs, (2) it facilitates trans-national technology transfer, (3) it changes the role of SMEs in domestic market economies where SMEs become agents of change in the economy, and (4) it creates opportunities for SMEs to participate in international business (OECD, 2008; Le, 2010; OECD, 2011; Audretsch *et al.*, 2012). The following section discusses different strategies that are adopted by SMEs to conquer barriers to entry into the global marketplace.

3.4.2 International Competitiveness Strategies of SMEs with Globalisation

Internationalisation has increasingly become important to the competitiveness strategies of SMEs (European Commission, 2010; Wilson, 2012). A study of European SMEs found that internationalisation has become a much more differentiated business activity. It is also shown that SMEs strive to optimise their competitiveness by using new business opportunities in the value chain, encompassing trade, cross-border clustering, cross-border collaboration, alliances, branches and joint ventures overseas (European Commission, 2003; Le, 2010). The OECD (2000) specifies the key competitiveness strategies of SMEs, including innovation, information technology, niche, network, cluster, and foreign direct investment (FDI) strategies.

3.4.2.1 Forming Alliances

There are different types of linkages among enterprises. They consist of strategic alliances, formal and informal networks and joint ventures (Gomes-Casseres, 1996, 1997; Thurik, 2009; European Commission, 2010). It can be stated that the higher degree of vertical disintegration under the model of the entrepreneurial economy in the age of globalisation has resulted in more co-operation among independent enterprises. This replaces internal transactions with a large vertically integrated corporation. The existence of a greater number of enterprises in the entrepreneurial economy implies that there is greater co-operation among enterprises (Audretsch and Thurik, 2001; Woods, 2001; Audretsch, 2003; Thurik, 2003; Le, 2010). One form of partnership among enterprises is an alliance. An alliance is an administrative arrangement to manage an incomplete contract between separate enterprises in which each partner has limited flexibility and control. The constellation constituted from alliances of the set of enterprises then becomes a new unit of competition (Gomes-Casseres, 1997, p34; Le, 2010, p99). The main benefit of alliances is that they can gain access to new products, new processes, technology and organisational competencies, particularly those recognised as essential to advance their core competencies (Acs and Preston, 1997; Audretsch and Thurik, 2001; Le, 2010).

In addition, SMEs have utilised alliances as an intermediated type of international business to provide them scale and scope needed for success overseas by depending on larger partners. Hence, SMEs can evolve into multinationals through either their own investments or as a result of alliance formations (Acs and Preston, 1997; Thurik, 2009; Le, 2010). SMEs can follow different approaches to alliances that rely on their relative size. For instance, enterprises that are small relative to competitors and to the requirements of the market appear to utilise alliances to reach scale and scope economies. Enterprises that are large relative to the same benchmark depend upon internal capabilities to expand in the marketplace (Gomes-Casseres, 1997; Thurik, 2009; Le, 2010).

Cross-border alliances are common in terms of technological agreements. This form of alliance is a typical phenomenon in OECD economies, which host most of the global innovative companies (OECD, 2005, 2011). However, the number of inter-enterprise technology agreements involving partners from developing economies is significantly increasing. Joint ventures and technological alliances have proliferated, especially in new processes, new technology and the automobile industry. The reasons for undertaking alliances are many: (1) the high costs and risks of research and development (R&D) and technology development, (2) the requirement to pre-empt other competitors by undertaking R&D rapidly, (3) it benefits from a mutual exchange of complementarities in R&D expertise, and (4) a reduction of the time needed to develop products and processes (OECD, 2005; UNCTAD, 2005; Le, 2010).

However, forming an alliance to become more competitive in the global market is not often a choice for SMEs. Most SMEs tend to prefer an independent approach to enter international markets. They utilise strategies that do not reduce their managerial control or do not weaken their equity (OECD, 2008; Le, 2010; OECD, 2011). Gomes-Casseres (1997) and Le (2010) found that not all SMEs enter into an alliance. Many SMEs refuse to share their technologies and insist on going it alone. The joint study by the OECD and APEC (2007) is accepted that behind the level of individual action lay a background of informal networks and local context necessary in describing the amount of information and contacts required for any successful strategy of internationalisation (Le, 2010; OECD, 2011).

3.4.2.2 Networking and Clustering

Networking can facilitate increased economic specialisation external to an enterprise as well as superior access to information (Audretsch and Thurik, 2001; Le, 2010; Audretsch *et al.*, 2012). In the era of globalisation, inter-enterprise networks can support SMEs to compete on a par with larger enterprises (Harvie and Lee, 2005a). Networks can allow enterprises to engage in accelerated- and peer-based-learning. They can also facilitate the reconfiguration of relationships with which to enable enterprises to innovate and offer the scope for increased efficiency through collective action (OECD, 2000, p3; Le, 2010). Hence, the network structure allows SMEs to reduce costs, pool resources and knowledge, improve innovation and enhance their competitiveness (OECD, 2000, 2008; Le, 2010).

Biggs and Shah (2006) states that networks can be formed by ethnic groups, industry and community organisations. Community networks play an important role in the membership of African business networks. Adam (2006) emphasises that shared cultural backgrounds, beliefs and attitudes made it easier for SMEs in the

Indonesian garment industry to understand the behaviour and needs of other members in a network. A network of enterprises in the same industry can enable members to engage in collective action such as in the purchase of inputs (or labour sharing) that will benefit all of them (OECD, 2000; Le, 2010)

While geographic concentration is not needed for networks, it is required for a cluster. Porter (2000) describes that a cluster is a geographically proximate group of interconnected enterprises and associated institutions in a particular area, involved in the production of a product at the same (horizontal cluster) or different (vertical cluster) stages in the production process. Hence, a cluster of firms has both a product and geographic dimensions. It also provides a seedbed for exchange of new ideas (Porter, 2000; Le, 2010). Audretsch and Thurik (2001) and Le (2010) similarly explain that physical proximity facilitates the transmission of knowledge, especially tacit knowledge, and enhances the development of institutions and makes them more effective. Economic reasons for the geographic concentration of particular industries arises from the existence of unique natural resources, economies of scale and scope, proximity to the market, labour pooling, the existence of equipment suppliers and shared infrastructure (OECD, 2000; Le, 2010). Nevertheless, some of these factors are not important for existing clusters. For instance, the most significant factors that control clusters in Japan are the presence of leading large enterprises, the availability of a pooled labour market and the existence of public R&D and testing facilities (Yamawaki, 2002; Le, 2010).

Clustering can help SMEs conquer growth barriers and compete in markets even though this is not an automatic result. Clustering is important as SMEs can grow through collaboration with the mobilisation of financial and human resources in incremental steps (Schmitz and Nadvi, 1999; Le, 2010). A number of studies have confirmed the many benefits of clustering to SMEs, as follows: (1) it enables greater efficiency for SMEs in a static and dynamic context, (2) it provides the advantage of adaptation of technology with large indivisibilities through the sharing of costs and risks (Sandee and Rietveld, 2001; Berry *et al.*, 2002; Le, 2010). However, Albaladejo (2002) argues that clustering did not guarantee economic success for the case of Latin American SMEs. Government policies should aim to strengthen inter-enterprise co-operation and competition among economic sectors, creating specific location advantages for SMEs. These should be combined with government interventions at the national level with specific schemes to establish the technological capabilities of SMEs, complemented by well-designed and suitably implemented institutional interventions. Nevertheless, these supply oriented support measures require to be supplemented by demand oriented assistance (Albaladejo, 2002; Le, 2010).

There are many suggestions to increase the chance of success of government assistance to SME clusters. These comprise: (1) promoting a greater customer rather than supplier orientation by cluster enterprises, (2) directing the support at groups of firms, and (3) facilitating synergies between cluster members and enabling continual upgrading and the maintenance of competitiveness (Humphrey and Schmitz, 1995; Humphrey, 2003; Le, 2010). The collaboration of SMEs in networks and clusters can facilitate the joint evaluation of market opportunities, enable participation in trade fairs, establish contacts with other producers or buyers, facilitate an upgrading of technology, develop new products and new processes, restructure organisational production and capabilities, and improve product standards and attain international standards organisation (ISO) accreditation to become more competitive in international markets (Harvie and Lee, 2008; Le, 2010). Thus, it can be emphasised that networks and clusters can facilitate SMEs to combine the advantage of small scale or flexibility with the benefits of economies of scale (OECD, 2000; Harvie and Lee, 2008; Le, 2010).

3.4.2.3 Subcontracting and Participating in Value Chains

A symbiotic relationship between SMEs and large enterprises in the global market has emerged. This has occurred as international competition induces multinationals to source from the most efficient global suppliers (Acs *et al.*, 1997; OECD, 2000; Le, 2010). International production in the age of globalisation has brought with it the development of cross-border production operations, comprising collaboration of different types. One form of collaboration is subcontracting relationships that can facilitate economic specialisation of enterprises as well as superior access to information (OECD, 2000; Harvie and Lee, 2005a; Le, 2010; OECD, 2011).

Subcontracting is related to the putting-out[48] system which is a vertical inter-

---

[48] The putting out system refers to large global retailers sourcing their products from SMEs. They do not produce a final product but rather retail products in their global retail outlets such as K-Mart or

enterprise network commonly formed by large enterprises on the ordering side with SMEs as suppliers. Large enterprises on the ordering side are frequently wholesalers or commercial capitalists who are not involved directly in the production process, and control SMEs as suppliers from outside the production process (Sato, 1983; Le, 2010; OECD, 2011). In this system, wholesalers assist and provide benefits to SMEs through many mechanisms, including supplying raw materials, lending funds, and supplementing important facilities and tools.

On the other hand SMEs can participate in the global marketplace by becoming part of the production networks of global suppliers. This form of network is often called a value chain (Humphrey, 2003; Lim and Kimura, 2009; Le, 2010). Kaplinksy and Readman (2001); Humphrey (2003) and Kaplinsky and Morris (2007) emphasise that a value chain explains a full range of business activities which are needed to bring a product or service from conception through the different stages of the production process, involving a combination of physical transformation and the input of many producer services, delivery to the final consumers, and the final disposal after utilisation. SMEs complement the activities of large enterprises in these value chains, exploiting the advantages of flexibility and lower transaction costs due to factors such as close contact with customers and faster decision-making, whereas large firms exploit different advantages such as economies of scale. Trans-national corporation (TNC)-SME linkages and global values chains can serve as a major bridgehead to export competitiveness. This can occur with the right combination of SMEs and large enterprises, and an adequate division of skilled labour that combines economies of scale with the flexibility and advantages of specialisation (UNCTAD, 2006; Kaplinsky and Morris, 2007; Le, 2010).

Humphrey (2003) explains that enterprises and clusters of firms may undertake only a limited range of functions in some global value chains. For subcontracting enterprises, they can work to a design provided for them, utilising materials which are sourced by other enterprises. However, in these circumstances other enterprises may be located thousands of miles away. There is also value chain cooperation among SMEs. This tends to occur more easily when it involves vertical value chain links than when it involves cooperation between enterprises engaged in

---

Wal-Mart. Thus, this form of collaboration occurs in the retail sector. Production networks consist of collaboration in the manufacturing sector. Inputs to produce a final product are sourced from SMEs.

similar products or services. For instance, shoe, leather and machinery enterprises cooperate much more readily than do only shoe manufacturers (Kaplinksy and Readman, 2001; Humphrey, 2003; Le, 2010).

To effectively participate in global value chains, it is essential for SMEs to upgrade from low to higher value added activities in these value chains. Businesses that tend to suffer most from new market conditions are those mainly engaged in activities at the bottom of a value chain, while firms involved in the finalisation of products have a greater likelihood of succeeding in the global market (UNCTAD, 2005; Lim and Kimura, 2009; Le, 2010). Upgrading within global value chains relies on firm level and cluster level investment. The reasons for this are that there are areas where customers cannot provide assistance and if enterprises in the cluster can contribute their own upgrading endeavours to the value chain, this increases the value to other enterprises in the value chain and provides additional protection from substitution. Thus, firm-level innovation efforts are important in this circumstance (Humphrey, 2003; Lim and Kimura, 2009; Le, 2010).

3.4.2.4 Niche Market Strategy

One of the important strategies for SMEs to compete in the global market is via a niche market strategy, in which SMEs select to become sophisticated global providers in a narrow product line (OECD, 2000, p10; Lim and Kimura, 2009; Le, 2010). To pursue a niche market strategy, SMEs can compete with larger enterprises and reach to export markets (Harvie and Lee, 2005a). A niche strategy for SMEs can be categorised in two ways, including specialised markets and innovation niches (OECD, 2000; O'Regan *et al.*, 2006). There are two trends which tend to be conductive to SMEs from the market niche perspective. These include: (1) customer trends through increased demand for customisation and variety, and (2) technological trends which appear to create opportunities for new specialised products (You, 1995; Le, 2010).

Gomes-Casseres (1997) and Le (2010) describe that an explanation for the success of SMEs is that they make appropriate strategic choices. SMEs focus upon activities where there are no economies of scale or even diseconomies of scale. The survival and growth of SMEs relies upon their ability to create market niches and avoid head-on confrontations with large enterprises, involving product differentiation within industries, SMEs may have the advantage in serving markets for specialised products and services, while large enterprises appear to be strong in standardised markets (You, 1995, p453). The flexibility of SMEs can enable them to become specialised in market segments in which they have the advantage. For instance, services appear to be specialised and dedicated compared to manufactured products. Hence, the prevalence of SMEs in the service sector (You, 1995; Biggs, 2002; Le, 2010).

In developed economies, SMEs commonly follow a niche strategy utilising high product quality, flexibility and responsiveness to customer needs as a mean of competing with large-scale mass producers (Snodgrass and Biggs, 1995; Hallberg, 2000; Le, 2010). Enterprises in a niche market are often the technological leaders within their industries (Gomes-Casseres, 1997; Le, 2010). SMEs may focus upon producer products which are sold to a limited group of industrial buyers. In doing so, they can follow strategies such as maintaining a leadership position in technology and cost, and developing relationships with a handful of multinational buyers (Gomes-Casseres, 1997, p37). For SMEs in developing economies, they can follow the above focus to produce specialised products. They can also offer goods and services with lower quality which are beneficial and affordable to low income customers (Le, 2010).

3.5 SME PERFORMANCE MEASURES – TRADITIONAL APPROACH

3.5.1 SMEs and Profitability

Typical performance measures of firms are changes in sales, employment and profitability (return on investment and sales, net profit) (Rosa and Scott, 1999; Serrasqueiro, 2008; Park *et al.*, 2009). Bartlett (2004) specifies that SME performance can be measured by the growth of sales or turnover growth, absolute profitability, profitability per employee and percentage change in profitability. Chen *et al.* (2007) also indicates that financial indexes are mainly used to measure SME performance, comprising enterprises' growth ability, profitability and financial ability. Thus, profitability plays a crucial role in determining the failure or success of firms (Rosa and Scott, 1999; Nguyen, 2001; Serrasqueiro, 2008; Park *et al.*, 2009).

A number of studies have identified key factors that could influence SME profitability, these being revenue, cost and capital (Cohen, 1989; Ross *et al.*, 1999; Nguyen, 2001; Olutunla and Obamuyi, 2008; Pangarkar, 2008). Revenue can be determined by marketing, sales management and new product development. Cost and capital are influenced by financial management practices. McDonald (1999) investigates the determinants of profitability of Australian manufacturing enterprises in the period 1984 to 1993 using firm level data. This study found that union density and import penetration are negatively-related to profitability, whereas industry concentration is positively correlated with profitability.

At the early stage of establishment, firms may place a strong emphasis on profitability and sales growth but they may not be profitable due to investments and expenses arising from starting up the business. When firms become mature, profits should increase (Olutunla and Obamuyi, 2008; Pangarkar, 2008; Hemilä and Oinas, 2009). Nguyen (2001) suggests that SMEs should place more focus on profitability because it is an important determinant of a firm's credit risk. Regarding this point, methods to measure profitability are as follows (Ross *et al.*, 1999; Nguyen, 2001; Olutunla and Obamuyi, 2008), (1) return on sales (ROS) can be calculated by dividing profits by total operating revenue. Profitability can be expressed as a percentage of total operating revenue and is an important indicator of profitability, (2) return on assets (ROA) gives an indication of how profitable firms are relative to their total assets, or how profitable a firm's assets are in generating revenue, and (3) return on equity (ROE) can be defined as net income divided by average stockholders' equity. ROE also measures a firm's efficiency at generating profits for every unit of stockholders' equity.

Furthermore, there are different ratios to measure the profitability of enterprises. These include (Cohen, 1989; Nguyen, 2001; Hemilä and Oinas, 2009): (1) asset earning power, which is a common profitability measure that can identify the profitability of firms by taking their total earnings before taxes and dividing it by total assets, (2) return on owner's equity, which can be calculated by dividing net profit by average equity, and represents the return that firms obtained in exchange for investment, and (3) net profit on sales, which can be determined by the ratio of net profit to net sales or by dividing net income before taxes and total sales, expressed as a percentage.

3.5.2 SMEs and Exports

Exporting is another important SME performance measure (Rankin, 2001; Bigsten *et al.*, 2002; Racic *et al.*, 2008; Amornkitvikai *et al.*, 2010). The export participation of SMEs in the global market is increasingly important (Theingi, 2004; Lu and Beamish, 2006; Le, 2010). However, the seedbed role of SMEs does not extend to exports in most economies, particularly in developing economies. The propensity of SMEs in developing countries to export is relatively low. The participation of SMEs in international trade is also low compared to their share in national GDP (Biggs, 2002; Bigsten *et al.*, 2002; OECD, 2005; Granér and Isaksson, 2009; Le, 2010). In APEC countries, SMEs contributed around 35 percent of total direct[49] exports in the mid-1990s (Kuwayama, 2001; OECD, 2005; Organisation for Small & Medium Enterprises and Regional Innovation Japan (SMRJ), 2008).

In OECD economies, SMEs contribute between 15 and 50 percent of total exports and account for 20 to 80 percent of export-oriented SMEs and active exporters, respectively (OECD, 2005; Harvie and Lee, 2008; Le, 2010). Thus, exporting is a key aspect of international trade and remains a significant factor of entry to the global market for SMEs (Rankin, 2001; Biggs, 2002; Bigsten *et al.*, 2002; Racic *et al.*, 2008; Amornkitvikai *et al.*, 2010). Many studies have found that exporting SMEs are more productive than non-exporting SMEs (Lu and Beamish, 2006; Racic *et al.*, 2008; Granér and Isaksson, 2009; Le, 2010). SME exporters are also found to outperform non-SME exporters in many countries in terms of profitability, production, wages and sales volume (Theingi, 2004; OECD, 2005; Le, 2010).

Focusing on exporting activities, SMEs may be involved in two types of activity (Biggs, 2002; Granér and Isaksson, 2002; Hall, 2002; Le, 2010): direct and indirect exporting. If SMEs are engaged in the global market they are likely to be involved as indirect exporters by supplying intermediate inputs or subcontracting to large enterprises (Biggs, 2002; Racic *et al.*, 2008; Harvie *et al.*, 2010; Le, 2010). SMEs face difficulties in exporting because they face higher transaction costs in dealing with international markets and experience higher transaction costs per transaction than large enterprises. SMEs may also be burdened more due to the high

[49] SMEs can export indirectly through the products they sell to TNCs which then export the processed product.

costs of obtaining information and have greater difficulty in dealing with export opportunities and other contract enforcement problems (Rankin, 2001; Biggs, 2002; Lu and Beamish, 2006; Le, 2010). Hence, it can be specified that SMEs are commonly integrated into the global market as indirect exporters, and so their role and contribution to exports may be substantial but not adequately highlighted in export data.

Intal (1997) argues that a strong SME sector has been crucial for successful export oriented industrialisation in Northeast Asia. SMEs can increase the flexibility of supply in response to rapid changes in overseas markets. SMEs can support exporting through subcontracting as suppliers of specialised inputs, such as parts and components as discussed previously (Intal, 1997; Lu and Beamish, 2006; Saleh and Ndubisi, 2008; Le, 2010). SMEs can also link with large local exporting enterprises and thereby integrate into global value chains or production networks. Fast and efficient SME suppliers and subcontractors can add a critical flexibility and provide just-in-time benefits to the supply chain, which are significant sources of competitive advantage in the global market (Biggs, 2002; Gregory *et al.*, 2002; Le, 2010).

Furthermore, there is an important view in the context of the fast changing international economy that an industry's vitality relies on low levels of market friction, such as minimum transactions costs of operating businesses and having a high degree of flexibility. Flexibility is significant in the light of increasingly shorter product cycles, greater product diversity and growing demands for product differentiation. Thus, it can be suggested that a broad-based industrial structure with strong inter-firm linkages between large firms and SMEs through subcontracting, could result in a high level of economic and business flexibility (Intal, 1997; Biggs, 2002; Yang, 2006; Le, 2010).

Focusing on direct exporters, SMEs also have the potential to compete directly in international markets. The experiences of Italy, Taiwan and Hong Kong indicate that SMEs can succeed in the global market (Biggs, 2002; Luetkenhorst, 2005; OECD, 2011). Exporting SMEs in these countries have successfully created competitive niches and prospered in international markets by working through industry-based clusters. The ability to develop competitive industry clusters is based mainly upon family social networks which can reduce the usual substantial transaction costs (Biggs, 2002; Lu and Beamish, 2006; Le, 2010). Granér and

Isaksson (2002); Racic *et al.*(2008); Le (2010) highlight that the role and contribution of SMEs to direct export revenues varies among countries, especially among developing countries.

SMEs contribute a large share of East Asian manufactured exports, for example, 56 percent in Taiwan, more than 40 percent in China and Korea, and 31 percent in India. However, the contribution of exporting SMEs in Africa is marginal, with little documented cross-border and sub-regional trade (Bigsten *et al.*, 2002; Biesebroeck, 2005; Luetkenhorst, 2005; OECD, 2005). It is important to note that the exporting pattern in Western and Asian SMEs is obviously different. Western SME exporting involves a predominately entrepreneurial activity which can reflect the capacities of firms' owners or managers. On the other hand, Asian exporting SMEs tend to involve strong production network participation, such as that of a client-supplier relationship (Kuwayama, 2001; Harvie *et al.*, 2010; Le, 2010; Punyasavatsut, 2010).

3.5.3 SME Growth

SME growth is increasingly recognised as important to overall economic growth (Robson and Bennett, 2000; McMahon, 2001; O'Gorman, 2001; O'Regan *et al.*, 2006; Krasniqi, 2007; Pasanen, 2007; Serrasqueiro, 2008; Tambunan, 2008a). Storey (1994) acknowledges that SME growth in terms of employment, business establishments, revenues and GDP are of crucial importance in an economy. Many studies have focused upon the growth of SMEs as a measure of their performance (Havnes and Senneseth, 2001; Beck *et al.*, 2005; Harvie and Lee, 2005a; Lu and Beamish, 2006; Chen *et al.*, 2007; Goh, 2007; Harvie, 2007; Doern, 2009; Hemilä and Oinas, 2009). For instance, Storey (1994) affirms that growth has been widely utilised as a simple measure of success in business. Growth has been recognised as the most appropriate indicator of performance and for the survival of firms (O'Gorman, 2001; Pasanen, 2007; Serrasqueiro, 2008). Growth is also a significant prerequisite for achieving financial goals in firms and businesses (Mambula, 2002; Beck *et al.*, 2005; Pasanen, 2006).

Robson and Bennett (2000) finds that SME growth can be measured from various perspectives, comprising government policy, management and economic sources. From these perspectives, SME growth is measured in terms of an increase in

SME employment and a reduction of unemployment. In addition, the growth of SMEs can be measured from several aspects, including percentage change in a firms' turnover, change in profitability, market share, return on capital employed and productivity (Beck *et al.*, 2005; Goh, 2007; Doern, 2009). Hence, SME growth has been associated with a firm's overall success and survival (Beck *et al.*, 2005; Pasanen, 2006; Rose *et al.*, 2006; Hemilä and Oinas, 2009)

The literature on small business growth has emphasised that new product introductions are positively related to growth (Cambridge Small Business Research Centre, 1992; O'Gorman, 2001). An ability to respond to market changes is the crucial requirement for small business growth (Smallbone *et al.*, 1995; World Bank, 2001; Serrasqueiro, 2008). You (1995) explains that the life cycle model of small firm growth is based upon age, size, growth and survival relationships. The firm enters small and grows large through the process of learning. Lundvall and Battese (2000) states that expansion of a small firm segment can lead to more efficient resource allocation, less unequal income distribution and less underemployment due to small enterprises utilising more labour intensive technologies. This may not always be the case if we consider human capital separately from labour input. Many small enterprises can constitute the seedbed for young entrepreneurs. Thus, the major source of growth in a mature economy is reliance mainly on SMEs and that the size of SMEs will eventually become larger[50] (Beck *et al.*, 2005; Pasanen, 2006; Chen *et al.*, 2007). The reason for this is that new firms commonly enter on a relatively small scale, but most small firms tend to remain small (Beck *et al.*, 2005; Audretsch *et al.*, 2009; Le, 2010). The mortality rate of small firms is also very high and, hence, very few succeed in becoming a large enterprise.

However, Biggs (2002) and Le (2010) argue that many small enterprises remain small in developing economies and are unable to move into growth-oriented and innovative categories. Small firms face a high turbulence rate and are subject to considerable churning (O'Gorman, 2001; Pasanen, 2007; Le, 2010). Hence, the concept of a seedbed cannot be disassociated from business trial and error which means firm birth and death (Thurik *et al.*, 2008; Le, 2010). A number of studies

[50] Recent changes in technology and ICT are encouraging a decline in average firm size due to increased market opportunities, the growth of niche markets and the need for greater flexibility due to rapidly changing markets and demand.

have found that statistically very few small enterprises can survive in the long term and grow up to be medium and large enterprises (Beck *et al.*, 2005; Pasanen, 2006; Rose *et al.*, 2006; Hemilä and Oinas, 2009; Le, 2010). Small firms have a high failure rate among firms in both developed and developing economies (Beck *et al.*, 2005; Chen *et al.*, 2007; Pasanen, 2007; Le, 2010).

Thus, government initiatives to encourage business creation and growth should anticipate turbulence and be able to tolerate a high failure rate (Le, 2010; Reynolds and Curtin, 2011). Krasniqi (2007); Mambula (2002); Le (2010) indicate that the government should reduce the cost of becoming formal for small firms and reduce the common constraints to SME growth, including a lack of capital, lack of access to pertinent business information, difficulties in marketing and distribution, policies and regulations that generate market distortions. It should also recognise and protect the property rights of small enterprises (Baier, 2008; Harvie, 2008; Tambunan, 2008a). Through these support measures, SMEs have a greater chance to grow and survive in the market place.

3.6 EFFICIENCY MEASURES – CONTEMPORARY ECONOMIC APPROACH

3.6.1 Concept of Efficiency

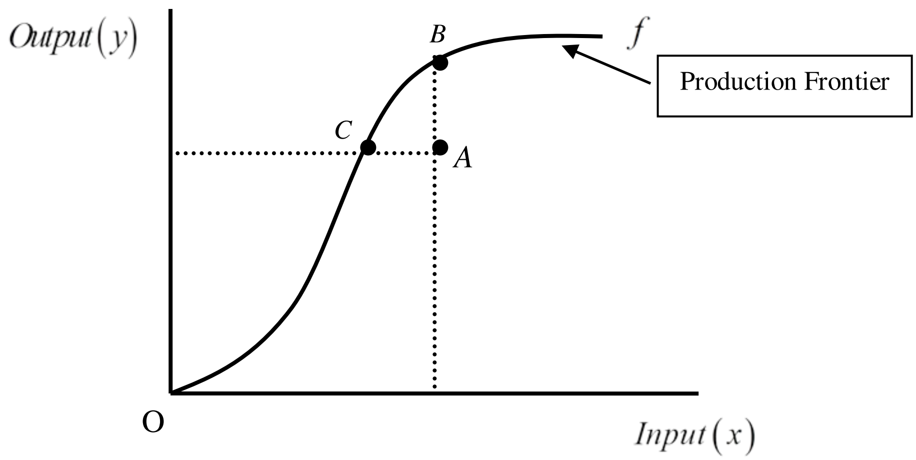
While the above measures of SME performance are based on traditional measures of profitability, export performance and firm growth, this section emphasises the measurement of firm performance based upon the concept of economic efficiency, including technical and allocative efficiencies[51] (Farrell, 1957; Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Arunsawadiwong, 2007; Assaf, 2007). Technical efficiency is defined as the ability of a firm to generate the maximum level of output from a given set of inputs. In this context, the output of a firm can be the level of production in terms of units or value added, while inputs can be resources such as labour and capital (Herrero and Pascoe, 2002; Coelli *et al.*, 2005; Major, 2008; Granér and Isaksson, 2009). Allocative efficiency is referred to as the firm's ability to use inputs in optimal proportions given their respective prices.

[51] In the remainder of this study, the measurement of SME performance, and factors impacting upon this, will be based upon technical efficiency.

Thus, technical and allocative efficiencies can be combined in order to provide a measure of overall economic efficiency (Admassie and Matambalya, 2002; Coelli *et al.*, 2005; Arunsawadiwong, 2007; Zahid and Mokhtar, 2007). In an attempt to understand the difference between these terms it is useful to consider the production process in which a single input (x) is utilised to produce a single output (y).

In Figure 3.1 the line O*f* represents a production frontier[52] that can be utilised to define an association between input and output. The production frontier indicates the maximum output achievable from each input level. It reflects the current state of technology in an industry. If the firm operates on the frontier, it is technically efficient. If the firm operates below the frontier, it is not technically efficient. Point *A* in Figure 3.1 represents an inefficient point, whereas points *B* and *C* represent efficient points. A firm that operates at point *A* is inefficient, but it can increase output to the level associated with point *B* without requiring more inputs, or it can produce the same level of output utilising less input by producing at point *C*. In addition, Figure 3.1 describes the concept of a feasible production set which represents the set of all input-output combinations that are feasible. This set comprises all points between the production frontier, O*f* and the x-axis (Coelli *et al.*, 2005).

Figure 3.1: Production Frontier and Technical Efficiency



Source: Adapted from Coelli *et al*. (2005, p4)

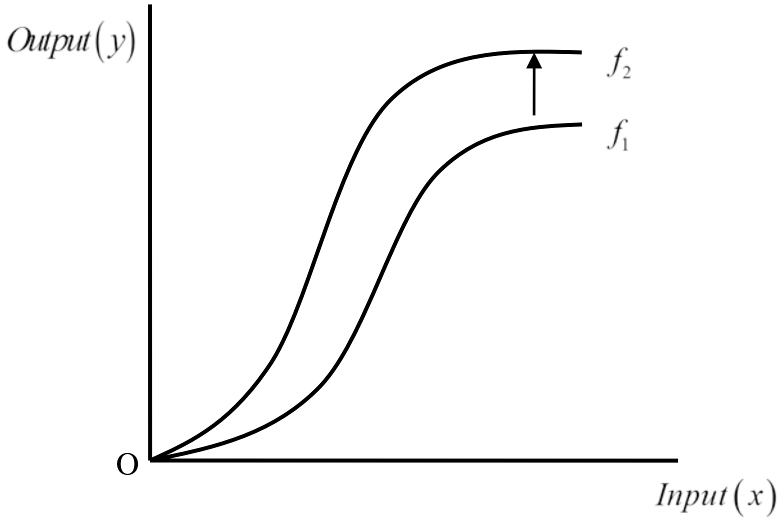
[52] This section discusses the general concept of a production frontier and technical efficiency. The following chapter will discuss a stochastic production frontier in more detail.

Furthermore, the term technical efficiency is related to the concept of productivity. The term productivity refers to the ratio that can estimate the relationship between input and output, and is a measurement of the production level in the absolute sense (Herrero and Pascoe, 2002; Murillo-Zamorano, 2004; Coelli *et al.*, 2005). Coelli *et al.* (2005) specifies that the term productivity of the firm[53] can be defined as the ratio of total output over input. The terms productivity and efficiency are regularly used interchangeably. When we include a time component to capture changes in technical efficiency and productivity over time, we can describe this as technical change (see Figure 3.2). This involves advances in technology that can be represented by an upward shift in the production frontier (O*f*).

From Figure 3.2 technical change can be represented by the movement of the production frontier from Of_1 in period 1 to Of_2 in period 2. It is assumed that in period 2 all enterprises may technically produce more output for each level of input relative to what was possible in period 1. For instance, installation of a new boiler for a coal-fired power plant can expand plant productivity potential beyond previous limits. This is an example of embodied technical change, where the technical change is embodied in capital input (Coelli *et al.*, 2005, p5). Technical change occurs when a firm has increased its technical efficiency and productivity from one period to another period (see Figure 3.2). An improvement of firm productivity does not only require efficiency improvements, but it may also have been due to technical change or exploitation of scale economics or a combination of efficiency improvements, technical change and scale economies.

[53] The term firm is utilised to describe any type of decision-making unit (DMU).

Figure 3.2: Technical Change between Two Periods



Source: Coelli *et al*. (2005, p6)

Moreover, Farrell (1957); Herrero and Pascoe (2002); Murillo-Zamorano (2004); Coelli *et al.*(2005) argue that total efficiency can be divided into two components: allocative and technical efficiency. First, allocative efficiency is the market condition in which resources are allocated in such a way that the net benefit obtainable is maximised. Allocative efficiency can be measured as the reduction in cost that can be obtained when the firm uses its optimal combination of inputs. Second, technical efficiency can occur when the maximum quantity of the output is produced for a given set of inputs (output-oriented technical efficiency) or when the minimum quantity of inputs are used to produce a given output level (input-oriented technical efficiency). Thus, the firm is considered to be technically efficient if it produces at the maximum amount of output, which is technologically feasible given by the amount of inputs.

3.6.2 Input-Orientated Measures

Farrell (1957) and Coelli *et al*. (2005) describe that the firm utilises two inputs (x_1 and x_2) to produce a single output (q), under the assumption of constant returns to scale (CRS). This assumption permits the technology to be represented utilising the unit isoquant. Knowledge of the unit isoquant of the fully-efficient firm[54], as represented by the line II′ in Figure 3.3, permits the measurement of technical efficiency. If the firm utilises amounts of inputs as defined by the point A to produce a unit of output, the technical inefficiency of this firm can be represented by the distance BA, which is the quantity by which all inputs can be proportionally reduced without a reduction in output. In this case it can be indicated in percentage terms by the ratio BA/OA, which represents the percentage of all inputs that require to be reduced to obtain technically efficient production.

Thus, technical efficiency can be measured by the ratio OB/OA (Farrell, 1957; Coelli *et al.*, 2005). Technical efficiency is, therefore, also equal to one minus BA/OA, which takes a value between zero and one. It also provides an indication of the degree of technical efficiency of the firm. Hence, a value of one indicates that the firm is fully technically efficient. Point B is technically efficient, because this point lies on an efficient isoquant line (II′). Figure 3.3 represents two inputs and a single output production technology (Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Assaf, 2007). An input-orientated measure of technical efficiency of the firm can be described by input distance function $d_i(x,q)$ as follows (Coelli *et al.*, 2005):

$$\text{Technical Efficiency (TE)} = 1/d_i(x,q) \quad (3.1)$$

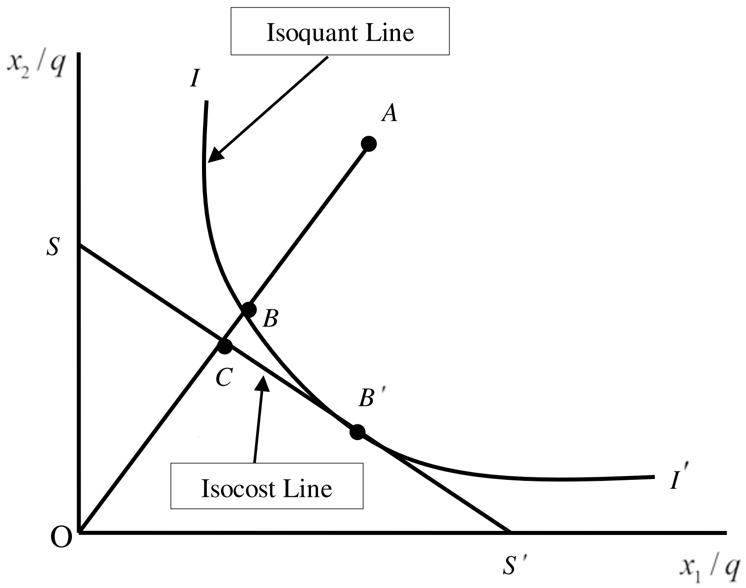
From equation 3.1, a technically efficient firm lies on the frontier; in this case TE = 1 and $d_i(x,q)$ is equal to one. In the presence of input price information, it is possible to measure the cost-efficiency of the firm. The input price ratio can be represented by the slope of the isocost line (SS′) in Figure 3.3. This is also known as allocative efficiency and technical efficiency. Hence, allocative efficiency and technical efficiency measures can be calculated utilising the isocost line; these can be defined as (Coelli, 1996a; Coelli *et al.*, 2005):

$$\text{Allocative Efficiency (AE)} = OC/OB$$
$$\text{Technical Efficiency (TE)} = OB/OA \quad (3.2)$$

[54] The term "fully-efficient firms" must be estimated from observation on the sample of firms in a specific industry.

Equation 3.2 follows from the observation that the distance CB represents a reduction in production costs that can occur if the production were to occur at allocatively and technically efficient point B', instead of at the technically efficient but allocatively inefficient point B.

Figure 3.3: Two Inputs and Single Output Production Technology

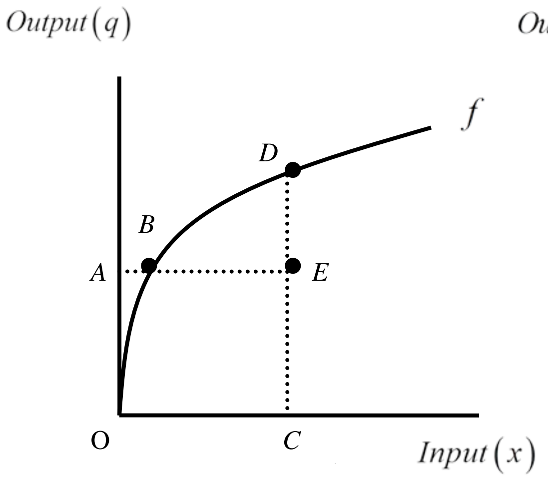


Source: Adapted from Coelli *et al*. (2005, p52)

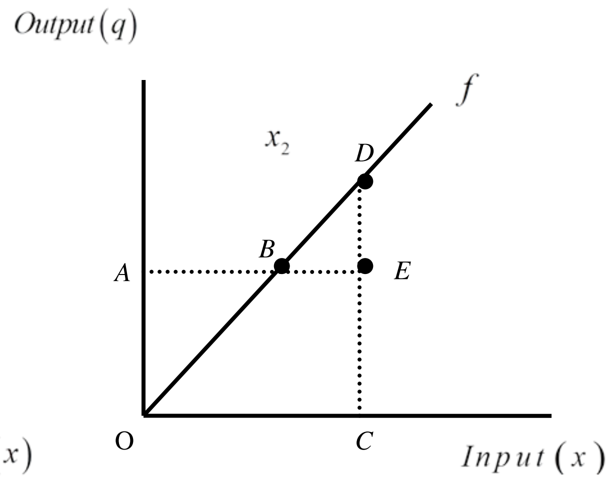
3.6.3 Output-Orientated Measures

The distinction between output and input-orientated measures can be represented by utilising a single input (x) and a single output (y). These are drawn in Figure 3.4, which consists of two diagrams. Figure 3.4 (a) illustrates decreasing returns to scale (DRS), represented by the line O*f* (the production frontier), and an inefficient firm operating at point E. The Farrell (1957) input-orientated measure of technical efficiency is equal to the ratio AB/AE, whereas an output-orientated measure of technical efficiency can be represented by CE/CD. Thus, output and input-orientated measures of technical efficiency are equivalent measures of technical efficiency when CRS exist (Färe and Lovell, 1978; Coelli *et al.*, 2005). The case of CRS is depicted in Figure 3.4 (b), where it can be observed that AB/AE = CE/CD, for an inefficient firm operating at point E.

Figure 3.4: Input- and Output-Oriented Technical Efficiency Measures and Types of Returns to Scale



(a) Decreasing Return to Scale (DRS)

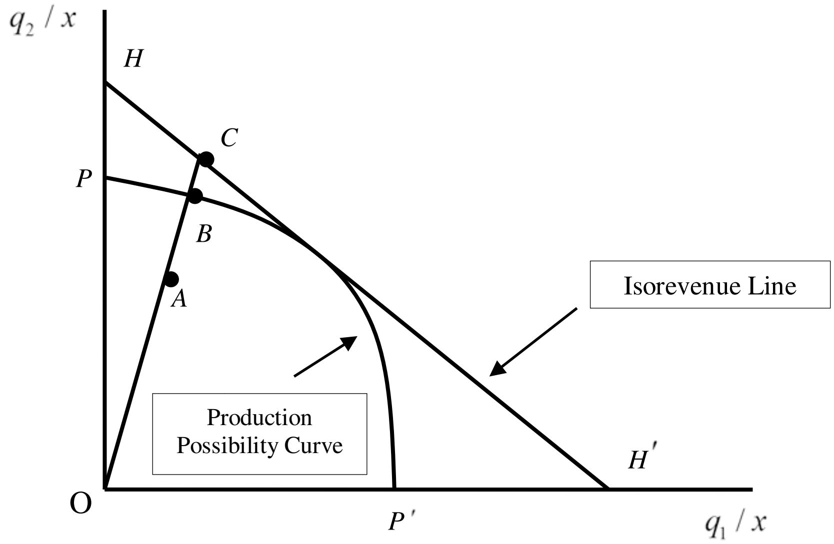


(b) Constant Returns to Scale (CRS)

Source: Adapted from Coelli *et al.* (2005, p55)

The output-orientated measures can, moreover, be represented by utilising two outputs (q_1 and q_2), and one input (x). If we assume CRS, we can represent the technology by a production possibility curve (PP') in two dimensions (Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Moffat, 2008). This can be shown in Figure 3.5, where the curve PP' is a production possibility curve and point A corresponds to an inefficient firm. An inefficient firm operates at a point such as A which lies underneath the curve, PP', which represents the upper bound of the production possibilities. The distance between A and B represents technical inefficiency, where output can be increased without requiring any more inputs. Hence, a measure of output-orientated technical efficiency is defined by the ratio OA/OB. In addition, if price information is available, we can depict the isorevenue line (HH'). Technical and allocative efficiencies can be measured by the ratios OA/OB and OB/OC, respectively (see Figure 3.5) (Coelli *et al.*, 2005).

Figure 3.5: Technical and Allocative Efficiencies from Output-orientated Measures



Source: Adopted from Coelli *et al*. (2005, p55)

3.7 SUMMARY

This chapter has discussed the role of SMEs in an economy and globalisation. SMEs contribute importantly to an economy in several ways, including the number of business establishments, employment, creation of economic opportunities, local economic development, economic empowerment, entrepreneurship and poverty reduction (Hallberg, 2000; McMahon, 2001; Biggs, 2002; Kirby and Watson, 2003; Beck *et al.*, 2005; Harvie, 2007; Harvie and Lee, 2008; Audretsch *et al.*, 2009; Le, 2010). SMEs have the potential to play a significant role in the current and future development of both developed and developing economies. This chapter has also specified that SMEs play a crucial role in creating a substantial proportion of employment and jobs and are the major source of newly generated jobs (Hallberg, 2000; Biggs, 2002; Beck *et al.*, 2005; Harvie and Lee, 2005a; Le, 2010). SMEs can be seen as a significant seedbed for innovation and entrepreneurship and play a seedbed role by being the breeding ground for new and large enterprises (Luetkenhorst, 2005; Wang *et al.*, 2007; Audretsch *et al.*, 2009). In addition, this chapter has discussed the major competitive strategies of SMEs in the age of globalisation and discussed barriers to SME access to international markets.

This chapter has also conducted a literature review on the size distribution of firms in the economy. Potential factors that can determine the size distribution of firms in the economy are: economies of scale; transaction costs and market structure; consumption patterns; degree of market competition; resource endowment; technology; stage of economic development; and institutions and taxation (Ace and Audretsch, 1990; Hallberg, 2000; McMahon, 2001; Biggs, 2002; Beck *et al.*, 2005; Harvie and Lee, 2008; Audretsch *et al.*, 2009; Yang and Chen, 2009; Le, 2010).

This chapter has also discussed the typical performance measures of SMEs in the literature, including profitability, exports and growth (Rosa and Scott, 1999; Regnier, 2000; Nguyen, 2001; Liedholm, 2002; Bartlett, 2004; Chen *et al.*, 2007; Serrasqueiro, 2008; Tambunan, 2008b; Park *et al.*, 2009). These performance measures have traditionally been used as the most important indicators of SME success (Storey, 1994; Hallberg, 2000; McMahon, 2001; Mambula, 2002; Beck et al., 2005; Pasanen, 2007; Tambunan, 2008a).

This chapter has also conducted a review of the literature on the measurement of efficiency. The performance of a firm can be measured in terms of economic efficiency, including technical and allocative efficiencies (Farrell, 1957; Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Arunsawadiwong, 2007; Assaf, 2007). Technical efficiency is referred to as the ability of the firm to produce the maximum possible output from a given bundle of inputs. Allocative efficiency is defined as the firm's ability to use inputs in optimal proportions given their respective prices (Rogers, 1998; Herrero and Pascoe, 2002; Mortimer, 2002; Coelli *et al.*, 2005). Furthermore, this chapter has discussed the concept of efficiency and a measure of input- and output-orientated technical efficiency and types of returns to scale. Finally, the basic measures of technical and allocative efficiencies from output-orientated measures have been discussed in this chapter.

Finally, the key issues identified in this chapter will be linked and developed in subsequent chapters. The following chapter will review the research methodology to be utilised for the empirical analysis conducted in Chapters 6 and 7. Chapter 4 will also compare and discuss the difference between non-parametric and parametric approaches, which include DEA and SFA approaches, for measuring the technical efficiency of Thai manufacturing SMEs.

CHAPTER 4

METHODOLOGY

4.1 INTRODUCTION

Following the literature review of the concepts of efficiency, production frontier, technical efficiency, scale efficiency, types of returns to scale, and the measurement of efficiency in the previous chapter, the principle objective of this chapter is to provide an overview and a detailed discussion of the research methodology to be used in the estimation of technical efficiency of Thai manufacturing SMEs. The two most common approaches of estimating a production frontier, and thus technical efficiency, are data envelopment analysis (DEA) and stochastic frontier analysis (SFA). DEA is a non-parametric approach that makes no assumptions concerning the form of the production function. SFA, on the other hand, is a parametric approach where the form of the production function is assumed to be known, or is estimated statistically (Admassie and Matambalya, 2002; Coelli *et al.*, 2005; Arunsawadiwong, 2007; Zahid and Mokhtar, 2007; Kontodimopoulos *et al.*, 2010; Le, 2010; Amornkitvikai and Harvie, 2011; Charoenrat and Harvie, 2012). The theoretical foundations of the DEA and SFA approaches are discussed in detail in this chapter.

The structure of this chapter is as follows: Section 4.2 outlines the methodologies adopted in this study, namely the DEA and SFA approaches. This section also compares and identifies key differences between these approaches. Section 4.3 provides an overview of the DEA approach, which can be used to predict scale efficiency, constant returns to scale (CRS) technical efficiency and variable returns to scale (VRS) technical efficiency. Section 4.4 provides a detailed discussion of the SFA approach, which can be adopted for estimating a firm's technical efficiency. Section 4.5 explains technical progress and efficiency improvement in the DEA and SFA frontiers. Finally, a summary of the major conclusions from this chapter is presented in Section 4.6.

4.2 APPROACHES FOR MEASURING TECHNICAL EFFICIENCY

4.2.1 Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) Approaches

The two most commonly-used techniques for estimating technical efficiency and a production frontier, and predicting maximum possible firm output, are the DEA and SFA approaches (Coelli, 1996a, 1996b; Mortimer, 2002; Coelli *et al.*, 2005). DEA is a non-parametric approach that involves the use of a linear programming method to construct a frontier and measure technical efficiency (Coelli, 1996b; Coelli *et al.*, 2005; Cooper *et al.*, 2006; Assaf, 2007; Kontodimopoulos *et al.*, 2010; Lee, 2011, 2013). Coelli *et al.* (2005); Moffat (2008) and Lee (2011) highlight that the DEA technique is computationally simple and is based upon production theory as a means to measure production efficiency. DEA adopts a deterministic approach to determine the relatively efficient production frontier, which is based on a chosen mix of inputs and outputs of a number of entities (namely, decision making units (DMUs)). From the set of available data, DEA identifies reference points (relatively efficient DMUs) that define an efficient frontier as the best practice production technology, and then estimates the inefficiency of other units and the interior points (relatively inefficient DMUs) that are within the frontier (Coelli *et al.*, 2005; Lee, 2011).

DEA does not require *a priori* assumptions concerning the specific form of the production function (Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Cooper *et al.*, 2006; Arunsawadiwong, 2007; Assaf, 2007; Moffat, 2008; Lee, 2011). The best practice production function is estimated empirically from observed inputs and outputs. However, DEA precludes the possibility of evaluating the marginal products and the elasticity of substitution of the production technology. Furthermore, DEA does not identify the difference between technical inefficiency and random error. By utilising linear programming methods to measure technical efficiency, it produces no standard errors, with deviations from a frontier treated as technical inefficiency, leaving no provision for random shocks of any type (Admassie and Matambalya, 2002; Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Cooper *et al.*, 2006; Arunsawadiwong, 2007; Assaf, 2007; Zahid and Mokhtar, 2007; Lee, 2011).

Furthermore, DEA is a deterministic rather than statistical technique and is thus sensitive to the measurement of random errors. For instance, if the inputs or outputs of firms are underestimated or overestimated, then these firms can become outliers. DEA significantly distorts the shape of the frontier and reduces the technical efficiency score of other firms, included in the sample. It also does not provide a means for hypothesis testing concerning the presence of technical inefficiency or the structure of production technology, because the mathematical programming techniques have estimators with unknown statistical properties (Wadud, 2003; Assaf, 2007; Seelanatha, 2007). In summary, DEA has the following limitations and problems (Mortimer, 2002; Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Cooper *et al.*, 2006; Arunsawadiwong, 2007; Assaf, 2007; Seelanatha, 2007; Moffat, 2008):

(1) DEA can be extremely sensitive to variable selection and measurement errors. The basic assumption is that random errors do not exist and all deviations from the frontier indicate inefficiency.

(2) Errors in measurement and other noise can influence the shape and the position of the frontier. Outliers could affect results.

(3) DEA has no production, cost, and profit functions that can be estimated from the data. It precludes the possibility of evaluating marginal products, partial elasticities and marginal costs.

(4) DEA uses the linear programming technique to estimate efficiency components. It is a non-statistical technique that makes the linear programming solution of DEA produce no standard errors, and leaves no room for hypothesis testing.

(5) Exclusion of significant inputs or output can result in biased results. The efficiency scores obtained are only relative to the best firms in the sample. The inclusion of extra firms can reduce efficiency scores.

These limitations make the use of the DEA approach unfavourable in various situations such as Admassie and Matambalya (2002); Coelli *et al.* (2005); Arunsawadiwong (2007); Assaf (2007); Kontodimopoulos *et al.* (2010); and Amornkitvikai and Harvie (2011). An alternative approach to solve these problems is the SFA approach. SFA is a parametric approach where the form of the production function is assumed to be known or is estimated statistically. SFA also allows other parameters of the production technology to be explored. The advantages of this approach are that hypotheses can be tested with statistical rigour, and that relationships between inputs and outputs follow known functional forms. However, the SFA approach is more computationally demanding than the DEA approach

(Coelli *et al.*, 2005; Assaf, 2007; Kontodimopoulos *et al.*, 2010; Le, 2010; Amornkitvikai, 2011).

When compared to the conventional econometric approach, the SFA approach is superior in that it estimates the best practice technology upon which the production function concept is based, while the former case is based on averaging estimators. Therefore, the conventional econometric model may produce results that are fundamentally inconsistent with the definition of the production function (Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Arunsawadiwong, 2007; Assaf, 2007). Estimation of the frontier production function provides a tool for measuring the technical efficiency level of each firm within the given sample (Assaf, 2007). Modelling the production function in the context of SFA[55] is consistent with production function theory (Coelli *et al.*, 2005; Major, 2008; Le, 2010). Moreover, SFA is employed because of its superior conceptual treatment of noise. This method takes into account measurement errors as well as other random factors, such as the effect of weather, strikes, and luck on the value of output variables, together with the combined effects of unspecified input variables in the production function (Coelli, 1996a; Wadud, 2003; Coelli *et al.*, 2005; Cooper *et al.*, 2006).

Coelli *et al.*(2005); Assaf (2007); and O'Donnell *et al.*(2009) point out that SFA allows not only just for the measurement of inefficiency, but also acknowledges the fact that random shocks outside the control of the firm can influence the level of output. The important concept behind SFA is that the error term can be decomposed into two components: the first error component is assumed to follow a symmetric distribution (the standard error), and the other component reflects inefficiency and is assumed to follow common distributions, including half-normal, truncated and exponential distributions. As a consequence, the SFA-based model yields technical efficiency that is free from distortion and statistical noise inherent in the deterministic DEA model. However, there are some arguments against the usage of SFA which are as follows: (Favero and Papi, 1995; Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Assaf, 2007; Seelanatha, 2007; Moffat, 2008; O'Donnell *et al.*, 2009; Kontodimopoulos *et al.*, 2010):

[55] SFA offers flexibility in modelling different aspects of the production function, such as production and marketing risks.

(1) Many studies based upon a parametric approach are unable to incorporate the different technologies of both large and small firms together in a single model. For example, the commonly used Cobb-Douglas and Translog production functions provide a poor approximation when applied to firms of all sizes.

(2) The parametric approach utilises a specific production functional form for the production function and the shape of the production frontier is pre-assumed.

(3) It is difficult to implement in multi-input and multi-output settings.

(4) Results obtained from a parametric approach are critically influenced by the size of the sample. If there is a small sample size, the estimated econometric model can provide ambiguous results. DEA is more applicable for the case of a small sample size.

Furthermore, in order to understand the difference between the DEA and SFA approaches, it is important to consider the production process in which a single input (X_i) is used to generate a single output (Y_i) (Wadud, 2003; Coelli *et al.*, 2005; Smith and Street, 2005). The line O*f* in Figures 4.1 (a) and (b) illustrates the DEA and SFA frontiers. O*f* defines the relationship between input and output. It also indicates the maximum output achievable from each input level. As presented in Figure 4.1 (a), in the DEA[56] approach, the location and shape of the efficiency frontier can be determined only by extreme observations (Smith and Street, 2005). This is different from the SFA frontier, which measures the estimated frontier from the behaviour of all observed organisations (see Figure 4.1 (b)).

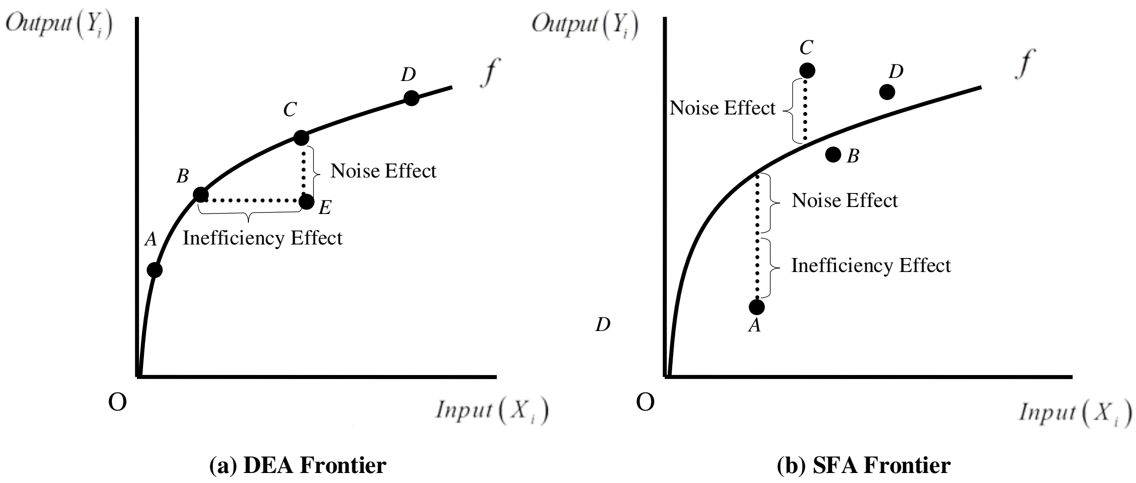
Hence, the DEA efficient frontier comprises the piece-wise linear frontier that interpolates between those extreme observations with the highest ratios of output to input. As a result, the DEA frontier envelops all observations. In Figure 4.1(a), observations *A, B, C* and *D* are considered efficient points at the scale of their operations. The inefficient point of the observation *E* is indicated by its vertical or its horizontal distance from the DEA frontier. In order to lie on the production frontier, the observation (DMUs) *E* is required to use more input to operate at a similar level of output to the observation *B,* and despite using a similar amount of input to the observation *C,* it produces less output (Wadud, 2003; Coelli *et al.*, 2005; Smith and Street, 2005; Le, 2010).

---

[56] DEA is based upon the simple notion that an organisation that uses less input than another to generate the same amount of output can be considered more efficient (Smith and Street, 2005).

By contrast, the SFA frontier does not necessarily correspond to the line of best fit through all observations that can be produced by a simple regression model. The SFA frontier also does not essentially have to pass through the observation that operates the maximum level of output conditional on inputs (the observation *C*) (see Figure 4.1(b)) (Smith and Street, 2005). The reason for this is that the SFA frontier is estimated after recognising that some of the differences between observed output and the level of output that is predicted by the explanatory variables (firm-specific factors) may be attributed to noise (Smith and Street, 2005; Le, 2010). In Figure 4.1(b) the observation *C* lies above the frontier as the SFA approach allows for a noise effect. From this case, noise is both positive and larger than the inefficiency effects. For the observation *B*, which lies below the frontier, the shortfall reflects both a noise effect and inefficiency effects (Wadud, 2003; Coelli *et al.*, 2005; Smith and Street, 2005; Le, 2010). Table 4.1 summarises the main attributes of the DEA and SFA approaches.

Figure 4.1: The Difference between DEA and SFA Frontiers



Source: Adapted from Smith and Street (2005) and Le (2010)

Table 4.1: Attributes of the DEA and SFA Approaches

Main Attributes	DEA	SFA
Measurements	Non-parametric Approach	Parametric Approach
Pre-specific Functional Form	x	✓
Allows for Inefficiency	✓	✓
Accounts for Statistical Noise	x	✓
Identifies Returns to Scale	✓	x
Measures Technical Efficiency	✓	✓
Measures Allocative Efficiency	✓	✓
Measures Technical Inefficiency Effects	x	✓
Measures Technical Change	✓	✓
Measures Total Factor Productivity (TFP)	✓	✓
Uses Cross Sectional Data	✓	✓
Uses Panel Data	✓	✓
Uses Unbalanced Panel Data	✓	✓
Captures Input Quantities	✓	✓

Source: Herrero and Pascoe (2002); Coelli *et al*. (2005) and Arunsawadiwong (2007)

4.3 DATA ENVELOPMENT ANALYSIS (DEA)

This section provides an extensive review of the literature on the DEA approach. It proceeds as follows: (1) the input-orientated DEA model, (2) the output-orientated DEA model, (3) the problem of slacks in the DEA model, and (4) the two-stage DEA model and a Tobit model.

4.3.1 The Input-orientated DEA Model

DEA is a non-parametric mathematical approach that involves the use of a linear programming method to construct a production frontier and to estimate technical efficiency (Coelli, 1996b; Zhu, 2003; Coelli *et al.*, 2005; Cooper *et al.*, 2006; McDonald, 2009; Lee, 2011). The term "DEA" was first proposed by Charnes, Cooper, and Rhodes (1978) (CCR model), having an input orientation and assumed constant returns to scale (CRS) in the production function. The input-orientated CRS model assumes that all firms are operating at an optimal scale. Thus, DEA can be represented as the ratio of all outputs over all inputs as follows (Charnes *et al.*, 1978; Alvarez and Crespi, 2003; Zhu, 2003; Coelli *et al.*, 2005; Cooper *et al.*, 2006; McDonald, 2009; Amornkitvikai, 2011):

$$\frac{u'y_i}{v'x_i} \tag{4.1}$$

where each of the *i* firms is represented by the vectors of outputs (y_i) and inputs (x_i). *u* and *v* are weights obtained by solving the mathematical programming problem as follows (Alvarez and Crespi, 2003; Coelli *et al.*, 2005; Cooper *et al.*, 2006; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011):

$$\begin{aligned} & Max_{u,v} \quad \left(\frac{u'y_i}{v'x_i}\right), \\ & \textit{Subject to} \quad \frac{uy_j}{v'x_j} \leq 1, \quad j = 1, 2, ..., I, \\ & \qquad u, v \geq 0. \end{aligned} \tag{4.2}$$

where there are data on *x* inputs and *y* inputs for each of *i* firms. *u* is a *m* x 1 vector of output weights, *v* is a *n* x 1 vector of input weights, *y* is a *m* x 1 output matrix and *x* is a *n* x 1 input matrix. These equations involve finding values for *u* and *v* such that the efficiency measure for the *i-th* firm is maximised, subject to the restrictions that (1) all efficiency measures for firms must be less than or equal to one, and (2) the values for *u* and *v* must be equal to or greater than zero. However, there is a problem with the efficiency ratio obtained from this specification (equation 4.2), because it has infinite solutions. To avoid this problem, the restriction $v'x = 1$ is imposed, and the maximisation problem can be specified as follows (Alvarez and Crespi, 2003; Coelli *et al.*, 2005; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011):

$$\begin{aligned} & Max_{u,v} \quad (u'y_i), \\ & \textit{Subject to} \quad v'x_i = 1, \\ & \qquad u'y_j - v'x_j \leq 0, \quad j = 1, 2, ..., I, \\ & \qquad u, v \geq 0. \end{aligned} \tag{4.3}$$

Utilising the duality in linear programming, the equivalent maximisation problem can be derived as follows (Alvarez and Crespi, 2003; Coelli *et al.*, 2005; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011):

$$\begin{aligned} &Min_{\theta,\lambda} && \theta, \\ &Subject\ to && -y_i + Y\lambda && \geq 0, \\ & && \theta x_i - X\lambda && \geq 0, \quad j = 1, 2, ..., I, \\ & && \lambda && \geq 0. \end{aligned} \qquad (4.4)$$

where θ is a scalar (an efficiency parameter) and λ is a I x 1 vector of constants. The specification of the CRS model (equation 4.4) is also known as the multiplier form. The value of θ specifies the efficiency score for the *i-th* firm. If the value[57] of θ is equal to one, this indicates that a firm is technically efficient, whereas a value of less than one specifies that the firm is technically inefficient (Coelli *et al.*, 2005; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011). However, it is possible that firms do not operate at optimal scale efficiency due to government regulations, imperfect competition and financial restrictions. With these problems it is not applicable to use the CRS model if not all firms are operating at optimal scale efficiency, because the estimated results for technical efficiency can be confused with scale efficiencies.

Thus, several empirical studies have suggested adjusting the CRS model to account for variable returns to scale (VRS) (Färe *et al.*, 1983; Banker *et al.*, 1984; Zhu, 2003; Coelli *et al.*, 2005; Cooper *et al.*, 2006). The use of the VRS specification allows for estimates of technical efficiency which is devoid of scale efficiencies. Equation (4.4) demonstrates that the CRS model can be modified to account for the VRS model by including the convexity constraint $\left(I1'\lambda = 1\right)$ as follows (Alvarez and Crespi, 2003; Coelli *et al.*, 2005; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011):

[57] The linear programming problem can be solved I times, once for each firm in the sample. As a result the value of θ is obtained for each firm (Coelli *et al*., 2005).

$$
\begin{aligned}
&Min_{\theta,\lambda} && \theta, \\
&Subject\ to && -y_i + Y\lambda && \geq 0, \\
& && \theta x_i - X\lambda && \geq 0, \quad j = 1, 2, ..., I, \\
& && I1'\lambda && = 1, \\
& && \lambda && \geq 0.
\end{aligned}
\tag{4.5}
$$

where $I1'$ is an I x 1 vector of ones. There are I rows and one column in which all values are equal to unity. The convexity constraint $(I1'\lambda = 1)$ basically ensures that inefficient firms can only be benchmarked against similar firms in terms of size. For the CRS model this convexity constraint is not imposed, and thus the firm can be benchmarked against firms that are substantially larger or smaller than it. In addition, the λ weights can add up to a value less than unity or greater than unity (Färe *et al.*, 1983; Banker *et al.*, 1984; Zhu, 2003; Coelli *et al.*, 2005; Cooper *et al.*, 2006; Amornkitvikai, 2011).

4.3.2 The Output-orientated DEA Model

The output-orientated VRS model assumes that firms are not operating at the optimal scale efficiency due to several constraints, such as government regulations and imperfect competition in financial markets and capital structure (Coelli *et al.*, 2005; Cooper *et al.*, 2006; Seelanatha, 2007; Racic *et al.*, 2008; Amornkitvikai, 2011). The output-orientated VRS model is utilised assuming fixed input quantities and maximised output production. Thus, the output-orientated[58] DEA model under the assumption of VRS can be expressed as follows (Alvarez and Crespi, 2003; Wadud, 2003; Coelli *et al.*, 2005; Hoff, 2007; Amornkitvikai, 2011):

$$
\begin{aligned}
&Max_{\phi,\lambda} && \phi, \\
&Subject\ to && -\phi y_i + Y\lambda && \geq 0,
\end{aligned}
$$

[58] The output-orientated DEA model (equation 4.6) is quite similar to the input-orientated DEA model (equation 4.5), except that ϕ is imposed while θ is removed from Equation 4.5 (Alvarez and Crespi, 2003; Coelli *et al.*, 2005; Amornkitvikai, 2011).

$$x_i - X\lambda \geq 0, \quad j = 1, 2, ..., I,$$
$$I1'\lambda \leq 1,$$
$$\lambda \geq 0. \qquad (4.6)$$

Where:

ϕ is a scalar (an efficiency parameter). $1 \leq \phi < \infty$ and $\phi - 1$ represents the proportional increase in outputs (y_i) that can be obtained by the *i-th* firm, while holding input quantities (x_i) constant;

$\frac{1}{\phi}$ is the technical efficiency score that varies between zero and unity and defines a technical efficiency score for the *i-th* firm;

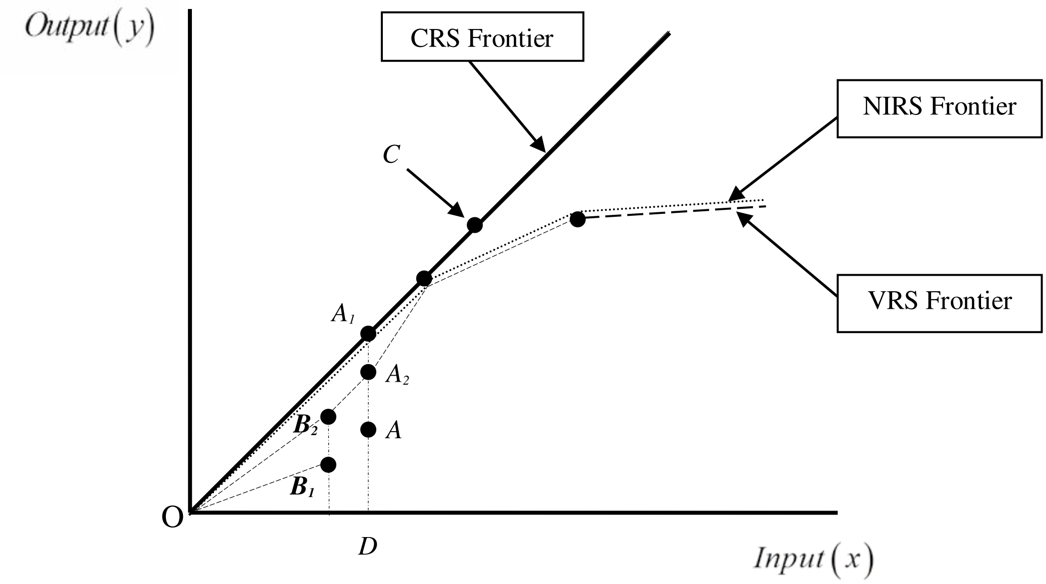
x_i is an input vector for the *i-th* firm;

λ is a vector of constants; and

$I1'\lambda$ represents non-increasing returns to scale (NIRS).

The output-orientated DEA model under the VRS takes the *i-th* firm and then radially expands the output vector (y_i) for the *i-th* firm as much as possible, while still remaining within the feasible output set. The inner-boundary of this output set represents a linear production possibility curve that can be determined by all firms in the sample. The output-orientated DEA model replaces the convexity constraints which are imposed for the VRS: $I1'\lambda = 1$ and VRS: $I1'\lambda \leq 1$. The modified VRS: $I1'\lambda \leq 1$ specifies that the VRS can only have non-increasing returns to scale. It can be stated that the constraint: $I1'\lambda \leq 1$ ensures that the *i-th* firm is not benchmarked against firms that are larger than it, but is set to be compared with firms that are smaller than it (Alvarez and Crespi, 2003; Wadud, 2003; Coelli *et al.*, 2005; Hoff, 2007; Amornkitvikai, 2011). Hence, the output-orientated DEA model under the assumption of VRS can be demonstrated with Figure 4.2:

Figure 4.2: Efficiency Measurement under the Output-orientated DEA Model



Source: Adapted from Coelli *et al*. (2005) and Amornkitvikai (2011)

Figure 4.2 describes that the firm uses a single input (*x*) to produce a single output (*y*). The CRS technical inefficiency can be expressed by the distance between A to A_1. The VRS technical inefficiency can be demonstrated by the distance between A to A_2. The difference between the CRS and VRS technical inefficiencies, which can be expressed by the distance between A_1 to A_2, specifies scale inefficiency. The VRS technical efficiency can be demonstrated by the distance ratio DA_2 to DA, while the CRS technical efficiency can be expressed by the ratio DA_1 to DA. Thus, the scale efficiency can be represented as the ratio of the CRS technical efficiency to the VRS technical efficiency (DA_1/DA_2).

However, the disadvantage of the estimate of scale efficiency is that it does not specify whether the firm is operating under constant, increasing, or decreasing returns to scale (Alvarez and Crespi, 2003; Wadud, 2003; Coelli *et al.*, 2005; Hoff, 2007; Amornkitvikai, 2011). In solving this problem, the term 'non-increasing returns to scale' (NIRS, $I1'\lambda \leq 1$) is imposed in conducting empirical analysis for constant, increasing and decreasing returns to scale (see Equation 4.6). If the NIRS technical efficiency is equal to the VRS technical efficiency, as is the case for point C in Figure 4.2, then decreasing returns to scale exist for this firm. If the NIRS technical efficiency and the VRS technical efficiency are unequal, as is the case for point *A* in Figure 4.2, then increasing returns to scale apply. If the CRS technical efficiency is equal to VRS technical efficiency, constant returns to scale apply (see Figure 4.2) (Färe *et al.*, 1983; Wadud, 2003; Coelli *et al.*, 2005; Amornkitvikai, 2011).

Furthermore, input and output-orientated models are the most commonly used form of the DEA approach (Coelli *et al.*, 2005; Hoff, 2007; Kontodimopoulos *et al.*, 2010; Amornkitvikai, 2011). First, the input-orientated DEA model can estimate technical efficiency as a proportional reduction in input usage, with output levels held fixed. The input-orientated model is appropriate when firms have fixed output levels, and hence they are forced to minimise their input usage. Second, the output-orientated DEA model can measure technical efficiency as a proportional increase in output production when input levels are constant. The output-orientated model is practical when firms have fixed input quantities, and thus they are forced to maximise output production. Therefore, Coelli *et al.* (2005); Cooper *et al.*(2006); and McDonald (2009) emphasise that input- and output-orientated DEA models can provide the same technical efficiency scores under the assumption of constant returns to scale (CRS), but the technical efficiency scores are unequal when variable returns to scale (VRS) is assumed.

4.3.3 The Problem of Slacks in the DEA Model

There is a problem with the DEA model frontier for firms operating parallel to the axes, causing the problem of slacks. For example, when a firm is operating on a frontier or on an efficient point, and the amount of inputs can be reduced without changing the output, it is called ‘input slack’ or ‘input excess problem’ in the case of the input-orientated DEA model (Wadud, 2003; Zhu, 2003; Coelli *et al.*, 2005; Cooper *et al.*, 2006; Amornkitvikai, 2011). For the output-orientated DEA model this problem is known as ‘output slack’ or ‘output excess’, when the firm’s production can be increased without utilising any more inputs. Mortimer (2002); Coelli *et al.* (2005); and Cooper *et al.* (2006) suggest there are a number of methods that can be utilised to treat the problem of slacks, such as first-stage DEA, two-stage DEA and multi-stage DEA. The single-stage DEA can solve the problem of slacks through linear programming, for example in the output-oriented DEA model under the VRS (equation 4.6) where slacks can be calculated residually. The two-stage DEA can maximise the sum of slacks required to move from the single-stage projected point, as in the case for point B_1 in Figure 4.2, to an efficient point (as is the case for point B_2) in Figure 4.2.

However, the two-stage DEA is appropriate when there is only one efficient point to choose from the vertical facet, but it is inappropriate when there are two or more dimensions of slacks. Thus, the multiple-stage DEA is useful, since it is invariant to units of measurement and its efficient projected points contain input and output mixes that are similar to those of inefficient points (Mortimer, 2002; Wadud, 2003; Zhu, 2003; Coelli *et al.*, 2005; Amornkitvikai, 2011). Furthermore, the treatment of slacks can be applied by a DEA (computer) program (DEAP) version 2.1, developed by Coelli (1996b). The DEAP program consists of three options in addressing the treatment of slack: (1) one-stage DEA, (2) two-stage DEA, and (3) multi-stage DEA. Therefore, the multi-stage DEA is the method used to measure VRS and CRS technical efficiencies for the first-stage DEA. In addition, scale efficiency can be obtained by estimating CRS and VRS technical efficiencies. Technical efficiency can be decomposed into scale inefficiency and pure technical inefficiency under the assumption of VRS.

4.3.4 The Two-stage DEA Model and a Tobit Model

The two-stage technique is most often used for the DEA approach. It deals with explanatory variables or firm-specific factors (i.e., firm size, firm age, skilled labour, firm location, region and ownership characteristics) that could influence a firm's technical efficiency. The two-stage method can accommodate more than one firm-specific factor, which can be continuous, categorical or classificatory. It does not require prior assumptions concerning the direction of the influence of explanatory variables or firm-specific factors. Thus, a two-stage DEA comprises two steps (Alvarez and Crespi, 2003; Wadud, 2003; Coelli *et al.*, 2005; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011): (1) the first-stage DEA involves solving a linear programming problem utilising traditional inputs and outputs, as discussed above, and (2) in the second-stage DEA the technical efficiency scores obtained from the first stage DEA are regressed upon explanatory variables or firm-specific factors using ordinary least squares (OLS) regression.

Thus, the method of OLS regression can predict technical efficiency which is greater than unity. The signs of the estimated coefficients of firm-specific factors can specify the directions of influence, and formal hypothesis tests can be utilised to test the strength of the relationships (Coelli *et al.*, 2005; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011).

In addition to the second-stage DEA model a number of empirical studies (Alvarez and Crespi, 2003; Coelli *et al.*, 2005; Hoff, 2007; McDonald, 2009; Amornkitvikai and Harvie, 2010; Amornkitvikai, 2011) emphasise that the Tobit[59] regression technique is also recommended and can be adopted as the natural choice for modelling DEA scores in the second-stage estimations. The Tobit model is also an alternative approach to that of OLS regression and is appropriate for the case of truncated data (Kumbhakar and Lovell, 2000; Coelli *et al.*, 2005; Hoff, 2007; Amornkitvikai, 2011). Furthermore, the Tobit regression hypothesis tests can be conducted to test for the statistical significance of firm-specific factors and explanatory variables on a firm's technical inefficiency.

However, the disadvantage of the Tobit model is that if the variables used as inputs and outputs in the first-stage DEA are highly-correlated with firm-specific variables in the second-stage DEA, the results are likely to be biased. The second stage of the two-stage DEA model can be conducted by regressing firm-specific factors and explanatory variables on the firm's VRS technical inefficiency scores using Tobit regression, which can be estimated from the first step of the two-stage DEA model (Alvarez and Crespi, 2003; Coelli *et al.*, 2005; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011).

The technical efficiency scores of the firm are utilised as the dependent variable, which can be obtained by subtracting the technical efficiency scores estimated from the output-orientated DEA model from unity (Coelli *et al.*, 2005; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011). The set of firm-specific factors and explanatory variables can be utilised as independent variables for the two-stage DEA model. The estimated technical inefficiency scores are bounded between zero and unity. In addition, applying the technique of OLS regression with such a dependent variable that has values bounded between zero and unity may lead to

---

59 The advantage of the Tobit model is that it is easy to calculate and is straightforward and transparent (Coelli et al., 2005; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011).

biased and inconsistent estimators, since the OLS regression can predict technical inefficiency scores which are greater than unity. Therefore, the maximum likelihood method for a two-limit Tobit model can be written as follows (Alvarez and Crespi, 2003; Coelli *et al.*, 2005; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011):

$$(1-\theta_i)^* = \delta_0 + \sum_i^j \delta_j z_j + \varepsilon_i \qquad (4.7)$$

$$(1-\theta_i) = \begin{cases} (1-\theta_i)^* & \text{if} \quad 0 < (1-\theta_i)^* < 1 \\ 0 & \text{if} \quad (1-\theta_i)^* \leq 0 \\ 1 & \text{if} \quad (1-\theta_i)^* \geq 1 \end{cases}$$

Where:

$(1-\theta_i)^*$ denotes the unobserved technical inefficiency scores for the *i-th* firm;

$(1-\theta_i)$ represents the observed technical inefficiency scores for the *i-th* firm;

δ_j is an unknown parameter to be estimated for each explanatory variable or firm-specific factors of the *i-th* firm;

z_j is explanatory variables or firm-specific factors of the *i-th* firm; and

ε_i is a random variable, which is assumed to be an independently and identically distributed normal variable with zero mean and variance, $\varepsilon_i \sim iidN((0, \sigma_\varepsilon^2))$.

4.4 STOCHASTIC FRONTIER ANALYSIS (SFA)

This section provides a literature review of the theoretical foundations of the SFA approach. It comprises four sections: (1) the production function and criteria for selecting the functional form, (2) comparison between the Cobb-Douglas and Translog production functions, (3) a stochastic production frontier with cross-sectional data, and (4) a stochastic frontier model and technical inefficiency effects model.

4.4.1 The Production Function and Criteria for Selecting the Functional Form

A production function describes one dependent variable as a function of one or more independent variables. For instance, a production function expresses a single output as a function of various inputs. Thus, a production function can be written as (Kumbhakar and Lovell, 2000; Coelli *et al.*, 2005):

$$Y = f(X_1, X_2, ..., X_N) \tag{4.8}$$

Where:

Y represents the dependent variable;

$X_n (n = 1, ..., N)$ denotes independent variables; and

$f(.)$ represents a mathematical function concerning economic theory.

Thus, the first stage in estimating the relationship between dependent and independent variables is to specify an algebraic form of $f(.)$. It is necessary to discuss and review the functional form that can be used in the estimation of the stochastic frontier model before discussing the SFA approach. Coelli *et al.* (2005) revealed that different algebraic forms of $f(.)$ may give rise to different model specifications. Thus, the discussion of different forms can be described as follows (Kumbhakar and Lovell, 2000; Coelli *et al.*, 2005; Assaf, 2007):

(1) Flexible: the functional form is assumed to be first-order flexible if it has enough parameters to provide a first-order differential approximation to an arbitrary function at a single point. In case of a second-order flexible form, it has enough parameters to provide a second-order approximation. In Table 4.2 the linear and Cobb-Douglas functional forms are first-order flexible while the Translog functional form is second-order flexible. If everything is equivalent, the second-order flexible form is preferable to the first-order flexible form. However, increased flexibility comes at a cost. There are more parameters to estimate in a functional form. This could result in econometric difficulties such as multicollinearity (Coelli *et al.*, 2005; Griffiths and O'Donnell, 2005).

(2) Linear in the parameters: The linear functional form in Table 4.2 is linear in the parameters, making it amenable to estimation utilising the linear regression technique, whereas the Cobb-Douglas and Translog functional forms are non-linear and do not satisfy this property. However, this problem can be solved by taking

logarithms of both sides of the Cobb-Douglas and Translog functional forms as follows (Coelli *et al.*, 2005):

$$\text{(a) Cobb-Douglas: } \ln Y = A_0 + \sum_{n=1}^{N} \beta_n \ln X_n \text{ where } A_0 = \ln \beta_0 \quad (4.9)$$

$$\text{(b) Translog: } \ln Y = \beta_0 + \sum_{n=1}^{N} \beta_n \ln X_n + \frac{1}{2}\sum_{m=1}^{N}\sum_{n=1}^{N} \beta_{mn} \ln X_m \ln X_n \quad (4.10)$$

Thus, the Cobb-Douglas and Translog functional forms in equations 4.9 and 4.10 are both linear in the parameters. Hence, the parameters of these functional forms can be estimated in a linear regression model.

Table 4.2: Functional Forms

Functional Forms	Formulations
Linear	$Y = \beta_0 + \sum_{n=1}^{N} \beta_n X_n$
Cobb-Douglas	$Y = \beta_0 \prod_{n=1}^{N} X_n^{\beta_n}$
Translog	$Y = \exp\left(\beta_0 + \sum_{n=1}^{N} \beta_n \ln X_n + \frac{1}{2}\sum_{m=1}^{N}\sum_{n=1}^{N} \beta_{mn} \ln X_m \ln X_n \right)$

Note: The above functional forms, where β_n and β_m are unknown parameters to be estimated.

Source: Coelli *et al*. (2005, p211)

4.4.2 A Comparison between the Cobb-Douglas and Translog Production Functions

Cobb-Douglas and Translog functional forms are the most often used functional forms for the SFA approach (Coelli, 1996a; Kumbhakar and Lovell, 2000; Wadud, 2003; Coelli *et al.*, 2005; Assaf, 2007). Varian (1999); Coelli *et al* (2005); and Phan (2004) state that a Cobb-Douglas functional form is relatively simple to estimate and the results are easy to interpret. The Translog functional form is a generalisation of the Cobb-Douglas form, where less restrictive assumptions regarding the production technology are made. Griffiths and O'Donnell (2005) and Zahid and Mokhtar (2007) argue that the Cobb-Douglas form is easy to estimate and mathematically simple to manipulate, but is restrictive in the properties it imposes on the production structure such as a fixed returns to scale value and the elasticity of substitution being equal to unity (Battese and Coelli, 1995; Coelli, 1995; Admassie and Matambalya, 2002; Phan, 2004). The Translog form does not impose these restrictions on the production structure, but this comes at the cost of having a form which is more difficult to mathematically manipulate and can suffer from degrees of freedom and multicollinearity problems (Coelli, 1995; Coelli *et al.*, 2005; Arunsawadiwong, 2007; Zahid and Mokhtar, 2007).

Hence, the Cobb-Douglas function can be considered as a special case of the Translog function, because it can be obtained from the Translog function by setting all β_{nm} = 0 (see Table 4.2). The Cobb-Douglas function is often used because of its simplicity and parsimony (Battese and Coelli, 1995; Coelli *et al.*, 1998; Admassie and Matambalya, 2002; Batra and Tan, 2003; Vu, 2003; Coelli *et al.*, 2005; Griffiths and O'Donnell, 2005; Arunsawadiwong, 2007; Assaf, 2007).

4.4.3 The Stochastic Production Frontier with Cross-sectional Data

A stochastic production frontier model was simultaneously proposed by Aigner, Lovell and Schmidt and Meeusen and van den Broeck in 1977 (Stevenson, 1980; Coelli *et al.*, 2005). This model can be expressed as follows (Kumbhakar and Lovell, 2000; Coelli *et al.*, 2005):

$$\ln Y_i = X_i'\beta + V_i - U_i \qquad (4.11)$$

Equation 4.11 contains a symmetric random error (V_i) to account for statistical noise[60]. Statistical noise may occur from an accidental omission of the relevant variables from the vector (X_i). It also arises from measurement errors and approximation errors associated with choice of the functional form. This model incorporates an efficiency term into the analysis and captures the effect of exogenous

[60] The term statistical noise may refer to the effects of weather, strikes and luck on the value of the output variable (Coelli *et al.*, 2005).

shocks beyond the control of a firm. In addition, this model also covers errors in both observations and the measurement of outputs (Kumbhakar and Lovell, 2000; Coelli *et al.*, 2005; Assaf, 2007). Hence, the model is called a stochastic frontier production frontier, because the output values are bounded from above by a random variable, $\exp\left(X_i'\beta + V_i\right)$. The random error $\left(V_i\right)$ can be positive or negative, and the stochastic frontier outputs vary regarding the deterministic part of the model, $\exp\left(X_i'\beta\right)$. However, the significant characteristics of a stochastic frontier model can be represented graphically as in Figure 4.3. It is convenient to restrict attention to a firm that generates output $\left(Y_i\right)$ utilising a single input $\left(X_i\right)$. Therefore, for a Cobb-Douglas function in logarithmic terms, a single output stochastic frontier model may be written as follows (Kumbhakar and Lovell, 2000; Coelli *et al.*, 2005; Assaf, 2007; Amornkitvikai, 2011):

$$\ln Y_i = \beta_0 + \beta_1 \ln X_i + V_i - U_i \tag{4.12}$$

$$Y_i = \exp\left(\beta_0 + \beta_1 \ln X_i + V_i - U_i\right) \tag{4.13}$$

$$Y_i = \underbrace{\exp\left(\beta_0 + \beta_1 \ln X_i\right)}_{\substack{\text{Deterministic}\\ \text{Component}}} \times \underbrace{\exp\left(V_i\right)}_{\text{Noise}} \times \underbrace{\exp\left(-U_i\right)}_{\text{Inefficiency}} \tag{4.14}$$

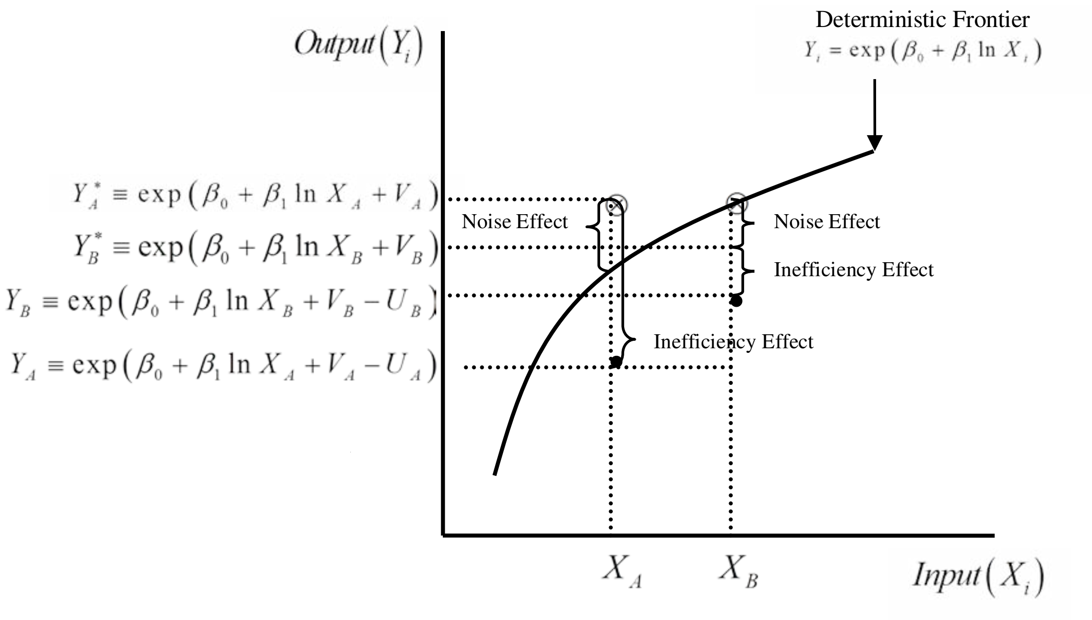
As previously discussed in Section 3.5 of Chapter 3, this section discusses in more detail about the use of a stochastic production frontier to be used in the SFA analysis. Figure 4.3 illustrates a production frontier. The term $V_i - U_i$ is a composite error term, where V_i represents a statistical noise term that is assumed to be an independently and identically distributed normal random variable with zero mean and variance, and is assumed to be independently distributed of U_i. U_i denotes a non-negative random term assumed to account for technical inefficiency effects in the production function and is assumed to be independently distributed as a truncation at the zero of the normal distribution (Kumbhakar and Lovell, 2000; Coelli *et al.*, 2005; Assaf, 2007).

Thus, Figure 4.3 plots the inputs and outputs of two firms, *A* and *B*, where the deterministic element of the frontier has been depicted to reflect the existence of diminishing returns to scale. The values of input are measured along the horizontal axis, and outputs are measured on the vertical axis. Firm *A* utilises an input at level X_A to generate an output (Y_A) whereas firm *B* uses an input at level X_B to produce output(Y_B). These observed values are specified by the points marked with $\otimes$ in Figure 4.3. However, if there are no technical inefficiency effects such as if $U_A = 0$ and $U_B = 0$, then it can be stated that the stochastic production frontiers would be (Coelli *et al.*, 2005, p243): $Y_A^* \equiv \exp(\beta_0 + \beta_1 \ln X_A + V_A)$ and $Y_B^* \equiv \exp(\beta_0 + \beta_1 \ln X_B + V_B)$ for firms *A* and *B*, respectively. In this case, these frontier values are specified by points marked with $\otimes$ in Figure 4.3.

From Figure 4.3, it can be seen that the frontier for firm *A* lies above the deterministic part of the production frontier because the noise effect is positive $(V_A > 0)$, while the frontier for firm *B* lies below the deterministic part of the frontier because the noise effect is negative $(V_B < 0)$. It can also be seen that output of firm *A* lies below the deterministic part of the frontier, because the sum of the noise and technical inefficiency effects are negative $(V_A - U_A < 0)$(Kumbhakar and Lovell, 2000; Coelli *et al.*, 2005).

Hence, it can be concluded that the values of the observed outputs will be above the deterministic frontier if $V_i > U_i$, and below the deterministic frontier if $V_i < U_i$, such as $Y_i > \exp(X_i\beta)$ if $V_i > U_i$ and $Y_i < \exp(X_i\beta)$ if $V_i < U_i$. Furthermore, the characteristics of a stochastic frontier model $\ln Y_i = \beta_0 + \beta_1 \ln X_i + V_i - U_i$ can be generalised to the case where firms utilise multiple inputs. In particular, the observed frontier outputs appear to be equally distributed above and below the deterministic part of a frontier. In fact, frontier outputs can only lie above the deterministic part of the frontier when the noise effect is positive, and larger than the technical inefficiency effect, such as $Y_i^* < \exp(X_i'\beta)$ if $\varepsilon_i \equiv V_i - U_i > 0$ (Coelli *et al.*, 2005; Assaf, 2007).

Figure 4.3: A Stochastic Production Frontier



Source: Adapted from Coelli *et al*. (2005, p244)

4.4.4 A Stochastic Frontier Model and Technical Inefficiency Effects Model

As discussed above, identifying technical efficiency should begin with the estimation of a stochastic frontier model, $\ln Y_i = \beta_0 + \beta_1 \ln X_i + V_i - U_i$ as defined by equation (4.12), and then there is a need to obtain an estimate of the technical inefficiency (U_i). To do so requires separating estimates of statistical noise (V_i) and technical inefficiency (U_i) which are extracted from estimates of $\varepsilon_i = V_i - U_i$ for each firm. This requires distributional assumptions on V_i and U_i (Kumbhakar and Lovell, 2000; Coelli *et al.*, 2005; Assaf, 2007). The noise component V_i is a random variable which is assumed to be an independently and identically distributed normal variable with zero mean and variance $\left(V_i \sim iidN\left(0, \sigma_V^2\right)\right)$, and is assumed to be independently distributed of U_i.

U_i is a non-negative random variable assumed to account for technical inefficiency in the production function, and is assumed to be independently and identically distributed as a truncation at zero of the normal distribution,

$\left(U_i \sim iidN^+\left(0,\sigma_U^2\right)\right)$. Thus, it can be assumed that each V_i is distributed independently of each U_i, and both error terms are uncorrelated with the explanatory variables in X_i (Battese and Coelli, 1995; Kumbhakar and Lovell, 2000; Coelli *et al.*, 2005; Assaf, 2007; Amornkitvikai and Harvie, 2011).

Technical efficiency is measured by the ratio of observed output to the equivalent stochastic frontier output as follows (Coelli *et al.*, 2005; Assaf, 2007; Amornkitvikai, 2011):

$$TE_i = \frac{Y_i}{\exp\left(X_i'\beta + V_i\right)} = \frac{\exp\left(X_i'\beta + V_i - U_i\right)}{\exp\left(X_i'\beta + V_i\right)} = \exp(-U_i) \qquad (4.15)$$

Technical efficiency of the i-*th* firm can be defined by $TE_i = \exp(-U_i)$. The measure of technical efficiency has a value between zero and one, with the maximum value of technical efficiency $TE_i = 1$. This measures the output of the i-*th* firm relative to the output that can be achieved by a fully-efficient firm utilising the same input vector. Thus, this result from a stochastic frontier model can provide a basis for the prediction of individual firm technical efficiency. Furthermore, a number of firm-specific factors can be hypothesised to affect technical efficiency, such as firm size, firm age, skilled labour, firm location and ownership characteristics as identified in Chapter 3. To estimate the determinants of technical inefficiency, U_i is assumed to be a function of the explanatory variables or firm-specific factors. This can be defined as follows (Battese and Coelli, 1995; Coelli *et al.*, 2005; Amornkitvikai and Harvie, 2011):

$$U_i = \delta_0 + X_i\delta + \omega_i, \qquad (4.16)$$

Where:

X_i is a (1 x m) vector of explanatory variables associated with technical efficiency effects;

δ is an (m x 1) vector of unknown coefficients to be estimated for the $i-th$ firm; and

ω_i is the unobserved random variables, which are assumed to be independently and identically distributed, obtained by truncation of a normal distribution with zero mean and unknown variance, σ^2 $\left(iidN(0,\sigma^2)\right)$, $(\omega_i \sim N(0,\sigma_\omega^2))$ (Battese and Coelli, 1995; Coelli *et al.*, 2005; Amornkitvikai and Harvie, 2011).

The coefficients of the stochastic frontier model and technical inefficiency effects model can be measured utilising the maximum likelihood method, under the assumption of non-negative variables which are independently and identically distributed normal random terms as truncations at zero with $X_i\delta$ means and variances σ_U^2 for $U_i s$ (Battese and Coelli, 1995; Coelli *et al.*, 2005; Tran *et al.*, 2008; Amornkitvikai and Harvie, 2011). The appropriateness of the stochastic frontier approach can be tested by calculating the value of the gamma parameter (γ), which contains a value between 0 and 1 and depends on two variance parameters of the stochastic frontier function. The maximum likelihood function is defined in terms of variance parameters as follows (Battese and Corra, 1977; Kumbhakar and Lovell, 2000; Coelli *et al.*, 2005):

$$\sigma_s^2 \equiv \sigma_v^2 + \sigma_u^2 \text{ and } \gamma \equiv \sigma_u^2 + \sigma_s^2$$

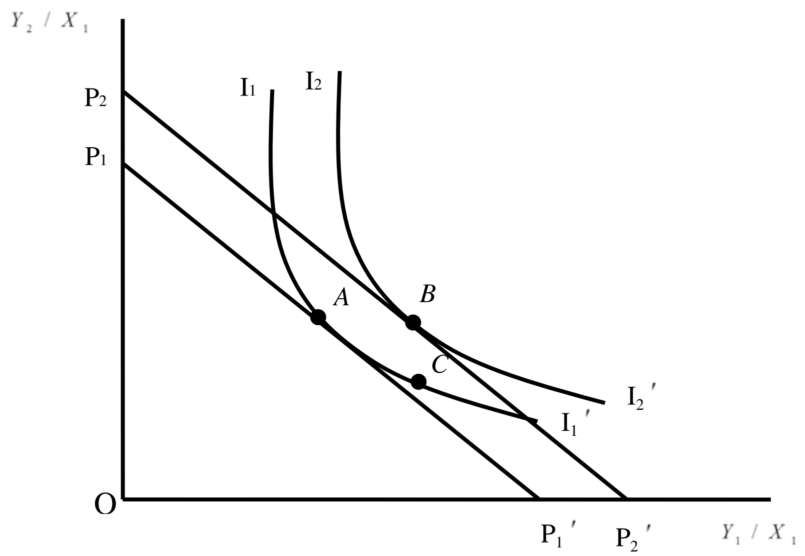
where γ represents the share of technical inefficiency in the overall residual variance. If the value γ is close to zero, deviations from the frontier are largely attributable to noise, whereas a value close to unity indicates considerable technical inefficiency (Coelli *et al.*, 2005; Tran *et al.*, 2008; Amornkitvikai and Harvie, 2011).

4.5 TECHNICAL PROGRESS AND EFFICIENCY IMPROVEMENT IN THE DEA AND SFA FRONTIERS

This section describes technical progress and efficiency improvement in DEA and SFA frontiers. The technical progress and efficiency improvement may change over time due to technological advances and developments (Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Arunsawadiwong, 2007; Le, 2010; Amornkitvikai, 2011). The concepts of technical progress and efficiency improvement can be demonstrated under the assumption of conventional isoquants (II') and factor price lines (PP') (see Figures 4.4 and 4.5). Figure 4.4 presents two states of equilibrium (points *A* and *B*) where point *A* represents equilibrium with lower technical advancement than point *B*, whereas point *C* shows a disequilibrium point. However, technical progress can change over time and the firm may shift from points *A* to *B*, representing equilibrium with higher technical advancement.

Thus, this process can occur as an upward shift of the production frontier (Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Arunsawadiwong, 2007; Seelanatha, 2007). Figure 4.5 presents the movement from an initial equilibrium point *A* to the new equilibrium point *C*. Point *A* represents an equilibrium point where the relative factor price line (PP') is tangential with isoquant (II'). However, two outputs (Y_1 and Y_2) can change over time[61] and result in a shift from (PP') to (SS'). Thus, point *A* now becomes a disequilibrium point from the standpoint of relative factor prices given by SS', and optimum factor proportions shift to new values which can be implied by the new equilibrium point *C* (see Figure 4.5). This process can result in the movement of observations below the frontier closer towards the new frontier, representing an improvement in efficiency of the production process (Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Arunsawadiwong, 2007).

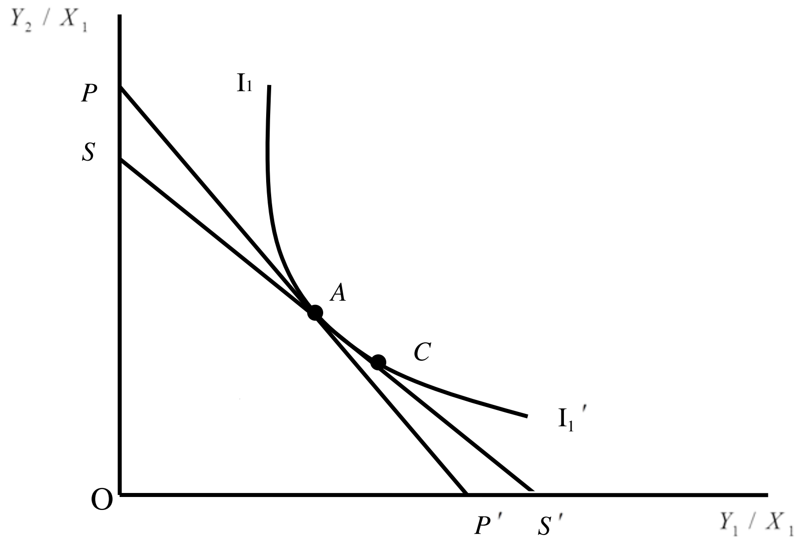
Figure 4.4: Technical Progress



Source: Adapted from Arunsawadiwong (2007, p213)

[61] The labour-capital composition changes overtime and this can affect the slope of the factor price line (Coelli *et al.*, 2005; Arunsawadiwong, 2007).

Figure 4.5: Efficiency Improvement



Source: Adapted from Arunsawadiwong (2007, p213)

4.6 SUMMARY

This chapter has focused upon identifying and comparing techniques (or approaches) for measuring the technical efficiency of firms, highlighting key differences between non-parametric and parametric approaches which include the DEA and SFA approaches. DEA involves the use of linear programming for the construction of an efficiency frontier. It can be implemented without specifying an algebraic form of an association between inputs and outputs. It can estimate the efficiency frontier without specifying whether the output is a linear, non-linear or some other function of inputs (Admassie and Matambalya, 2002; Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Arunsawadiwong, 2007; Assaf, 2007; Zahid and Mokhtar, 2007; Moffat, 2008). On the other hand, SFA is an approach that estimates the efficiency-based frontier based upon a presumed functional form of association between inputs and outputs.

When a functional form is known, the unknown parameters of the function are estimated utilising an econometric technique. This makes the SFA approach more computationally demanding than the DEA approach (Admassie and Matambalya, 2002; Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Arunsawadiwong, 2007; Assaf, 2007; Zahid and Mokhtar, 2007; Moffat, 2008). DEA and SFA have advantages as well as disadvantages. For instance, there is no specific set of criteria to select the best and most relevant method for constructing the frontier (Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Seelanatha, 2007). Thus, there is no single method that is strictly preferable to any other (Wadud, 2003; Murillo-Zamorano, 2004; Coelli *et al.*, 2005).

This chapter has reviewed two common orientation models, including input- and output-orientated models, utilising the DEA approach. Coelli *et al.* (2005) emphasised that input- and output-orientated DEA models can provide the same technical efficiency scores under the assumption of constant returns to scale (CRS), but that the technical efficiency scores are unequal when variable returns to scale (VRS) is assumed. The output-orientated VRS model assumes that firms are not operating at optimal scale efficiency due to government regulations and imperfect competition in financial markets and capital structure (Coelli *et al.*, 2005; Cooper *et al.*, 2006; Amornkitvikai, 2011). In addition, this chapter has discussed the two-stage DEA model, focusing on a two-limit Tobit model. This technique deals with explanatory variables or firm-specific factors that can affect a firm's technical efficiency.

With respect to the SFA approach, this chapter has described the functional forms of the production function that can be used in an empirical analysis. This chapter also expressed criteria for choosing the functional forms in the estimation of a stochastic frontier model. It also discussed the advantages and disadvantages of the Cobb-Douglas and Translog production functions. This chapter has provided a detailed discussion of the SFA approach and its methodological extensions, and presented a description of a basic stochastic production frontier model similar to that used in this study. This chapter has also discussed a stochastic production frontier with cross-sectional data. It also illustrated how to estimate the parameters of a stochastic frontier model and the technical inefficiency effects model, using a truncation of a normal distribution. In this case, it explained maximum likelihood estimation of the parameters of these models. In addition, it also explained that a stochastic frontier model can be used to predict the technical efficiency of a firm and examine the factors influencing technical inefficiency in a firm simultaneously. Finally, this chapter has presented the impact of technical progress and efficiency improvement on the DEA and SFA frontiers.

This chapter has reviewed the two approaches to estimate the efficient frontier and measure technical efficiency of Thailand's manufacturing SMEs and thus rectified the gap in the existing literature. However, there are alternative programs and techniques to estimate technical efficiency such as LIMDEP, a meta-frontier production function model and the two-stage Bootstrap DEA approach. LIMDEP is unable to accommodate a wider range of assumptions regarding the error distribution term compared to the Frontier Version 4.1 (SFA). It is also unable to estimate the technical inefficiency effects model in a one-step process compared to the SFA approach (Herrero and Pascoe, 2002; Coelli *et al.*, 2005; Le, 2010; Amornkitvikai and Harvie, 2011). Nevertheless, LIMDEP can be considered for future research. With respect to the two-stage Bootstrap DEA approach introduced by Simar and Wilson (2007) and a meta-frontier production function model developed by Battese *et al.* (2004), it would be interesting to apply these techniques to measure and estimate the technical efficiency of Thai manufacturing SMEs in future research.

The next chapter will present and describe the data source and data classification to be used in this study, and provide a description of key variables to be utilised in the empirical analysis of the stochastic frontier production function and technical inefficiency effects model using the SFA approach and the two-stage DEA model (a two-limit Tobit model).

CHAPTER 5

DATA SOURCE AND DESCRIPTION OF VARIABLES

5.1 INTRODUCTION

The purpose of this chapter is to describe the data source, data classification and description of key variables to be utilised in the analysis. The data used in this study comes from the 1997 and 2007 industrial censuses conducted by the National Statistical Office of Thailand (NSO) of Thailand. The establishments under the scope of these censuses were those engaged primarily in the manufacturing industry. An interview method was employed in the data collection for both the 1997 and 2007 industrial censuses. These censuses are based upon large samples of firms in the manufacturing industry, consisting of small, medium and large enterprises, and contain the most recent and the most complete data available for Thailand's manufacturing enterprises (NSO, 2011a, 2011b). This thesis, however, only focuses on data for Thai manufacturing SMEs. Data for Thai manufacturing SMEs is categorised into six aspects: by aggregate manufacturing SMEs, by small, by medium, by domestic market intensity and export intensity, and by sub-manufacturing sectors, respectively. The total sample of Thai manufacturing SMEs in the 1997 and 2007 industrial censuses that are useable for this thesis are 22,685 and 56,441, respectively.

The chapter is structured as follows. Section 5.2 discusses in more detail the data sources utilised in this study. Section 5.3 outlines the key variables to be used in estimating a stochastic frontier production function for stochastic frontier analysis (SFA), the technical inefficiency effects model, and the first step of the two-stage Data Envelopment Analysis (DEA) model. Firm-specific factors and explanatory variables for the technical inefficiency effects model in the SFA approach and the second step of the two-stage DEA approach (a two-limit Tobit model) are explained and discussed in Section 5.3. Section 5.4 displays the data constructed from the 1997 and 2007 industrial censuses, after removing negative and invalid observed values, to be utilised in the empirical analysis of this study. Finally, a summary of the key findings from this chapter are presented in Section 5.5.

5.2 DATA SOURCES

Manufacturing statistical data is important for government agencies implementing their industrial policy, the SME promotion plan and policy formation. It is also vital for monitoring and evaluating manufacturing development projects. In addition, the manufacturing industrial census is a useful tool for entrepreneurs in implementing their business plan and expanding their businesses and investments (NSO, 2011a, 2011b, 2011c). As indicated previously, cross-sectional firm-level data from industrial censuses conducted in 1997 and 2007 by the NSO are used in this thesis, due to the most substantive data about Thai manufacturing establishments. These industrial censuses[62] are large samples of the manufacturing industry (category D International Standard Industrial Classification of All Economic Activities; ISIC: Revision 3).

The censuses cover all the different regions of Thailand, including Bangkok, Central and Vicinity, Northern and North-eastern, Southern regions and municipal and non-municipal areas. A Stratified Systematic Sampling methodology is used. Regions and provinces or cities were constituted strata while type of industrial activities and groups of industrial establishments were constituted sub-stratum. The sampling units were establishments. An establishment in each stratum was divided into industrial activity and number of persons employed. An interview method was employed in the data collection. Interviews were conducted by the enumerators, who were permanent and temporary staff members of the NSO. The target interviewees were the owners or the entrepreneurs and CEOs of manufacturing establishments (NSO, 2011a, 2011b).

In addition, government enumerators from the NSO have gathered this data on-site at the plant or establishment. Because the data collection is not self-reported but gathered by independent government personnel with expertise in each area, the quality of data is considered to be high, detailed, comprehensive and accurate (Phan, 2004; Arunsawadiwong, 2007; NSO, 2011a, 2011b). The censuses contain the most comprehensive data relating to SMEs in Thailand. The 1997 and 2007 industrial censuses obtained data for 32,489 and 73,931 firms, respectively. However, due to problems of sampling and non-sampling errors, missing values, non-responses,

[62] These industrial censuses are only collected every 10 years.

negative values and intentional misreporting and errors arising at coding and data entry stages (NSO, 2011a, 2011b), the final number of firms used in this study were 22,685 and 56,441 in 1997 and 2007, respectively.

5.2.1 The 1997 Industrial Census

The NSO of Thailand conducted the first industrial census in 1964[63] (NSO, 2011a, 2011b). This census aimed to collect basic information from firms in manufacturing industry such as business establishments, employment, cost of production and expenditure of establishments to assist in the implementation of the economic development plan and industrial policies at the local and national levels. The second industrial census was conducted in 1997. The 1997 industrial census comprises two stages of data collection, namely, the listing and enumeration stages (NSO, 2011a). The listing stage collected basic information on all manufacturing establishments that are located in the Bangkok area, municipal areas and other regions in Thailand. The enumeration stage collected all manufacturing establishments that engage only in manufacturing industry.

The benefits of the data obtained from the industrial census are the following: (1) it is useful for policy formulation, the industrial development plan and the development of SMEs, (2) it is important for implementing government policies and regulations, particularly in the manufacturing sector, (3) it can provide up-to date information of firms for the Thai government for evaluating the manufacturing development plan and related projects, and (4) the industrial census is useful for assisting the private sector to make decisions in relation to improvements, developments and investment by businesses (NSO, 2011a).

In addition, the 1997 industrial census included five parts: (1) general information of the establishment, (2) persons engaged and remuneration, (3) cost of production and expenditure of the establishment, (4) value of production and receipts of the establishment; and (5) fixed assets of the establishment. This thesis utilises the definition[64] of Thailand's manufacturing SMEs to identify the sample and focuses

---

[63] The 1964 industrial census is not available.

[64] The Ministry of Industry (MOI) of Thailand regulation of 11 September 2002 adopted employment as the criteria in defining the size manufacturing SMEs (Brimble *et al.*, 2002 and OSMEP, 2003).

only upon manufacturing SMEs. Hence, the total sample of manufacturing SMEs in the 1997 industrial census is 22,685[65].

Table 5.1 presents the number and percentage of interviewed SMEs by various categories in the 1997 industrial census. The largest numbers of interviewed SMEs were located in a municipal area, being 12,373 establishments or 54.54 percent of the total sample. In terms of the regional distribution of interviewed SMEs, from Table 5.1 it can be seen that the Bangkok area contained the highest number of interviewed SMEs in 1997, accounting for 9,256 SMEs or 40.80 percent of the total sample, followed by the Central and Vicinity regions, the Northern region, North-eastern region, and finally the Southern region. Table 5.1 also provides the distribution by type of ownership. Limited and public companies were the largest group interviewed in 1997, representing 10,728 SMEs or 47 percent of the total sample, followed by individual proprietors, juristic partnerships, cooperatives, and government and state enterprises.

Table 5.1: Number and Percentage of Interviewed SMEs by Location, Region and Type of Ownership in the 1997 Industrial Census

Categories	Number of Observations	Percentage (%)
Location		
Municipal Area	12,373	54.54
Non-municipal Area	10,312	45.46
Total	**22,685**	**100**
Regions		
Bangkok	9,256	40.80
Central and Vicinity Regions	7,779	34.29
Northern Region	2,071	9.13
North-eastern Region	1,889	8.33
Southern Region	1,690	7.45
Total	**22,685**	**100**

Source: NSO (2011a)

[65] Only enterprises employing less than or equal to 200 employees are included in this thesis.

Table 5.1: (continued) Number and Percentage of Interviewed SMEs by Location, Region and Type of Ownership in the 1997 Industrial Census

Categories	Number of Observations	Percentage (%)
Type of Ownerships		
Individual Proprietor	6,232	27.47
Juristic Partnership	5,295	23.34
Limited and Public Companies	10,728	47.29
Government and State Enterprises	37	0.16
Cooperatives	129	0.57
Unspecified	264	1.16
Total	**22,685**	**100**

Source: NSO (2011a)

5.2.2 The 2007 Industrial Census

The NSO conducted the third industrial census in 2007. The objective of the 2007 industrial census was to collect basic information and the distribution of establishments engaged in manufacturing industry only classified by ISIC: Revision 3. It also collected information on the operation of manufacturing establishments such as: the type of establishment; cost of production; cost of sales and administrative expenses. The census can be used for national account compilation and constructing economic indicators (NSO, 2011b). In addition, the 2007 industrial census consists of six parts: (1) general information of the establishment, (2) persons engaged and remuneration, (3) cost of production and expenditure of the establishment, (4) value of production and receipts of the establishment, (5) fixed assets of the establishment, and (6) research and development and laboratory spending and activities. Importantly, this study only focuses upon manufacturing SMEs. Thus, the total sample of manufacturing SMEs in the 2007 industrial census is 56,441.

Table 5.2 presents the number and percentage of interviewed SMEs in the 2007 industrial census by various categories. With regards to location, the largest number of interviewed SMEs can be found in non-municipal areas, having 31,599 SMEs or 55.99 percent of the total sample. In terms of the regional distribution of interviewed SMEs in 2007, the Central and Vicinity regions had the highest number of interviewed SMEs, amounting to 19,218 SMEs or 34.05 percent of the total sample. Focusing on the type of ownership of the interviewed SMEs in the 2007 industrial census, the number of individual proprietors was 28,192 or 49.95 percent of the total sample representing the largest number of interviewed SMEs, followed by limited and public companies, juristic partnership, cooperatives and government and state enterprises, respectively.

Table 5.2: Number and Percentage of Interviewed SMEs by Location, Region and Type of Ownership in the 2007 Industrial Census

Items	Number of Observations	Percentage (%)
Location		
Municipal Area	24,842	44.01
Non-municipal Area	31,599	55.99
Total	**56,441**	**1.00**
Regions		
Bangkok[66]	7,777	13.78
Central and Vicinity Regions	19,218	34.05
Northern Region	10,125	17.94
North-eastern Region	13,176	23.34
Southern Region	6,145	10.89
Total	**56,441**	**1.00**
Type of Ownerships		
Individual Proprietor	28,192	49.95
Juristic Partnership	4,376	7.75
Limited and Public Companies	15,147	26.84
Government and State Enterprises	114	0.20
Cooperatives	218	0.39
Unspecified	8,394	14.87
Total	**56,441**	**1.00**

Source: NSO (2011b)

5.2.3 Data Classification

As previously identified in Chapter 2, the definition of an SME used in Thailand is generally based upon the number of employees or the value of assets. Thus, an enterprise employing up to 50 workers, or with fixed assets, excluding land, not exceeding THB 50 million (approximately US$1.65 million) in the manufacturing

[66] The fluctuation in the number and percentage of SMEs in Bangkok in 2007 is likely to be due to the way in which the National Statistical Office of Thailand collected data on SMEs after 1997.

sector is considered a small enterprise. One employing between 51-200 workers or with fixed assets, excluding land, between THB 51-200 million (approximately US$1.68-6.6 million) is defined as a medium-sized enterprise (Brimble *et al.*, 2002; Mephokee, 2003; Office of Small and Medium Enterprises Promotion (OSMEP), 2003; Sahakijpicharn, 2007). Thus, manufacturing SMEs in this thesis are reported under different categories, as follows:

1) Aggregate manufacturing SMEs
2) Small-sized enterprises
3) Medium-sized enterprises
4) Domestic market intensive SMEs
5) Export intensive SMEs
6) Sub-manufacturing sectors of operation classified by the Standard International Trade Classification (SITC) : Revision 4[67], and includes SITC 0: food and live animals, SITC 1: beverages and tobacco, SITC 2: crude materials, inedible, except fuels, SITC 3: mineral fuels, lubricants and related materials, SITC 5: chemicals and related products, SITC 6: manufactured goods classified by material, SITC 7: machinery and transport equipment, SITC 8: miscellaneous manufactured articles (United Nations Statistics Division (UNSD), 2010).

Table 5.3 presents and compares the sample and percentage of interviewed SMEs in the 1997 and 2007 industrial censuses[68] classified by the above categories. In terms of the size of manufacturing SMEs, small manufacturing SMEs had 18,214 enterprises or 80.29 percent of the total sample in 1997. In 2007, the number of small manufacturing SMEs increased rapidly to 49,835, equivalent to 88.30 percent of the overall sample, an increase[69] of 33,756 enterprises over 1997. The number of medium-sized manufacturing SMEs increased to 6,606 enterprises or 11.70 percent of the overall sample in 2007, an increase of 2,135 enterprises from 1997.

Focusing on domestic and export intensive manufacturing SMEs, domestic[70] manufacturing SMEs consisted of 52,721 enterprises in 2007, or 93.41 percent of the

[67] The 1997 and 2007 industrial censuses do not cover SITC 4: Animal, vegetable oils and waxes.
[68] These industrial censuses are survey-driven. The numbers used do not capture all SMEs in Thailand but only a representative sample of them.
[69] This fluctuation in the sample and percentage of interviewed SMEs in 2007 is likely to be due to an improvement in statistical collection methods (the NSO, 2010a).
[70] Domestic market intensive manufacturing SMEs (export < 50 percent of total sales revenue)

total sample, an increase of 33,354 enterprises over 1997. Exporting[71] manufacturing SMEs consisted of 3,702 enterprises in 2007 or 6.59 percent of the overall sample, an increase of 402 enterprises from 1997. Finally, for sub-manufacturing sectors classified by SITC: Revision 4, the sample size of eight SME categories increased dramatically in 2007 compared to 1997 (see Table 5.3)

Table 5.3: The Sample and Percentage of Interviewed SMEs by Various Categories, 1997 and 2007

Years	The 1997 Industrial Census		The 2007 Industrial Census	
Categories	**Observations**	**Percentage (%)**	**Observations**	**Percentage (%)**
Aggregate Manufacturing SMEs Total	22,685	100	56,441	100
Size of Manufacturing				
Small Enterprises	18,214	80.29	49,835	88.30
Medium Enterprises	4,471	19.71	6,606	11.70
Total	**22,685**	**100**	**56,441**	**100**
Export Intensity				
Domestic SMEs	19,367	85.37	52,721	93.41
Exporting SMEs	3,318	14.63	3,720	6.59
Total	**22,685**	**100**	**56,441**	**100**
Sub-manufacturing Sectors				
SITC 0	3,070	13.53	12,080	21.40
SITC 1	538	2.37	1,765	3.13
SITC 2	1,481	6.53	4,608	8.16
SITC 3	38	0.17	76	0.13
SITC 5	2,569	11.32	4,833	8.56
SITC 6	6,631	29.23	17,541	31.08
SITC 7	2,793	12.31	3,892	6.90
SITC 8	5,565	24.53	11,646	20.63
Total	**22,685**	**100**	**56,441**	**100**

Note: SITC 0: Food and live animals, SITC 1: Beverages and tobacco, SITC 2: Crude materials, inedible, except fuels, SITC 3: Mineral fuels, lubricants and related materials, SITC 5: Chemicals and related products, n.e.s., SITC 6: Manufactured goods classified chiefly by material, SITC 7: Machinery and transport equipment, SITC 8: Miscellaneous manufactured articles.

Source: NSO (2011a, 2011b)

In addition, as enterprises in different sub-manufacturing sectors may operate with different technologies, it is practical to predict and compare the technical efficiency of Thai manufacturing SMEs according to sub-manufacturing sectors. The

[71] Export intensive manufacturing SMEs (export > 50 percent of total sales revenue)

1997 and 2007 industrial censuses comprise enterprises engaged in manufacturing activities which are classified by ISIC: Revision 3. However, ISIC has 23 sub-manufacturing sectors in both industrial censuses. To keep the analysis tractable, this study adopts SITC: Revision 4 which consists of only 8 sectors as summarised in Table 5.4.

Table 5.4: Standard International Trade Classification, SITC: Revision 4

Code/ Division of ISIC: Revision 3	Code/Division of SITC: Revision 4
ISIC 15: Manufacture of food products	SITC 0: Food and live animals
ISIC 16: Manufacture of beverage and tobacco	SITC 1: Beverages and tobacco
ISIC 17: Manufacture of textiles	SITC 6: Manufactured goods classified by material
ISIC 18: Manufacture of wearing apparel dressing	SITC 8: Miscellaneous manufactured articles
ISIC 19: Tanning, dressing of leather and manufacture of luggage, handbags, saddlery, harness and footwear	SITC 8: Miscellaneous manufactured articles
ISIC 20: Manufacture of wood and products of cork	SITC 2: Crude materials, inedible, except fuels
ISIC 21: Manufacture of paper and paper products	SITC 2: Crude materials, inedible, except fuels
ISIC 22: Publishing and printing and reproduction of recorded media	SITC 8: Miscellaneous manufactured articles
ISIC 23: Manufacture of coke, refined petroleum products	SITC 3: Mineral fuels, lubricants and related materials
ISIC 24: Manufacture of chemicals and chemical products	SITC 5: Chemicals and related products
ISIC 25: Manufacture of rubber and plastics products	SITC 5: Chemicals and related products
ISIC 26: Manufacture of other non-metallic mineral products	SITC 6: Manufactured goods classified by material
ISIC 27: Manufacture of basic metals	SITC 6: Manufactured goods classified by material
ISIC 28: Manufacture of fabricated metal products	SITC 6: Manufactured goods classified by material
ISIC 29: Manufacture of machinery and equipment n.e.c.	SITC 7: Machinery and transport equipment
ISIC 30: Manufacture of office and computing machinery	SITC 7: Machinery and transport equipment
ISIC 31: Manufacture of electrical machinery and apparatus n.e.c.	SITC 7: Machinery and transport equipment
ISIC 32: Manufacture of radio, television and communication equipments	SITC 7: Machinery and transport equipment
ISIC 33: Manufacture of medical, precision and optical instruments	SITC 8: Miscellaneous manufactured articles
ISIC 34: Manufacture of motor vehicles, trailers and semi-trailers	SITC 7: Machinery and transport equipment
ISIC 35: Manufacture of other transport equipment	SITC 7: Machinery and transport equipment
ISIC 36: Manufacture of furniture; manufacturing n.e.c.	SITC 8: Miscellaneous manufactured articles
ISIC 37: Recycling	SITC 6: Manufactured goods classified by material

Source: NSO (2011a, 2011b); UNSD (2010)

5.3 DESCRIPTION OF VARIABLES

This section reviews key variables required for the derivation of a stochastic frontier production function for the SFA approach, technical inefficiency effects model and the first step of the two-stage DEA model. This section also discusses possible inputs and output from the literature that can be utilised for the empirical analysis in Chapter 6. Coelli *et al*. (2005) argued that input and output quantities and quality characteristics are important for the measurement of technical efficiency (Amornkitvikai, 2011).

Before describing each variable in detail below, Table 5.5 provides a brief description and summary of the key variables used in this study. A single output (value added) and two inputs (capital and labour) are selected to estimate the technical inefficiency scores from the SFA approach and the first step of the two-stage DEA approach. Finally, there are sixteen firm-specific factors and explanatory variables used for the technical inefficiency effects model in the SFA approach and the second step of the two-stage DEA approach (a two-limit Tobit model).

Table 5.5: Summary of Key Variables and Description

Variables	Description
Output:	
Value added (*Y*)	Value added is measured as the value of gross output minus intermediate consumption.
Inputs:	
Capital Input (*K*)	Capital input is measured as the net value of fixed assets after deducting accumulated depreciation at the end of the year.
Labour Input (*L*)	Labour input is measured by the total number of workers in the firm.
Firm-specific Factors and Explanatory Variables:	
Firm Size	Dummy variable (1 = small enterprises employing up to 50 workers; 0 = medium enterprises employing between 51-200 workers)
Firm Age	Age of firms, represented by operating years
Skilled Labour	The ratio of skilled workers to total workers
Firm Location	Dummy variable (1 = Municipal area; = 0 otherwise)
Bangkok Area	Dummy variable (1 = Bangkok; = 0 otherwise)
Central and Vicinity Regions	Dummy variable (1 = Central and Vicinity regions; = 0 otherwise)
Northern Region	Dummy variable (1 = Northern region; = 0 otherwise)
North-eastern Region	Dummy variable (1 = North-eastern region; = 0 otherwise)
Individual Proprietor	Dummy variable (1 = Individual proprietor; = 0 otherwise)
Juristic Partnership	Dummy variable (1 = Juristic partnership; = 0 otherwise)
Limited and Public Limited Companies	Dummy variable (1 = Limited company ; = 0 otherwise)
Government and State Enterprises	Dummy variable (1 = State enterprises; = 0 otherwise)

Table 5.5: (continued) Summary of Key Variables and Description

Variables	Description
Cooperatives	Dummy variable (1 = Cooperatives; = 0 otherwise)
Foreign Investment	Dummy variable (1 = Foreign Investment; = 0 otherwise)
Exports	Dummy variable (1 = exports more than 50 per cent of total sales revenue, = 0 otherwise)
Government Assistance (BOI)	Dummy variable (1 = obtains privileges from the BOI; = 0 otherwise)

5.3.1 Output (Value Added, (*Y*))

Output (value added) is measured as the value of gross output minus intermediate consumption and is used as output production (Phan, 2004; Arunsawadiwong, 2007; NSO, 2011a, 2011b). The value of gross output refers to the receipts of the establishment as follows: (1) sales of goods produced, (2) sales of goods purchased for resale minus purchase of goods for resale, (3) receipts for contract and commission work, (5) receipts for rent on building, vehicles, machinery and equipment, and (6) change in value of stocks of goods. Intermediate consumption refers to all expenses in the production process on goods or services by the establishment, including: (1) purchase of raw materials and components, (2) cost of production (i.e., cost of fuels and electricity used in the production process, cost of repair and maintenance, cost of repair and maintenance of machinery and equipment), (3) cost of contract and commission work, (4) cost of sales (i.e., advertising, transportation, commission and insurance premium), (5) administrative expenses (administrative expenses minus value of rent on land and interest paid), and (6) change in value of stocks of raw materials, parts and components (NSO, 2011a, 2011b).

Value added is the most commonly used measure of output production in the manufacturing sector (Lundvall and Battese, 2000; Wiboonchutikula, 2002; Batra and Tan, 2003; Kim, 2003; Phan, 2004; Chapelle and Plane, 2005; Arunsawadiwong, 2007; Minh *et al.*, 2007). Phan (2004) argues that the use of value added as output can help to compare the usage intensities of materials in different manufacturing activities. The use of value added can minimise double counting in the aggregation of the output measurement across manufacturing sectors (Phan, 2004, p151).

Therefore, in this study the value added[72] for each firm in the 1997 and 2007 industrial censuses is utilised as a proxy for output. However, the value added in both 1997 and 2007 industrial censuses is reported in current prices. Thus, the value added (*Y*) of each firm is deflated by the Producer Price Index (PPI) of manufactured products in 1997 and 2007, respectively, with 2000 as the base year obtained from the Bureau of Trade and Economic Indices, Ministry of Commerce of Thailand (Bureau of Trade and Economic Indices of Thailand, 2010).

5.3.2 Capital Input (*K*)

There are a number of methods that can be utilised to calculate capital input using firm-level data, such as the perpetual inventory method (PIM), survey method and the total capital service method (Coelli *et al.*, 2005; Le, 2010; Amornkitvikai, 2011). The most popular method for capital input is PIM (Phan, 2004; Coelli *et al.*, 2005; Le, 2010). However, PIM is not available in both the 1997 and 2007 industrial censuses. An alternative method is the net value of fixed assets, being the aggregate of the book value of land, building, machinery, tools, transport and office equipment. A number of empirical studies have also used the value of net fixed assets as their measure of capital input (Wiboonchutikula, 2002; Kim, 2003; Hossain and Karunaratne, 2004; Phan, 2004; Yang, 2006; Arunsawadiwong, 2007; Minh *et al.*, 2007; Zahid and Mokhtar, 2007; Pham *et al.*, 2009).

Capital (*K*) is measured in this study as the net value of fixed assets after deducting accumulated depreciation at the end of the year. The net value of fixed assets for each firm is utilised as a proxy for capital. However, the net values of fixed assets in these censuses are all in current prices. To convert them into constant prices, the net value of fixed assets of each firm is deflated by the Producer Price Index (PPI) of capital equipment in each year, with 2000 as the base year (Bureau of Trade and Economic Indices of Thailand, 2010).

5.3.3 Labour Input (*L*)

Labour and capital are the two main inputs of considerable quantitative importance (Coelli *et al.*, 2005; O'Donnell *et al.*, 2009; Kontodimopoulos *et al.*, 2010). There are a number of variables that can be used to measure labour input, including number of

[72] Value added (*Y*) is calculated by subtracting the value of intermediate consumption from the value of gross output.

persons employed, number of hours of labour input, number of full-time equivalent employees, and the total wages and salaries bill (Coelli *et al.*, 2005; Le, 2010; Amornkitvikai, 2011). In the economic literature, the total number of hours worked is regarded as the best indicator of labour input (Phan, 2004; Coelli *et al.*, 2005). However, due to data constraints in the industrial censuses, the total number of hours worked cannot be calculated. Instead, the total number of workers is adopted as the measurement of labour input in this study. Many other empirical studies have utilised the total number of employees as their labour input (Lundvall and Battese, 2000; Batra and Tan, 2003; Kim, 2003; Hossain and Karunaratne, 2004; Phan, 2004; Arunsawadiwong, 2007; Minh *et al.*, 2007; Pham *et al.*, 2009). Labour input (L) is measured as the number of workers in the firm, including owner or partner, unpaid workers, skilled labour, unskilled labour and other workers.

5.3.4 Firm-specific Factors

Firm-specific factors are utilised for the technical inefficiency effects model (SFA) and the two-stage DEA model. This section aims to identify firm-specific factors and explanatory variables that can influence technical efficiency of Thai manufacturing SMEs. As discussed in chapter 3, potential firm-specific factors and explanatory variables contributing to the technical inefficiency of Thai manufacturing SMEs based upon the literature are: firm size; firm age; skilled labour; firm location; region; type of ownership; foreign ownership or investment; export intensity and government assistance.

5.3.4.1 Firm Size

Firm size is one of the significant firm-specific factors influencing a firm's performance. There are a number of variables that can be utilised to capture firm size (Lundvall and Battese, 2000; Kim, 2003; Hossain and Karunaratne, 2004; Phan, 2004; Major, 2008; Le, 2010; Liao *et al.*, 2010; Amornkitvikai, 2011), such as the values of total sales, value added, fixed assets and the number of employees. In this study, the number of workers is used as the proxy for firm size. The use of number of workers is consistent with the definition of manufacturing SMEs used in Thailand, which is generally based on the number of employees or the value of assets[73] (Mephokee, 2003; OSMEP, 2003).

Many studies have found that the size of a firm has a positive association with a firm's technical efficiency (Lundvall and Battese, 2000; Admassie and Matambalya, 2002; Yang, 2006; Tran *et al.*, 2008; Amornkitvikai and Harvie, 2010, 2011). Jovanovic (1982) acknowledges that larger firms are much more efficient than smaller firms. Phan (2004) also emphasises that large firms are able to obtain new technology faster than small firms, because they have less capital constraints. However, a number of empirical studies have highlighted that firm size can have a negative association with technical efficiency (Biggs, 2002; Wiboonchutikula, 2002; Alvarez and Crespi, 2003; Yang and Chen, 2009; Le, 2010). The benefits of being a small firm are as follows: 1) they have the flexibility to adjust and diversify their activities in order to become more efficient; 2) small firms add dynamism to business activities which can improve economic performance; 3) small firms are likely to have a cost advantage relative to medium- and large-sized firms (Biggs, 2002; Biesebroeck, 2005; Yang and Chen, 2009; Le, 2010).

5.3.4.2 Firm Age

Firm age can also contribute positively to technical efficiency. A number of empirical studies have found that firm age has a positive impact upon technical efficiency (Admassie and Matambalya, 2002; Batra and Tan, 2003; Phan, 2004; Tran *et al.*, 2008). Older firms in these sectors may have greater management experience. They have learned from past mistakes, and are more likely to achieve higher efficiency because of 'learning by doing', and improved managerial skills (Phan, 2004; Tran *et al.*, 2008; Le, 2010). Thus, the variable used for firm age is represented by the number of years since a firm's establishment (Lundvall and Battese, 2000; Le, 2010; Amornkitvikai, 2011). The age of a firm is then calculated up to the industrial census year.

On the other hand, firm age can be negatively related to technical efficiency (Phan, 2004; Le, 2010; Le and Harvie, 2010). Tran (2008) finds that firm age was associated with lower efficiency levels in non-state small and medium manufacturing

[73] Due to data constraint in both the 1997 and 2007 industrial censuses, the value of assets cannot be used in this research.

industries in Vietnam[74]. For older firms, the learning by doing process could be offset by obsolete technology as compared with younger firms. Pasanen (2007); Tran *et al.* (2008) and Le (2010) also find that older firms tend to possess older machinery and equipment, while younger firms have just entered the market and are equipped with modern technology. Furthermore, many empirical studies have found that the age of a firm has an insignificant association with the level of its technical efficiency (Lundvall and Battese, 2000; Phan, 2004; Tran *et al.*, 2008).

5.3.4.3 Skilled labour

Skilled labour is one of the most important firm-specific factors affecting SME development in Thailand (Regnier, 2000; Wiboonchutikula, 2002; Huang, 2003; SME Development for Sustainability and Competitiveness, 2004; OSMEP, 2009). In this research, the variable used for skilled labour[75] is represented by the ratio of skilled labour in the production process to total workers, expressed as a percentage. Several empirical studies have found that skilled labour is positively related to firm technical efficiency (Admassie and Matambalya, 2002; Zahid and Mokhtar, 2007; Amornkitvikai and Harvie, 2010, 2011). For instance, Admassie and Matambalya (2002) emphasises that skilled labour was positively related to technical efficiency for SMEs in Tanzania; while Zahid and Mokhtar (2007) finds that skilled labour had a positive effect on the technical efficiency of Malaysian manufacturing SMEs. Saleh and Ndubisi (2008) also finds that a lack of skilled labour is one of the internal challenges in Malaysian SMEs. Krasniqi (2007) similarly finds that an internal barrier to SME growth is access to skilled labour.

However, a negative relationship between skilled labour and technical efficiency can be explained by the fact that such firms are working with out of date or labour intensive technology, where additional skilled labour simply exacerbates existing production and technology inefficiencies.

---

[74] This is likely to be a characteristic of an economy in transition from plan to market. Older firms are more used to functioning in a planned economy in which the role of the private sector is negligible, and to lack experience in operating in a market economy. In this situation, firm age is not likely to produce benefits (Tran *et al.*, 2008, Le, 2010).

[75] This refers to workers in the production process who have been trained for at least three months or who have work experience of at least five years in specific works such as fabrication, assembly, material handling, warehousing and shipping, maintenance and repair.

5.3.4.4 Firm Location (Municipality)

A dummy variable is used to control for differences in firm location. Many studies show that a municipal area has a positive impact on technical efficiency (Krasachat, 2000; Li and Hu, 2002; Yang, 2006; Park *et al.*, 2009; Le and Harvie, 2010). For example, Le (2010) states that enterprises in big cities may have greater access to resources, such as capital, labour, finance, technology, information and communications technology infrastructure. Tran *et al*. (2008) finds that enterprises located in metropolitan areas are more technically efficient than their counterparts located in non-metropolitan areas in almost all Vietnamese manufacturing sectors, with the exception of the miscellaneous industries sector.

They also indicated that the metropolitan efficiency effect is suggestive of agglomeration economies in the private sector, as a consequence of better availability of educated workers and managers, and market opportunities in metropolitan locations relative to non-metropolitan locations (Li and Hu, 2002; Tran *et al.*, 2008; Huggins, 2009). However, a recent study of the technical efficiency performance of Vietnamese manufacturing SMEs finds that SMEs located in urban centres in Vietnam have lower technical efficiency compared with SMEs located in rural areas, due to the higher costs for land, labour and space constraints. These issues may negatively affect urban SME efficiency (Li and Hu, 2002; Le, 2010; Le and Harvie, 2010).

5.3.5 Regions

Focusing on different regions in which manufacturing SMEs are located, a dummy variable is used to classify each of the following regions:

5.3.5.1 Bangkok Area

The Bangkok area contains the highest density of SMEs in Thailand, accounting for around 30 percent of total SMEs, on average, over the period 1994 to 2009. Bangkok is recognised as the major economic centre of the nation and is a regional force in finance and business (OSMEP, 2001-2009). SMEs in the Bangkok area are likely to have greater market access, greater access to credit facilities, higher managerial training, greater market opportunities and face greater competition than their counterparts in other provinces of Thailand (Brimble *et al.*, 2002; Huang, 2003;

Mephokee, 2003; Arunsawadiwong, 2007; OSMEP, 2008). Thus, a dummy variable is utilised for the Bangkok area.

5.3.5.2 Central and Vicinity Regions

The Central and Vicinity regions are captured by means of a dummy variable. Central and Vicinity regions contain many of Thailand's large businesses, and are the focal point of trade and transport of the nation. The economy of this region relies heavily on industry and manufacturing, such as that of integrated circuits and the automotive parts industry, steel production, electrical appliances and textiles and garments (OSMEP, 2008).

5.3.5.3 Northern Region

A dummy variable for the Northern region is also used for this study. This contains 17 of the 78 provinces of Thailand (Office of National Research Council of Thailand (ONRCT), 2012). The Northern region had 311,681 SMEs, equivalent to 17 percent of all SMEs, on average during 1994 to 2008 (OSMEP, 2001-2008). The economy of the Northern region relies mainly on agriculture, such as the production of rice, lychees and strawberries, and also depends upon the manufacture of wooden furniture, including tables, chairs, teak wood stools and decorative accessories (OSMEP, 2007a, 2008).

5.3.5.4 North-eastern Region

The North-eastern region has the highest population in the country and occupies the largest land area in the nation (ONRCT, 2012). The major income of this region depends upon agriculture, such as the cultivation of rice, sticky rice, sugar cane and manioc (OSMEP, 2007b). According to the OSMEP (2001-2008) the second highest number of SMEs in the nation can be found in the North-eastern area, having 514,498 SMEs equivalent to 27.41 percent of all SMEs on average during 1994 to 2008. Hence, a dummy variable for North-eastern region is used for this research.

5.3.6 Types of Ownership

Focusing upon different types of ownership, a dummy variable is utilised to classify each type of ownership in this thesis as follows:

5.3.6.1 Individual Proprietor Ownership

Individual or sole proprietorship ownership is one of the important determinants of technical efficiency. Advantages of being an individual or sole proprietorship are many: (1) complete control and decision-making power over a business, (2) sale or transfer of the enterprise is at the discretion of an individual or sole proprietor, (3) it requires minimal legal costs to enter the market, (4) it has fewer legal and reporting requirements, and (5) greater flexibility in adjusting to rapidly changing markets and technology (Zheka, 2005; Buranajarukorn, 2006; Cooper *et al.*, 2006; Fernández and Nieto, 2006; Ha, 2006). Thus, a dummy variable is used in this study to capture individual proprietor ownership.

5.3.6.2 Juristic Partnership Ownership

A dummy variable for juristic partnership is also considered for this study. As compared to an individual or sole proprietorship, a juristic partnership has the benefits of allowing the owner to draw on resources and expertise of co-partners who share responsibilities. It can be easily formed by an oral agreement between two or more people. Within a juristic partnership, partners share risk and management and solve barriers to doing business (Zheka, 2005; Cooper and Dunkelberg, 2006; Fernández and Nieto, 2006; Ha, 2006).

5.3.6.3 Limited and Public Limited Companies

A number of studies have emphasised the advantages of limited and public limited companies, and these are: (1) it has a legal existence which separates management from shareholders, (2) a company can continue to trade despite the resignation or bankruptcy of management and its members, and (3) new shareholders and investors can be easily incorporated and employees can acquire shares (Zheka, 2005; Cooper and Dunkelberg, 2006; Fernández and Nieto, 2006; Ha, 2006). Hence, a dummy variable for the limited and public limited companies is utilised for this thesis.

5.3.6.4 Government and State Ownership

A dummy variable for government and state ownership is used for this study. Many studies have found that weak corporate governance and business practices, corruption and a lack of competition are prevalent explanations of the poor efficiency performance of government and state ownership of SMEs (Brimble *et al.*, 2002; Sahakijpicharn, 2007; OSMRJ, 2008). In addition, Government firms and agencies are not well-equipped to promote or improve the business performance of SMEs (Sahakijpicharn, 2007; OECD, 2011).

5.3.6.5 Cooperative Ownership

A number of studies highlight the benefits of cooperative ownership: (1) all shareholders must be active in the cooperative, (2) shareholders have an equal vote at general meetings regardless of their shareholding or involvement, and (3) a cooperative is owned and controlled by its members (Zheka, 2005; Cooper and Dunkelberg, 2006; Ha, 2006; Thuvachote, 2007). Such a form of ownership is most likely to be prevalent in the agriculture or rural sector. Thus, a dummy variable for co-operative ownership is used for this thesis

5.3.7 Foreign Investment

Cooperation[76] involving foreign ownership or investment can affect a firm's technical efficiency and this too can be captured by means of a dummy variable (Le, 2010; Amornkitvikai, 2011). A dummy variable for foreign investment is used for this research. Several empirical studies have found that foreign ownership or investment in a firm has a positive relationship with its technical efficiency (Fukuyama *et al.*, 1999; Goldar *et al.*, 2003; Bottasso and Sembenelli, 2004). A firm having cooperation with a foreign partner can benefit from superior technology, management style, managerial knowledge, good corporate governance and other performance improving business practices (Phan, 2004; Kimura and Kiyota, 2007). However, there is the possibility that a local enterprise with no foreign ownership or investment may be restricted by the terms of the cooperation arrangements that can limit its flexibility and business performance (Lu and Beamish, 2006; Le, 2010).

5.3.8 Export Intensity

In an attempt to investigate the significance of exporting on technical efficiency, a dummy variable is utilised for export intensity. Many empirical studies have found a

[76] An enterprise may participate in different cooperation activities with foreign ownership or investment such as marketing activity, subcontracting, a joint venture and training programs (Le, 2010).

positive relationship between export intensity and technical efficiency (the learning by exporting hypothesis) (Rankin, 2001; Bigsten *et al.*, 2002; Granér and Isaksson, 2002; Kim, 2003; Granér and Isaksson, 2009; Amornkitvikai and Harvie, 2010). Exporting is used to measure the international competitiveness of an enterprise (Rankin, 2001; Theingi, 2004; Lu and Beamish, 2006; Le, 2010). Phan (2004) and Racic *et al.* (2008) indicate that enterprises that export their goods are expected to perform better than enterprises that do not export.

Exporting may force enterprises to be efficient as they have to maintain product quality, technology and other aspects of the production process up to international standards in order to retain market share (Phan, 2004; Fernández and Nieto, 2006; Kimura and Kiyota, 2007). However, the relationship between exporting and a firm's technical efficiency is still inconclusive. For instance, Alvarez and Crespi (2003) finds no significant impact upon the technical efficiency of Chilean manufacturing small enterprises from exporting. Dilling-Hansen *et al.* (2003) finds that there is no relationship between exporting and the technical efficiency of Danish enterprises. Le (2010) also finds no significant impact on the technical efficiency of Vietnamese manufacturing SMEs from exporting.

5.3.9 Government Assistance

A dummy variable to capture the impact of government assistance (via the Board of Investment (BOI)) on firm technical efficiency is utilised in this research. Several empirical studies have shown that government assistance has a positive and significant impact upon a firm's technical efficiency (Vu, 2003; Tran *et al.*, 2008; Amornkitvikai, 2011; Amornkitvikai and Harvie, 2011). Government assistance can be in the form of financial support (i.e. credit assistance, income tax exemption or reduction, and duty privileges) and non-financial assistance (i.e., managerial, technical and training assistance) (Amornkitvikai and Harvie, 2010; Le and Harvie, 2010; Amornkitvikai, 2011; Amornkitvikai and Harvie, 2011). From the viewpoint of government, it is expected that firms should improve their performance from obtaining assistance. However, the effect of government assistance on a firm's technical efficiency is still ambiguous. For example, Le (2010) finds that government assistance in the form of land, premises and credit, have a significant negative impact upon the technical efficiency of Vietnamese manufacturing SMEs.

5.4 DATA FOR ANALYSIS

The data extracted for manufacturing SMEs from the 1997 and 2007 censuses are based on that required to estimate a Cobb-Douglas production function, and to examine the first step of the two-stage DEA model. As two inputs (capital and labour) and one output (value added) are converted into natural logarithm form for empirical analysis, data containing zeros or negative values have to be removed from this study (Le, 2010; Amornkitvikai, 2011). The values of output (value added) and capital input (fixed assets) in the 1997 and 2007 industrial censuses are all in constant prices (Thai million Baht) as discussed in sub-sections 5.3.1 and 5.3.2, respectively. Descriptive statistics (i.e., mean, maximum, minimum, and standard deviation) are also represented for each variable. Finally, a summary of the statistics used in the subsequent analysis, for aggregate manufacturing SMEs, by size of SMEs (small and medium), by domestic market and export oriented manufacturing SMEs, and sub-manufacturing sectors classified by SITC: Revision 4, are also represented in Tables 5.6, 5.7, and 5.8, respectively.

Table 5.6 shows that the average output (value added) of aggregate SMEs, small- and medium-sized enterprises tended to decrease from 1997 to 2007. The mean capital input (fixed assets) and labour input (number of workers) in these categories also decreased in 2007 compared to 1997, with the exceptions of capital and labour inputs in medium-sized SMEs. In Table 5.7, the average output, capital and labour inputs in domestic SMEs decreased in the period 2007 compared to the period 1997. The mean output, capital and labour inputs in exporting SMEs increased in 2007 compared to 1997 (see Table 5.7). From Table 5.8, the average output in six sub-manufacturing sectors, including SITC 0, SITC 1, SITC 2, SITC 5, SITC 6 and SITC 8 decreased in 2007 compared to 1997, with the exceptions of SITC 3 and SITC 7. The mean capital and labour inputs in all sub-manufacturing sectors decreased in the year 2007 compared to the year 1997, except for SITC 3 (see Table 5.8).

Table 5.6: Summary Statistics of Aggregate Manufacturing SMEs and Size of Manufacturing SMEs (small and medium)

Years	The 1997 Industrial Census					The 2007 Industrial Census				
Categories	Mean	Max	Min	Std.Dev.	Obs	Mean	Max	Min	Std.Dev.	Obs
Aggregate Manufacturing SMEs										
Output (Value added, in Thai Million Baht)	125,098.16	48,380,968.57	2.83	605,828.03	22,685	67,423.43	45,924,392.20	1.57	381,396.40	56,441
Capital input (Fixed asset, in Thai Million Baht)	203,171.11	639,654,983.34	2.64	4,320,266.64	22,685	113,881.15	374,149,659.86	1.28	1,736,805.47	56,441
Labour input (Number of Workers)	34.68	200	2	39.32	22,685	23.22	200	2	33.83	56,441
Size of Manufacturing										
Small Enterprises										
Output (Value added, in Thai Million Baht)	51,513.52	15,844,513.57	2.83	187,400.67	18,214	26,581.53	29,072,218.73	1.57	185,438.84	49,835
Capital input (Fixed asset, in Thai Million Baht)	113,460.11	639,654,983.34	2.64	4,747,512.58	18,214	45,562.57	62,658,721.96	1.28	445,549.67	49,835
Labour input (Number of Workers)	18.25	50	2	11.15	18,214	12.82	50	2	11.79	49,835
Medium Enterprises										
Output (Value added, in Thai Million Baht)	424,867.94	48,380,968.57	11.3	1,267,881.98	4,471	375,530.58	45,924,392.20	5.03	935,953.43	6,606
Capital input (Fixed asset, in Thai Million Baht)	568,636.57	44,047,049.09	22.03	1,648,390.42	4,471	629,269.71	374,149,659.86	1.7	4,896,673.23	6,606
Labour input (Number of Workers)	101.6	200	51	41.97	4,471	101.71	200	51	41.89	6,606

Table 5.7: Summary Statistics of SME Export Intensity (Domestic and Exporting SMEs)

Years	The 1997 Industrial Census					The 2007 Industrial Census				
Categories	Mean	Max	Min	Std.Dev.	Obs	Mean	Max	Min	Std.Dev.	Obs
Export Intensity										
Domestic SMEs										
Output (Value added, in Thai Million Baht)	105,801.57	20,599,332.58	2.83	453,228.15	20,791	58,469.67	45,924,392.20	1.57	357,898.44	54,676
Capital input (Fixed asset, in Thai Million Baht)	184,336.30	639,654,983.34	2.64	4,494,411.04	20,791	93,426.07	68,569,957.85	1.28	686,760.32	54,676
Labour input (Number of Workers)	30.82	200	2	35.29	20,791	21.34	200	2	31.17	54,676
Exporting SMEs										
Output (Value added, in Thai Million Baht)	336,922.62	48,380,968.57	78.96	1,446,772.79	1,894	344,792.18	19,784,567.60	117.05	777,511.74	1,765
Capital input (Fixed asset, in Thai Million Baht)	409,926.38	39,085,259.32	94.16	1,330,174.01	1,894	747,536.74	374,149,659.86	297.62	9,026,680.58	1,765
Labour input (Number of Workers)	76.97	200	3	53.82	1,894	81.48	200	2	54.81	1,765

Table 5.8: Summary Statistics of Sub-manufacturing Sectors Classified by SITC: Revision 4

Years	The 1997 Industrial Census					The 2007 Industrial Census				
Categories	Mean	Max	Min	Std.Dev.	Obs	Mean	Max	Min	Std.Dev.	Obs
Sub-manufacturing Sectors										
SITC 0: Food and live animals										
Output (Value added, in Thai Million Baht)	142,443.68	13,462,669.68	8.71	559,681.97	3,070	46,394.35	10,360,641.88	1.57	254,493.38	12,080
Capital input (Fixed asset, in Thai Million Baht)	197,094.13	40,903,083.70	2.64	957,517.68	3,070	77,972.33	14,016,340.57	1.02	390,907.83	12,080
Labour input (Number of Workers)	30.76	200	2	34.33	3,070	16.49	200	2	27.47	12,080
SITC 1: Beverages and tobacco										
Output (Value added, in Thai Million Baht)	119,253.41	20,599,332.58	61.09	1,134,646.97	538	36,718.66	7,945,626.97	2.99	344,519.63	1,765
Capital input (Fixed asset, in Thai Million Baht)	164,526.37	14,728,984.89	241.74	1,052,094.37	538	77,672.24	10,947,756.51	1.36	647,907.17	1,765
Labour input (Number of Workers)	22.47	200	2	27.43	538	11.36	199	2	20.21	1,765
SITC 2: Crude materials, inedible, except fuels										
Output (Value added, in Thai Million Baht)	138,502.07	9,934,061.48	45.24	486,514.97	1,481	46,883.58	3,675,163.02	1.57	156,186.67	4,608
Capital input (Fixed asset, in Thai Million Baht)	162,793.58	21,481,525.43	11.01	844,481.36	1,481	68,687.18	7,512,837.36	1.28	275,532.70	4,608
Labour input (Number of Workers)	36.67	200	2	39.44	1,481	23.2	200	2	32.69	4,608
SITC 3: Mineral fuels and lubricants										
Output (Value added, in Thai Million Baht)	584,613.67	3,267,619.13	5022.62	754,534.88	38	774,870.45	29,072,218.73	65.98	3,352,063.29	76
Capital input (Fixed asset, in Thai Million Baht)	518,361.27	3,310,407.49	2753.3	735,704.39	38	993,671.16	5,630,074.97	205.36	1,777,156.08	76
Labour input (Number of Workers)	57.05	185	6	59.01	38	46.05	172	2	44.81	76

Table 5.8: (continued) Summary Statistics of Sub-manufacturing Sectors Classified by SITC: Revision 4

Years	The 1997 Industrial Census					The 2007 Industrial Census				
Categories	Mean	Max	Min	Std.Dev.	Obs	Mean	Max	Min	Std.Dev.	Obs
Sub-manufacturing Sectors										
SITC 5: Chemicals and related products										
Output (Value added, in Thai Million Baht)	228,729.13	48,380,968.57	29.86	1,236,097.67	2,569	167,942.56	45,924,392.20	1.92	773,162.33	4,833
Capital input (Fixed asset, in Thai Million Baht)	370,175.08	44,047,049.09	8.92	1,605,102.48	2,569	297,250.26	84,477,329.05	1.5	1,727,037.65	4,833
Labour input (Number of Workers)	45.3	200	2	46.2	2,569	40.77	200	2	43.51	4,833
SITC 6: Manufactured goods classified by material										
Output (Value added, in Thai Million Baht)	107,285.09	15,844,513.57	8.2	487,312.57	6,631	56,863.13	19,784,567.60	3.14	332,317.40	17,541
Capital input (Fixed asset, in Thai Million Baht)	160,618.40	17,062,452.07	16.52	560,239.68	6,631	97,650.31	62,658,721.96	1.7	792,855.57	17,541
Labour input (Number of Workers)	33.32	200	2	38.63	6,631	20.76	200	2	30.09	17,541
SITC 7: Machinery and transport equipment										
Output (Value added, in Thai Million Baht)	130,750.18	10,906,692.87	67.87	400,420.45	2,793	146,381.32	21,051,828.33	4.71	525,368.66	3,892
Capital input (Fixed asset, in Thai Million Baht)	426,112.85	639,654,983.34	13.22	12,114,082.14	2,793	291,585.12	374,149,659.86	25.51	6,048,341.19	3,892
Labour input (Number of Workers)	36.96	200	2	39.97	2,793	36.18	200	2	42.76	3,892
SITC 8: Miscellaneous manufactured articles										
Output (Value added, in Thai Million Baht)	79,938.31	9,100,460.10	2.8281	234,271.25	5,565	45,203.96	6,189,521.63	1.58	142,325.04	11,646
Capital input (Fixed asset, in Thai Million Baht)	81,071.02	8,010,519.81	16.5198	216,898.50	5,565	54,812.03	36,759,762.41	1.49	383,851.05	11,646
Labour input (Number of Workers)	32.9	200	2	38.63	5,565	23.96	200	2	35.23	11,646

5.5 SUMMARY

This chapter has provided important aspects required for an empirical analysis of a stochastic frontier production function and technical inefficiency effects model for the SFA approach and the two-stage DEA model. This chapter explained the data source, data classification, and the description of the data to be used in Chapter 6. This thesis uses the 1997 and 2007 industrial censuses data, collected by the NSO, concerning enterprises engaged in manufacturing industry activities only. It focuses only on manufacturing SMEs. Thus, the total sample of Thai manufacturing SMEs included in 1997 and 2007 is 22,685 and 56,441 respectively. Data for Thai manufacturing SMEs are categorised six ways: by aggregate manufacturing SMEs, by small, by medium, domestic market and export oriented manufacturing SMEs and by sub-manufacturing sectors.

Key variables extracted include output value added (Y), labour input (L) and capital input (K). Output value added (Y) is defined as the value of gross output minus intermediate consumption. Labour input (L) includes the number of workers in the enterprise, including the owner or partner, unpaid workers, skilled and unskilled labour. Capital input (K) is measured by the net value of fixed assets less depreciation at the end of the year. The value added (Y) of firms was deflated by the Producer Price Index (PPI) of manufactured products in 1997 and 2007 respectively. The capital (K) of firms was deflated by the PPI of capital equipment in 1997 and 2007 respectively. The year 2000 is taken as the base year.

Furthermore, this chapter has identified and discussed a number of firm-specific factors and explanatory variables that can be hypothesised to affect the technical efficiency of Thai manufacturing SMEs. These factors include: firm size; firm age; skilled labour; location; region of location; type of ownership;, foreign ownership or investment; export intensity and government assistance (via BOI). Firm-specific factors are used in the conduct of the technical inefficiency effects model (SFA) and a two-limit Tobit model. Finally, this chapter has presented a summary of the key statistics for selected variables used in the subsequent analysis. In the following chapter the results from an empirical analysis, utilising the SFA and DEA approaches are presented.

CHAPTER 6

EMPIRICAL RESULTS

6.1 INTRODUCTION

The main aim of this chapter is to conduct an empirical analysis of the technical efficiency of Thai manufacturing SMEs in the pre-(1997) and post-(2007) Asian financial crisis periods. This thesis applies SFA and DEA approaches to measure, compare and explain the technical efficiency of Thai manufacturing SMEs in these periods. It has been established in Section 4.2 of Chapter 4 that the SFA and DEA approaches each have their advantages as well as disadvantages, and that there is no specific set of criteria to select the best method for estimating technical efficiency (Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Seelanatha, 2007; Kontodimopoulos *et al.*, 2010; Amornkitvikai, 2011). Thus, it is quite reasonable to estimate and compare the technical efficiency performance of Thai manufacturing SMEs utilising both methods in an attempt to validate the results, as recommended in many empirical studies such as Kalaitzandonakes and Dunn (1995); Sharma *et al.* (1997); Wadud (2003); Minh *et al.*(2007); O'Donnell *et al.* (2009); Amornkitvikai and Harvie (2010) and Kontodimopoulos *et al.* (2010). Furthermore, this thesis is the first empirical study to use the SFA and DEA approaches to estimate the technical efficiency performance of Thailand's manufacturing SMEs.

With respect to the SFA approach, the maximum likelihood estimates for parameters of the stochastic frontier production function and a technical inefficiency effects model are estimated simultaneously, utilising the computer programme FRONTIER Version 4.1. For the DEA approach, the first step is to estimate the technical efficiency scores using the output-orientated variable returns to scale (VRS) model as analysed by the computer programme DEAP Version 2.1. The analysis is conducted using cross-sectional firm-level data obtained from the 1997 and 2007 industrial censuses, conducted by the National Statistical Office (NSO) of Thailand, containing 22,685 and 56,441 observations respectively, as discussed in Section 5.4 of Chapter 5. The estimation is conducted in six categories: by aggregate manufacturing SMEs; by small-sized firms; by medium-sized firms; by domestic market intensity; by export intensity; and by sub-manufacturing sectors.

The chapter proceeds as follows. Section 6.2 provides a brief review of the analytical framework to be used in this study. Section 6.3 highlights the hypothesis tests to be conducted. The empirical results from SFA and DEA are discussed in Section 6.4. Section 6.4.1 presents the results from the SFA approach. The results obtained from the DEA approach are provided in Section 6.4.2. Section 6.5 compares and discusses the empirical results between the SFA and DEA approaches. Finally, Section 6.6 presents a summary of the major findings from this chapter.

6.2 THE ANALYTICAL FRAMEWORK

This section consists of two sections: (1) the stochastic frontier production function and a technical inefficiency effects model (SFA), and (2) the two-stage DEA model (a Tobit model).

6.2.1 A Stochastic Frontier Production Function and Technical Inefficiency Effects Model (Using SFA)

As comprehensively discussed in Section 4.4 of Chapter 4, in empirical research Cobb-Douglas and Transcendental logarithmic (Translog) production functions are the most commonly used functional forms for SFA to estimate the level of technical efficiency and technical inefficiency effects (Battese and Coelli, 1995; Coelli, 1996a; Admassie and Matambalya, 2002; Batra and Tan, 2003; Kim, 2003; Vu, 2003; Phan, 2004; Coelli *et al.*, 2005; Tran *et al.*, 2008). Both the Cobb-Douglas and Translog production functions are tested to determine the preferred functional form. However, the Translog functional form produced inadequate estimation of returns to scale for almost all categories of Thai manufacturing SMEs in both 1997 and 2007, except only for aggregate manufacturing SMEs in 2007, due to the magnitudes of the estimated coefficients are too large for these categories.

Thus, this thesis uses a Cobb-Douglas[77] production function as a preferred functional form in the empirical analysis and a functional form[78] in logarithmic form utilising cross-sectional data can be written as follows (Vu, 2003; Coelli *et al.*, 2005; Tran *et al.*, 2008).:

---

[77] The Cobb-Douglas production function remains the work-horse in many empirical studies because of its flexibility, attractive properties and ease of estimation.

[78] The description and summary of a single output (value added) and two inputs (capital and labour) used in the SFA approach are discussed in Section 5.3 of Chapter 5.

$$lnY_i = \beta_0 + \beta_1 ln(K_i) + \beta_2 ln(L_i) + (V_i - U_i) \qquad ,i = 1,\ldots,N, \qquad (6.1)$$

Where:

Y_i = Output of the *i-th* firm;

K_i = Capital input of the *i-th* firm;

L_i = Labour input of the *i-th* firm;

V_i = Random error $(V_i \sim iidN(0, \sigma_V^2))$;

U_i = Non-negative random variable (or technical inefficiency) $(U_i \sim iidN^+(0, \sigma_U^2))$;

β_i = Coefficient ,i = 1,…,N.

To examine the determinants of technical inefficiency, U_i is assumed to be a function of firm-specific factors and explanatory variables[79]. This can be defined as a technical inefficiency effects model as follows:

$$\begin{aligned} U_i = {} & \delta_0 + \delta_1 Size_i + \delta_2 Age_i + \delta_3 Skill_i + \delta_4 Location_i + \delta_5 Bangkok_i + \delta_6 Central_i \\ & + \delta_7 Northern_i + \delta_8 North-eastern_i + \delta_9 Individual_i + \delta_{10} Juristic_i \\ & + \delta_{11} Limited_i + \delta_{12} State_i + \delta_{13} Co-operative_i + \delta_{14} Foreign_i \\ & + \delta_{15} Export_i + \delta_{16} Government-assis\tan ce_i + \omega_i \end{aligned} \qquad (6.2)$$

Where:

$Size_i$ = dummy for the size of firm i;

$Size_i$ = 1 for small enterprises employing up to 50 workers;

= 0 for medium enterprises employing between 51-200 workers

Age_i = age of firm i, represented by operating years;

$Skill_i$ = skilled labour of firm i, represented by the ratio of skilled labour to total workers;

$Location_i$ = dummy for municipal area[80];

$Location_i$ = 1 if firm i is located in a municipal area; = 0, otherwise;

[79] All of the firm-specific factors and explanatory variables are described and discussed in detail in Section 5.3.4 of Chapter 5.

[80] With respect to the Municipality (town or city) dummy variable, the dummy variable takes a value of 1 for SMEs located in urban areas and zero for SMEs located in rural areas for the entire nation (NSO, 2011a, 2011b).

$Bangkok_i$ = dummy for Bangkok[81];

$Bangkok_i$ = 1 if firm i is located in Bangkok; = 0, otherwise;

$Central_i$ = dummy for Central region[82];

$Central_i$ = 1 if firm i is located in the Central region; = 0, otherwise;

$Northern_i$ = dummy for Northern region;

$Northern_i$ = 1 if firm i is located in the Northern region; = 0, otherwise;

$North - eastern_i$ = dummy[83] for North-eastern region;

$North - eastern_i$ = 1 if firm i is located in the North-eastern region; = 0, otherwise;

$Individual_i$ = dummy for individual;

$Individual_i$ = 1 if firm i is owned by an individual proprietor; = 0, otherwise;

$Juristic\ partnership_i$ = dummy for juristic partnership;

$Juristic\ partnership_i$ = 1 if firm i is a juristic partnership; = 0, otherwise;

$Limited_i$ = dummy for limited-liability company;

$Limited_i$ = 1 if firm i is a limited-liability company; = 0, otherwise;

$State_i$ = dummy for state and government owned enterprises;

$State_i$ = 1 if firm i is a state or government owned enterprise; = 0, otherwise;

$Co - operative_i$ = dummy for co-operative;

$Co - operative_i$ = 1 if firm i is a cooperative; = 0, otherwise;

$Foreign_i$ = dummy for foreign investment;

$Foreign_i$ = 1 if firm i has foreign investment[84]; = 0, otherwise

---

[81] Focusing on the regional dummy for Bangkok, Central and Vicinity, Northern and North-eastern regions, the Office of National Research Council of Thailand (ONRCT) (2012) divides Thailand into six geographical regions, including the Bangkok area, Central and Vicinity regions, Northern region, North-eastern region, Eastern region and Southern region. Each one of these regions is different from the others in terms of population, social and economic development, natural features and basic resources. The dummy variable for each of these regions captures SMEs from the study sample located only in each of these regions in both urban centres or in the rural sector.

[82] The NSO (2011) included the Eastern region in the Central region in the 1997 and 2007 industrial censuses.

[83] The Southern region is excluded from the model in order to avoid the dummy trap.

$Export_i$ = dummy for exporting SMEs;

$Export_i$ = 1 if firm i exports more than 50% of its total sales revenue; = 0, otherwise;

$Government\ assistance_i$ = dummy for government assistance;

$Government\ assistance_i$ = 1 if firm i obtains promotional privileges from the Board of Investment (BOI); = 0, otherwise;

δ_i = a vector of unknown parameters to be estimated; and

ω_i = a random error defined as the truncation of the normal distribution $N(0, \sigma_\omega^2)$, the position of the truncation is $-(\delta_0 + z_i\delta)$ (Coelli *et al.*, 2005; Tran *et al.*, 2008).

In addition, the estimated coefficients of the stochastic frontier production function and technical inefficiency effects model can be measured utilising the maximum likelihood method under the assumption of a normal distribution for U_i (Battese and Coelli, 1992; Greene, 2003; Coelli *et al.*, 2005; Tran *et al.*, 2008; O'Donnell *et al.*, 2009), as discussed in Section 4.4 of Chapter 4. The validity of the technical inefficiency term and stochastic frontier production function can be tested by calculating the value of the gamma parameter (γ) (Battese and Corra, 1977; Coelli *et al.*, 2005; Arunsawadiwong, 2007). The γ parameter must contain a value between 0 and 1 and depends upon two variance parameters of the stochastic frontier function. This can be defined as (Battese and Corra, 1977; Coelli *et al.*, 2005; Arunsawadiwong, 2007; Tran *et al.*, 2008):

$$\gamma = \sigma_u^2 + \sigma^2 \text{ and } \sigma^2 = \sigma_v^2 / \sigma_u^2 \quad (6.3)$$

Where:

σ_v^2 = a statistical noise variance

σ_u^2 = a technical inefficiency effects variance

If the value of γ is close to zero deviations from the stochastic frontier function are ascribed to random error, whereas a value of γ close to unity indicates that deviations

[84] The Thai Foreign Business Act 1999 allows foreign investors to own up to 49 percent of a firm's total shares.

are due to technical inefficiency (Coelli *et al.*, 2005; Arunsawadiwong, 2007; Tran *et al.*, 2008).

6.2.2 The Two-stage DEA Model (Utilising a Tobit Model)

As exhaustively discussed in Section 4.3 of Chapter 4, a two-stage DEA approach consists of two steps: (1) the first-step DEA involves solving a linear programming problem using traditional inputs and outputs, (2) the second-step DEA, involves the technical inefficiency scores obtained from the first-step DEA being regressed upon firm-specific factors and explanatory variables. For the first-step DEA approach, this study employs the output-orientated VRS model to estimate the level of technical efficiency of manufacturing SMEs, which can be expressed as follows (Alvarez and Crespi, 2003; Coelli *et al.*, 2005; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011):

$$\begin{aligned}
&Max_{\phi,\lambda} && \phi, && \\
&Subject\ to && -\phi y_i + Y\lambda && \geq 0, \\
& && x_i - X\lambda && \geq 0, \quad j = 1, 2, ..., I, \\
& && I1'\lambda && \leq 1, \\
& && \lambda && \geq 0. \qquad (6.4)
\end{aligned}$$

Where:

ϕ = Scalar (an efficiency parameter) of the *i-th* firm;

$\frac{1}{\phi}$ = Technical efficiency of the *i-th* firm;

x_i = Input vector of the *i-th* firm;

λ = A vector of constants; and

$I1'\lambda$ = Non-increasing returns to scale (NIRS).

The second step of the two-stage DEA approach deals with firm-specific factors or explanatory variables that could affect a firm's technical efficiency. As an alternative to an OLS regression, a two-limit Tobit model can be utilised, and is recommended in the second-step DEA, as discussed in Section 4.3 of Chapter 4, (Kumbhakar and Lovell, 2000; Coelli *et al.*, 2005; Amornkitvikai, 2011). For the Tobit model, hypothesis tests can be conducted to test for the statistical significance of firm-specific factors on a firm's technical inefficiency. The technical inefficiency scores of the firm are used as the dependent variable, which can be obtained by subtracting the technical efficiency scores estimated from the output-orientated VRS DEA model from unity. The set of firm-specific factors can be utilised as independent variables for the two-stage DEA model. The estimated technical inefficiency scores are bounded between zero and unity (Alvarez and Crespi, 2003; Coelli *et al.*, 2005; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011).

Hence, the maximum likelihood method for a Tobit model can be expressed as follows (Alvarez and Crespi, 2003; Hoff, 2007; McDonald, 2009; Amornkitvikai, 2011):

$$(1-\theta_i)^* = \delta_0 + \sum_i^j \delta_j z_j + \varepsilon_i \qquad (6.5)$$

$$(1-\theta_i) = \begin{cases} (1-\theta_i)^* & \text{if} \quad 0 < (1-\theta_i)^* < 1 \\ 0 & \text{if} \quad (1-\theta_i)^* \leq 0 \\ 1 & \text{if} \quad (1-\theta_i)^* \geq 1 \end{cases}$$

Where:

$(1-\theta_i)^*$ = Unobserved technical inefficiency scores of the *i-th* firm;

$(1-\theta_i)$ = Observed technical inefficiency scores of the *i-th* firm;

δ_j = Unknown parameter to be estimated for each firm-specific factors of the *i-th* firm;

z_j = Firm-specific factors of the *i-th* firm; and

ε_i = Random error $(\varepsilon_i \sim iidN(0, \sigma_\varepsilon^2))$.

6.3 HYPOTHESIS TESTS

Three hypotheses are tested in this section using a stochastic frontier and technical inefficiency effects model (SFA), and a Tobit model (DEA). These are as follows: (1) absence of technical inefficiency effects, (2) absence of stochastic inefficiency effects, and (3) insignificance of joint inefficiency variables. These tests are conducted by utilising the generalised likelihood-ratio (LR) test which can be expressed as: (see Kim, 2003; Coelli *et al.*, 2005; Arunsawadiwong, 2007; Tran *et al.*, 2008; Amornkitvikai and Harvie, 2010, 2011):

$$\lambda = -2\{log[L(H_0)] - log[L(H_1)]\} \quad (6.6)$$

Where:

$log[L(H_0)]$ and $log[L(H_1)]$ are the values of a log-likelihood function for the stochastic frontier model under the null hypothesis (H_0) and the alternative hypothesis (H_1). The LR test statistic has an asymptotic chi-square distribution with parameters equal to the number of restricted parameters imposed under the null hypothesis (H_0), except hypotheses (1) and (2), which contain a mixture of a chi-square distribution (see Kodde and Palm, 1986). Hypotheses (1) and (2) involve the restriction that γ is equal to zero which defines a value on the boundary of the parameter space (Coelli, 1996a; Coelli *et al.*, 2005; Tran *et al.*, 2008).

6.3.1 Results for Hypothesis Tests for the SFA approach

Table 6.1 exhibits results for hypothesis tests for aggregate manufacturing SMEs in the periods 1997 and 2007. From Table 6.1 the first null hypothesis (H_0), which specifies that technical inefficiency effects are absent from the model, is strongly rejected at the 1 percent level of significance. This implies that the technical inefficiency effects model exists for aggregate manufacturing SMEs in 1997 and 2007, as defined by equations (6.1) and (6.2). The second null hypothesis (H_0) is that the inefficiency effects are not stochastic and is strongly rejected at the 1 percent level, implying that the estimated parameters can be defined in the technical inefficiency effects model for aggregate manufacturing SMEs in both 1997 and 2007, respectively. The last null hypothesis (H_0) specifies that all estimated parameters of the explanatory variables in the inefficiency effects model are equal to zero. The null hypothesis is strongly rejected at the 1 percent level for aggregate manufacturing SMEs in the years 1997 and 2007, respectively. This also indicates that the efficiency effects are not a linear function in the model (see Table 6.1).

Table 6.1: Statistics for Hypothesis Tests of the Stochastic Frontier Model and Technical Inefficiency Effects Model for Aggregate Manufacturing SMEs

Years	Pre-Crisis (1997) Period	Post-Crisis (2007) Period
	Aggregate Manufacturing SMEs	
(1) Null Hypothesis	**No Technical Inefficiency Effects**	**No Technical Inefficiency Effects**
	$(H_0 : \gamma = \delta_0 = \delta_1 = \cdots = \delta_{15} = 0)$	$(H_0 : \gamma = \delta_0 = \delta_1 = \cdots = \delta_{16} = 0)$
LR Statistics	4239.44	19956.16
Critical Value	**32.77***	**34.17***
Decision	Reject H_0	Reject H_0
(2) Null Hypothesis	**No Stochastic Inefficiency**	**No Stochastic Inefficiency**
	$(H_0 : \gamma = 0)$	$(H_0 : \gamma = 0)$
LR Statistics	754.48	2387.42
Critical Value	**5.41***	**5.41***
Decision	Reject H_0	Reject H_0
(3) Null Hypothesis	**No Joint Inefficiency Variables**	**No Joint Inefficiency Variables**
	$(H_0 : \delta_1 = \delta_2 = \cdots = \delta_{15} = 0)$	$(H_0 : \delta_1 = \delta_2 = \cdots = \delta_{16} = 0)$
LR Statistics	2874.81	16353.43
Critical Value	**30.58**	**32.00**
Decision	Reject H_0	Reject H_0

Note: All critical values of the test statistic are subject to the 1% level of significance, and * indicates a mixture of a chi-square distribution (see Kodde and Palm, 1986).

In Table 6.2 the first null hypothesis (H_0) specifying that technical inefficiency effects are absent from the model, is strongly rejected at the 1 percent level. This implies that the traditional response model is not an adequate representation of the data for size of manufacturing SMEs in the years 1997 and 2007, as specified by equations (6.1) and (6.2). The second null hypothesis (H_0), that inefficiency effects are not stochastic, is strongly rejected at the 1 percent level, meaning that the technical inefficiency effects model is applicable for size of manufacturing SMEs in 1997 and 2007. The last null hypothesis (H_0) specifies that all estimated parameters of the explanatory variables in the inefficiency effects model are equal to zero. The null hypothesis is strongly rejected at the 1 percent level for the size of manufacturing SMEs in both 1997 and 2007 (see Table 6.2).

Table 6.2: Statistics for Hypothesis Tests of the Stochastic Frontier Model and Technical Inefficiency Effects Model by Size of Manufacturing SMEs (small and medium)

Years	Pre-Crisis (1997) Period		Post-Crisis (2007) Period	
	Small Enterprises	**Medium Enterprises**	**Small Enterprises**	**Medium Enterprises**
(1) Null Hypothesis	**No Technical Inefficiency Effects**		**No Technical Inefficiency Effects**	
	$(H_0 : \gamma = \delta_0 = \delta_1 = \cdots = \delta_{14} = 0)$		$(H_0 : \gamma = \delta_0 = \delta_1 = \cdots = \delta_{15} = 0)$	
LR Statistics	3886.51	441.62	18120.21	2073.68
Critical Value	**31.35***		**32.77***	
Decision	Reject H_0	Reject H_0	Reject H_0	Reject H_0
(2) Null Hypothesis	**No Stochastic Inefficiency**		**No Stochastic Inefficiency**	
	$(H_0 : \gamma = 0)$		$(H_0 : \gamma = 0)$	
LR Statistics	711.14	69.96	2132.77	328.23
Critical Value	**5.41***		**5.41***	
Decision	Reject H_0	Reject H_0	Reject H_0	Reject H_0
(3) Null Hypothesis	**No Joint Inefficiency Variables**[85]		**No Joint Inefficiency Variables**	
	$(H_0 : \delta_1 = \delta_2 = \cdots = \delta_{14} = 0)$		$(H_0 : \delta_1 = \delta_2 = \cdots = \delta_{15} = 0)$	
LR Statistics	2651.95	287.22	15011.08	1416.28
Critical Value	**29.14**		**30.58**	
Decision	Reject H_0	Reject H_0	Reject H_0	Reject H_0

Note: All critical values of the test statistic are subject to the 1% level of significance, and * indicates a mixture of a chi-square distribution (see Kodde and Palm, 1986).

Table 6.3 presents results for hypothesis tests for domestic and exporting SMEs in 1997 and 2007. In Table 6.3 the first null hypothesis (H_0), which specifies that technical inefficiency effects are absent from the model, is strongly rejected at the 1 percent level. This specifies that the technical inefficiency effects model exists for domestic and exporting SMEs in both periods, given by equations (6.1) and (6.2). The second null hypothesis (H_0), that the inefficiency effects are not stochastic, is strongly rejected at the 1 percent level, indicating that the technical inefficiency effects model is applicable for domestic and exporting SMEs in both 1997 and 2007, as defined by equation (1). The last null hypothesis (H_0) specifies that all estimated parameters of the explanatory variables in the inefficiency effects model are equal to zero. The null hypothesis is strongly rejected at the 1 percent level for domestic and exporting SMEs in both periods (see Table 6.3).

[85] In 1997, small and medium sized enterprises had 14 explanatory variables, whereas there are 15 explanatory variables for 2007.

Table 6.4 summarises the results for a number of null hypotheses relating to sub-manufacturing sectors in 1997 and 2007. The first null hypothesis (H_0) tests whether technical inefficiency effects are absent from the model. This hypothesis is rejected at the 1 per cent level of significance for all sub-manufacturing sectors in both periods. The second null hypothesis (H_0), that technical inefficiency effects are not stochastic, is also rejected at the 1 per cent level of significance for all sub-manufacturing sectors in 1997 and 2007. The last null hypothesis (H_0), specifying that all estimated parameters of the explanatory variables in the technical inefficiency effects model are equal to zero, is rejected at the 1 per cent level of significance for all sub-manufacturing sectors in 1997 and 2007 (see Table 6.4).

Table 6.3: Statistics for Hypothesis Tests of the Stochastic Frontier Model and Technical Inefficiency Effects Model by Domestic and Exporting SMEs

Years	Pre-Crisis (1997) Period		Post-Crisis (2007) Period	
	Domestic SMEs	**Exporting SMEs**	**Domestic SMEs**	**Exporting SMEs**
(1) Null Hypothesis	**No Technical Inefficiency Effects**[95] $(H_0 : \gamma = \delta_0 = \delta_1 = \cdots = \delta_{15} = 0)$	**No Technical Inefficiency Effects** $(H_0 : \gamma = \delta_0 = \delta_1 = \cdots = \delta_{14} = 0)$	**No Technical Inefficiency Effects**[96] $(H_0 : \gamma = \delta_0 = \delta_1 = \cdots = \delta_{16} = 0)$	**No Technical Inefficiency Effects** $(H_0 : \gamma = \delta_0 = \delta_1 = \cdots = \delta_{15} = 0)$
LR Statistics	4037.52	151.67	19375.02	245.14
Critical Value	**32.77***	**31.35***	**34.17***	**32.77***
Decision	Reject H_0	Reject H_0	Reject H_0	Reject H_0
(2) Null Hypothesis	**No Stochastic Inefficiency** $(H_0 : \gamma = 0)$	**No Stochastic Inefficiency** $(H_0 : \gamma = 0)$	**No Stochastic Inefficiency** $(H_0 : \gamma = 0)$	**No Stochastic Inefficiency** $(H_0 : \gamma = 0)$
LR Statistics	747.25	11.90	2357.54	13.67
Critical Value	**5.41***	**5.41***	**5.41***	**5.41***
Decision	Reject H_0	Reject H_0	Reject H_0	Reject H_0
(3) Null Hypothesis	**No Joint Inefficiency Variables** $(H_0 : \delta_1 = \delta_2 = \cdots = \delta_{15} = 0)$	**No Joint Inefficiency Variables** $(H_0 : \delta_1 = \delta_2 = \cdots = \delta_{14} = 0)$	**No Joint Inefficiency Variables** $(H_0 : \delta_1 = \delta_2 = \cdots = \delta_{16} = 0)$	**No Joint Inefficiency Variables** $(H_0 : \delta_1 = \delta_2 = \cdots = \delta_{15} = 0)$
LR Statistics	2712.63	114.53	15893.11	210.03
Critical Value	**30.58**	**29.14**	**32.00**	**30.58**
Decision	Reject H_0	Reject H_0	Reject H_0	Reject H_0

Note: All critical values of the test statistic are subject to the 1% level of significance, and * indicates a mixture of a chi-square distribution (see Kodde and Palm, 1986).

[95] Domestic SMEs have 15 explanatory variables in 1997, while exporting SMEs in 1997 had 14 explanatory variables.

[96] For 2007, domestic SMEs had 16 explanatory variables, while exporting SMEs had 15 explanatory variables.

Table 6.4: Statistics for Hypothesis Tests of the Stochastic Frontier Model and Technical Inefficiency Effects Model by SITC: Revision 4

Years	Pre-Crisis (1997) Period								Post-Crisis (2007) Period							
	SITC 0	SITC 1	SITC 2	SITC 3[97]	SITC 5	SITC 6	SITC 7	SITC 8	SITC 0	SITC 1	SITC 2	SITC 3	SITC 5	SITC 6	SITC 7	SITC 8
(1) Null Hypothesis				**No Technical Inefficiency Effects** $(H_0 : \gamma = \delta_0 = \delta_1 = \cdots = \delta_{15} = 0)$								**No Technical Inefficiency Effects** $(H_0 : \gamma = \delta_0 = \delta_1 = \cdots = \delta_{16} = 0)$				
LR Statistics	386.19	202.61	223.69	N/A	371.79	1239.25	343.49	1247.41	3294.20	327.76	2090.87	N/A	2719.65	5416.55	945.22	5702.39
Critical Value				**32.77***								**37.17***				
Decision	Reject H_0	Reject H_0	Reject H_0	N/A	Reject H_0	Reject H_0	Reject H_0	Reject H_0	Reject H_0	Reject H_0	Reject H_0	N/A	Reject H_0	Reject H_0	Reject H_0	Reject H_0
(2) Null Hypothesis				**No Stochastic Inefficiency** $(H_0 : \gamma = 0)$								**No Stochastic Inefficiency** $(H_0 : \gamma = 0)$				
LR Statistics	42.49	50.82	40.74	N/A	52.26	207.56	118.53	174.34	418.42	44.89	248.00	N/A	346.08	463.13	68.44	762.02
Critical Value				**5.41***								**5.41***				
Decision	Reject H_0	Reject H_0	Reject H_0	N/A	Reject H_0	Reject H_0	Reject H_0	Reject H_0	Reject H_0	Reject H_0	Reject H_0	N/A	Reject H_0	Reject H_0	Reject H_0	Reject H_0
(3) Null Hypothesis				**No Joint Inefficiency Variables S[98]** $(H_0 : \delta_1 = \delta_2 = \cdots = \delta_{15} = 0)$								**No Joint Inefficiency Variables** $(H_0 : \delta_1 = \delta_2 = \cdots = \delta_{16} = 0)$				
LR Statistics	285.96	170.51	146.04	N/A	272.55	830.27	150.43	930.85	2652.63	247.24	1792.19	N/A	2159.52	4684.05	797.10	4641.08
Critical Value				**30.58**								**32**				
Decision	Reject H_0	Reject H_0	Reject H_0	N/A	Reject H_0	Reject H_0	Reject H_0	Reject H_0	Reject H_0	Reject H_0	Reject H_0	N/A	Reject H_0	Reject H_0	Reject H_0	Reject H_0

Note: Note: All critical values of the test statistic are subject to the 1% level of significance, and * indicates a mixture of a chi-square distribution (see Kodde and Palm, 1986). SITC 0: Food and live animals, SITC 1: Beverages and tobacco, SITC 2: Crude materials, inedible, except fuels, SITC 3: Mineral fuels, lubricants and related materials, SITC 5: Chemicals and related products, SITC 6: Manufactured goods classified by material, SITC 7: Machinery and transport equipment, SITC 8: Miscellaneous manufactured articles.

[97] The results for SITC 3 in 1997 and 2007 produced insignificant results due to the estimate of the gamma parameter (γ) being 0.0003, meaning that all deviations are largely attributable to noise. The estimated coefficients for SITC 3 in the technical inefficiency effect models, as specified by equation (6.2), are not statistically significant for the majority of this category. Furthermore, Thailand's manufacturing SMEs are heavily reliant on imported mineral fuels, lubricants, and related materials. SITC 3 also represents the smallest share of SME contribution to the economy compared to other sub-manufacturing sectors (Dhanani and Scholtès, 2002; OSMEP, 2006).

[98] In 1997, all sub-manufacturing sectors had 15 explanatory variables, whereas there are 16 explanatory variables in 2007.

6.3.2 Results for Hypothesis Tests for the DEA approach

Table 6.5 presents results for hypothesis tests using a Tobit model for the periods 1997 and 2007. In Table 6.5 the null hypothesis (H_0) specifies that all estimated parameters of the explanatory variables in the Tobit model are equal to zero. The null hypothesis (H_0) is strongly rejected at the 1 percent level of significance for all SME categories, including aggregate manufacturing SMEs, small and medium sized enterprises, and domestic and exporting SMEs in both periods, as specified by equation (6.5). This also signifies that the efficiency effects are not a linear function in the Tobit model.

Table 6.5: Statistics for Hypothesis Tests of the Tobit Model for Aggregate Manufacturing SMEs, Size of Manufacturing SMEs (small and medium), and Domestic and Exporting SMEs

Years	Pre-Crisis (1997) Period	Post-Crisis (2007) Period
	Aggregate Manufacturing SMEs	
Null Hypothesis	**No Joint Inefficiency Variables**[14] $(H_0: \delta_1 = \delta_2 = \cdots = \delta_{15} = 0)$	**No Joint Inefficiency Variables** $(H_0: \delta_1 = \delta_2 = \cdots = \delta_{16} = 0)$
LR Statistics	7163.24	30029.58
Critical Value	**30.58**	**32.00**
Decision	Reject H_0	Reject H_0
	Small Enterprises[15]	
Null Hypothesis	**No joint Inefficiency Variables** $(H_0: \delta_1 = \delta_2 = \cdots = \delta_{14} = 0)$	**No joint Inefficiency Variables** $(H_0: \delta_1 = \delta_2 = \cdots = \delta_{15} = 0)$
LR Statistics	3480.76	22553.36
Critical Value	**29.14**	**30.58**
Decision	Reject H_0	Reject H_0
	Medium Enterprises	
Null Hypothesis	**No joint Inefficiency Variables** $(H_0: \delta_1 = \delta_2 = \cdots = \delta_{14} = 0)$	**No joint Inefficiency Variables** $(H_0: \delta_1 = \delta_2 = \cdots = \delta_{15} = 0)$
LR Statistics	265.15	1958.32
Critical Value	**29.14**	**30.58**
Decision	Reject H_0	Reject H_0
	Domestic SMEs[16]	
Null Hypothesis	**No joint Inefficiency Variabl**es $(H_0: \delta_1 = \delta_2 = \cdots = \delta_{15} = 0)$	**No joint Inefficiency Variables** $(H_0: \delta_1 = \delta_2 = \cdots = \delta_{16} = 0)$
LR Statistics	6548.24	27827.88
Critical Value	**30.58**	**32.00**
Decision	Reject H_0	Reject H_0
	Exporting SMEs[17]	
Null Hypothesis	**No joint Inefficiency Variables** $(H_0: \delta_1 = \delta_2 = \cdots = \delta_{14} = 0)$	**No joint Inefficiency Variables** $(H_0: \delta_1 = \delta_2 = \cdots = \delta_{15} = 0)$
LR Statistics	124.79	199.64
Critical Value	**29.14**	**30.58**
Decision	Reject H_0	Reject H_0

Note: All critical values of the test statistic are presented at the 1% level of significance, obtained from a chi-square distribution.

[14] Aggregate manufacturing SMEs have 15 inefficiency variables in 1997, whereas there are 16 inefficiency variables in 2007.
[15] In 1997, small and medium sized enterprises had 15 inefficiency variables, whereas there are 16 inefficiency variables in 2007.
[16] Domestic SMEs had 15 inefficiency variables in 1997, whereas there are 16 inefficiency variables in 2007.
[17] For 1997, exporting SMEs had 14 inefficiency variables, whereas there are 15 inefficiency variables in 2007.

From Table 6.6, the null hypothesis (H_0) means that all estimated parameters of the explanatory variables in the Tobit model are equal to zero. The null hypothesis (H_0) is strongly rejected at the 1 percent level of significance for all sub-manufacturing sectors in 1997 and 2007, implying that the joint inefficiency effect of the explanatory variables is statistically significant, as defined by equation (6.5).

Table 6.6: Statistics for Hypothesis Tests of the Two-stage DEA Model (a Two Limit Tobit Model) by SITC: Revision 4

Years	Pre-Crisis (1997) Period								Post-Crisis (2007) Period							
	SITC 0	SITC 1[18]	SITC 2	SITC 3[19]	SITC 5	SITC 6	SITC 7	SITC 8	SITC 0	SITC 1	SITC 2	SITC 3	SITC 5	SITC 6	SITC 7	SITC 8
Null Hypothesis	No joint Inefficiency Variables[20] $(H_0 : \delta_1 = \delta_2 = \cdots = \delta_{15} = 0)$								No joint Inefficiency Variables $(H_0 : \delta_1 = \delta_2 = \cdots = \delta_{16} = 0)$							
LR Statistics	476.45	N/A	258.06	N/A	387.30	2129.32	233.48	1528.51	5086.27	324.01	2786.7	N/A	3606.64	8223.14	1878.91	6973.08
Critical Value	**30.58**								**32.00**							
Decision	Reject H_0	N/A	Reject H_0	N/A	Reject H_0	Reject H_0	Reject H_0	Reject H_0	Reject H_0	Reject H_0	Reject H_0	N/A	Reject H_0	Reject H_0	Reject H_0	Reject H_0

Note: All critical values of the test statistic are presented at the 1% level of significance, obtained from a chi-square distribution. SITC 0: Food and live animals, SITC 1: Beverages and tobacco, SITC 2: Crude materials, inedible, except fuels, SITC 3: Mineral fuels, lubricants and related materials, SITC 5: Chemicals and related products, SITC 6: Manufactured goods classified by material, SITC 7: Machinery and transport equipment, SITC 8: Miscellaneous manufactured articles.

[18] The estimation of SITC 1: Beverages and tobacco in 1997 failed to generate significant results.
[19] The estimation of SITC 3: Mineral fuels, lubricants and related materials in 1997 and 2007 failed to produce significant results.
[20] For 1997 all sub-manufacturing sectors had 15 inefficiency variables, whereas there are 16 inefficiency variables in 2007.

6.4 EMPIRICAL RESULTS FROM THE SFA AND DEA ANALYSIS

This section compares and discusses the empirical results obtained from the SFA and DEA approaches for Thai manufacturing SMEs in 1997 and 2007. For the SFA approach, as discussed in Section 6.4.1, the empirical results are categorised into two sections: (1) results from a stochastic frontier production function – input elasticities and gamma parameters, and (2) results for the simple average and the weighted average technical efficiency levels of Thai manufacturing SMEs. For the DEA approach, as described in Section 6.4.2, the empirical results can be divided into two sections: (1) results from the first-step of the two-stage DEA model, and (2) results for the simple average and the weighted average technical efficiency levels of Thai manufacturing SMEs. Finally, Section 6.4.3 compares and describes the empirical evidence from the SFA and DEA approaches for the robustness of the results.

6.4.1 Empirical Results from the SFA approach

The maximum likelihood estimates (MLE) for the parameters of the stochastic frontier production function and technical inefficiency effects model, as specified by equations (6.1) and (6.2), were estimated simultaneously using the FRONTIER[21] Version 4.1 developed by Coelli (1996a). The Coelli estimation technique is a three-step procedure (Coelli, 1996a). In step 1, OLS is applied to obtain unbiased estimates of the parameters of the production function. In step 2, the OLS estimates are used as starting values to estimate the final maximum likelihood model. The value of the likelihood function is estimated through a grid-search of γ between 0 and 1 given the values of the β's derived by OLS. Finally, an iterative Davidon-Fletcher-Powell algorithm calculates the final parameter estimates, using the values of the β's from the OLS and the value of γ from the intermediate step as starting values (Coelli, 1996a; Mortimer, 2002; Arunsawadiwong, 2007; Kontodimopoulos *et al.*, 2010; Le,

[21] LIMDEP is an alternative program to estimate a stochastic production frontier and technical inefficiency effects model. However, LIMDEP is unable to accommodate a wider range of assumptions regarding the error distribution term compared to SFA (Frontier 4.1). It is also unable to estimate the technical inefficiency effects model in a one-step process compared to Frontier 4.1. This may create bias, as the distribution of the technical inefficiency estimates is pre-determined through the distributional assumptions used in its empirical analysis (Herrero and Pascoe, 2002; Amornkitvikai and Harvie, 2011).

2010; Amornkitvikai, 2011). The estimated results are reported in Tables 6.7, 6.8 and 6.9, respectively.

6.4.1.1 Results from the Stochastic Frontier Production Function - Input Elasticities and Gamma Parameters

Table 6.7 presents the results of maximum likelihood estimation for aggregate manufacturing SMEs and by size of manufacturing SME (small and medium) in the periods 1997 and 2007. In 1997 the Cobb-Douglas[22] production function for aggregate manufacturing SMEs and by size of manufacturing SMEs have positive signs for both capital (β_1) and labour (β_2) input, and they are also highly significant at the 1 percent level. Aggregate manufacturing and medium-sized SMEs are found to have modest increasing returns to scale (IRS) in production, as the combined values of the estimated input coefficients obtained from the stochastic frontier model is higher than unity, being 1.06 and 1.07, respectively, while small SMEs experienced constant returns to scale (CRS) as the sum of the estimated input coefficients (1.02) is close to unity.

However, input elasticities for aggregate manufacturing, small- and medium-sized SMEs differ. The elasticities of labour input (β_2) in the stochastic production functions are much higher than that of capital input (β_1). From Table 6.7, the elasticities of labour (β_2) for aggregate manufacturing, small- and medium-sized SMEs are equal to 0.837, 0.825 and 0.724 respectively in 1997. The capital input (β_1) elasticities for aggregate manufacturing, small- and medium-sized SMEs are 0.222, 0.194 and 0.343 respectively. The high value of the labour input elasticity (β_2) indicates that aggregate manufacturing, small- and medium-sized SMEs are labour-intensive in production and labour can be considered as the most important factor in the production function. The low value of the capital input (β_1) elasticity in the production functions reveals that capital made a much lower contribution to the output of aggregate manufacturing, small- and medium-sized SMEs.

---

[22] With a Cobb-Douglas production function, the estimated input coefficient can be used to represent input elasticity in the production function. In addition, a measurement of returns to scale, specified by the combined value of the estimated input coefficients, provides economic meaning, signifying whether firms are operating under constant, increasing, or decreasing returns to scale (Griffiths and O'Donnell, 2005; Major, 2008; Amornkitvikai *et al*., 2010).

From Table 6.7 it can also be seen that in 1997 the gamma parameter (γ) is equal to unity, indicating that all deviations from the stochastic production function are caused by technical inefficiency (Phan, 2004; Coelli *et al*., 2005; Tran *et al*., 2008). The estimate of the gamma parameter (γ) for aggregate manufacturing SMEs is 0.797, meaning that the variation in the composite error term is due to the inefficiency component. The estimated gamma parameters (γ) of small- and medium-sized SMEs are 0.803 and 0.756 respectively, meaning that all deviations from the model are also ascribed to technical inefficiency.

In 2007 the Cobb-Douglas production function reveals IRS for aggregate manufacturing SMEs, as the combined value of the estimated input coefficients is 1.21 (see Table 6.7). The estimate of the variance parameter gamma (γ) is 0.650, meaning that all deviations are caused by technical inefficiency. Aggregate manufacturing SMEs have positive signs for capital (β_1) and labour (β_2), 0.233 and 0.973 respectively, and they are also highly significant at the 1 percent level. Table 6.7 also shows the results of maximum likelihood estimation by size of SME (small and medium) in 2007. Small SMEs have positive signs for both capital (β_1) and labour (β_2), which are 0.219 and 1.042 respectively, and they are also highly significant at the 1 percent level. Small SMEs are found to have IRS (1.26) in production. The estimated gamma parameter of small SMEs is 0.65, indicating that all deviations from the model are ascribed to technical inefficiency (see Table 6.7).

For medium-sized SMEs the coefficients of capital (β_1) and labour (β_2) have positive signs, 0.307 and 0.653 respectively, and they are statistically significant at the 1 percent level. Medium-sized SMEs have tended to have CRS (0.96) in production. The estimate of the variance parameter of gamma is 0.770, implying that all deviations are mainly due to technical inefficiency in the production function. However, there is a different elasticity by size of SME. The contribution of labour in the production function is higher than capital, irrespective of the size of the SME, showing that small- and medium-sized enterprises were labour-intensive in 2007 (see Table 6.7).

Table 6.7 also indicates noticeably different values for input elasticities by size of SME. Labour input elasticities are higher for both small- and medium-sized enterprises in comparison to capital input elasticities in production, and particularly so for small enterprises. Consequently, additional production can be more easily achieved in the case of both small- and medium-sized enterprises by using relatively

Table 6.7: Maximum Likelihood Estimates of the Parameters for the Stochastic Frontier Model and Technical Inefficiency Effects Model by Aggregate Manufacturing SMEs and Size of Manufacturing SMEs (small and medium)

Years	Pre-Crisis (1997) Period			Post-Crisis (2007) Period		
Variables	Aggregate Manufacturing SMEs	Small Enterprises	Medium Enterprises	Aggregate Manufacturing SMEs	Small Enterprises	Medium Enterprises
Number of Observations	**22685**	**18214**	**4471**	**56441**	**49835**	**6606**
	Coefficients	Coefficients	Coefficients	Coefficients	Coefficients	Coefficients
Stochastic Frontier Model						
Constant	6.139***	6.453***	5.219***	5.457***	5.407***	5.956***
	(0.045)	(0.054)	(0.159)	(0.032)	(0.039)	(0.144)
Capital	0.222***	0.194***	0.343***	0.233***	0.219***	0.307***
	(0.004)	(0.004)	(0.011)	(0.002)	(0.003)	(0.007)
Labour	0.837***	0.825***	0.724***	0.973***	1.042***	0.653***
	(0.009)	(0.012)	(0.032)	(0.006)	(0.007)	(0.028)
Technical Inefficiency Effects Model						
Constant	3.146***	2.761***	3.523***	3.031***	2.586***	1.719***
	(0.163)	(0.142)	(0.386)	(0.064)	(0.045)	(0.214)
Firm Size (dummy)	-0.386***	N/A	N/A	-0.492***	N/A	N/A
	(0.105)			(0.055)		
Firm Age (years)	-0.005*	0.001	-0.064***	-0.002**	-0.002*	-0.023***
	(0.003)	(0.003)	(0.013)	(0.001)	(0.001)	(0.004)
Skilled Labour (ratio)	N/A	N/A	N/A	-0.850***	-0.854***	0.411***
				(0.027)	(0.026)	(0.111)
Municipality (dummy)	-0.559***	-0.774***	0.402***	-0.347***	-0.385***	0.090
	(0.073)	(0.099)	(0.134)	(0.023)	(0.025)	(0.103)
Bangkok Area (dummy)	-3.202***	-2.893***	-3.425***	-2.186***	-2.343***	-2.055***
	(0.336)	(0.281)	(0.773)	(0.157)	(0.193)	(0.518)
Central & Vicinity Regions	-0.176**	-0.157*	0.021	-0.024	0.009	-0.425**
(dummy)	(0.076)	(0.091)	(0.189)	(0.036)	(0.037)	(0.207)
Northern Region (dummy)	-0.286***	-0.335***	0.377*	0.645***	0.641***	2.330***
	(0.085)	(0.104)	(0.230)	(0.035)	(0.035)	(0.212)
North-eastern Region (dummy)	0.376***	0.358***	0.684***	0.358***	0.389***	-0.129
	(0.084)	(0.121)	(0.246)	(0.035)	(0.033)	(0.195)
Individual Proprietor (dummy)	-2.606***	-2.594***	-3.300***	-1.104***	-1.245***	-1.584***
	(0.171)	(0.180)	(0.536)	(0.028)	(0.034)	(0.196)
Juristic Partnership (dummy)	-4.821***	-5.000***	-4.110***	-2.860***	-2.960***	-3.429***
	(0.302)	(0.355)	(0.574)	(0.086)	(0.101)	(0.300)
Limited & Public Limited	-5.753***	-5.959***	-5.114***	-4.064***	-4.469***	-4.545***
company (dummy)	(0.346)	(0.434)	(0.763)	(0.119)	(0.191)	(0.356)
Government & State Enterprises	-1.789***	-3.191***	-1.736***	0.599***	0.009	1.383***
(dummy)	(0.390)	(0.711)	(0.469)	(0.148)	(0.198)	(0.242)
Cooperatives (dummy)	-2.151***	-2.069***	-15.257***	-1.716***	-1.901***	-0.727*
	(0.210)	(0.224)	(4.129)	(0.149)	(0.163)	(0.443)
Foreign Investment (dummy)	-1.431***	-0.854**	-1.176***	-0.575***	-0.258	-0.951***
	(0.184)	(0.396)	(0.281)	(0.225)	(0.396)	(0.217)
Exports (dummy)	-0.608***	-1.020***	-0.226**	-0.414**	-0.621**	-0.194
	(0.094)	(0.177)	(0.106)	(0.177)	(0.264)	(0.333)
Government Assistance (BOI)	-0.054	0.228	-0.397**	-0.230	-0.353	-1.270***
(dummy)	(0.140)	(0.210)	(0.168)	(0.204)	(0.327)	(0.369)
Variance Parameters						
Sigma-squared	3.594***	3.581***	3.142***	1.787***	1.782***	2.664***
	(0.246)	(0.255)	(0.517)	(0.029)	(0.031)	(0.237)
Gamma	0.797***	0.803***	0.756***	0.651***	0.652***	0.770***
	(0.014)	(0.014)	(0.042)	(0.006)	(0.007)	(0.022)
Log-likelihood Function	-33204.03	-26595.03	-6483.26	-83151.65	-73972.99	-8800.36
Mean Technical Efficiency	0.59	0.58	0.62	0.44	0.42	0.65
Returns to scale	1.06	1.02	1.07	1.21	1.26	0.96

Note: Standard errors are in brackets; *, ** and *** indicate that the coefficients are statistically significant at 10%, 5% and 1%, respectively labour input in the production process, and particularly so for small enterprises. We can suggest, therefore, from Table 6.7, that there is an incentive to use relatively labour-intensive production techniques for both sizes of enterprise and that this incentive is even greater for small enterprises. This could be problematic for Thai SMEs, in that it may encourage or accentuate the dependence of SMEs on low-cost and unskilled labour operating in low-income and low value-adding activities, and discourage upgrading of technology through capital input acquisition. However, such a conclusion requires a more in-depth analysis that goes beyond the present study.

Table 6.8 shows the results for domestic and exporting SMEs in the periods 1997 and 2007. In 1997 the estimated coefficients of capital (β_1) and labour (β_2) are positive and strongly significant at the 1 percent level of significance for both domestic and exporting manufacturing SMEs. The input elasticities of capital (β_1) and labour (β_2) reveal IRS (1.06) in domestic manufacturing SMEs, whereas exporting SMEs exhibit DRS (0.89) in production. The elasticities of labour (β_2) in the stochastic production functions are much higher than capital (β_1) for the case of domestic and exporting manufacturing SMEs. From Table 6.5, the elasticities of labour (β_2) are 0.842 and 0.640 respectively, while the capital (β_1) elasticities are 0.219 and 0.254 respectively. The share of labour in the production function is higher than capital for domestic and exporting manufacturing SMEs. The estimates of the variance parameter gamma (γ) for domestic and exporting SMEs are 0.805 and 0.648 respectively, implying that all deviations from the production function are attributable to technical inefficiency in the production function (see Table 6.8).

In 2007 the Cobb-Douglas production function indicates that domestic and exporting SMEs have positive signs for both capital input (β_1) and labour input (β_2), and they are also strongly significant at the 1 percent level of significance. Domestic SMEs are found to have IRS (1.22), whereas exporting SMEs are found to have DRS (0.84) in production. However, these elasticities are different for domestic and exporting manufacturing SMEs. The elasticities of labour (β_2) in the stochastic production function are much higher than capital (β_1). From Table 6.8, the elasticities of labour (β_2) in the production functions for domestic and exporting SMEs are equal to 0.984 and 0.589 respectively. The capital (β_1) elasticities in the production function for domestic and exporting SMEs are 0.231 and 0.260 respectively. The high labour-elasticity value indicates that domestic and exporting

Table 6.8: Maximum Likelihood Estimates for Parameters of the Stochastic Frontier Model and Technical Inefficiency Effects Model by Domestic and Exporting SMEs

Years	**Pre-Crisis (1997) Period**		**Post-Crisis (2007) Period**	
Variables	**Domestic SMEs**	**Exporting SMEs**	**Domestic SMEs**	**Exporting SMEs**
Number of Observations	**20791**	**1894**	**54676**	**1765**
	Coefficients	Coefficients	Coefficients	Coefficients
Stochastic Frontier Model				
Constant	6.144***	6.684***	5.425***	6.925***
	(0.045)	(0.217)	(0.033)	(0.271)
Capital	0.219***	0.254***	0.231***	0.260***
	(0.004)	(0.015)	(0.002)	(0.017)
Labour	0.842***	0.640***	0.984***	0.589***
	(0.009)	(0.042)	(0.006)	(0.049)
Technical Inefficiency Effects Model				
Constant	3.154***	1.672**	3.006***	-0.096
	(0.182)	(0.724)	(0.067)	(0.970)
Firm Size (dummy)	-0.433***	0.764**	-0.483***	0.271
	(0.098)	(0.329)	(0.057)	(0.182)
Firm Age (years)	-0.004	-0.050***	-0.002**	0.005
	(0.004)	(0.019)	(0.001)	(0.007)
Skilled Labour (ratio)	N/A	N/A	-0.867***	0.316
			(0.027)	(0.209)
Municipality (dummy)	-0.553***	-0.733**	-0.361***	-0.040
	(0.080)	(0.345)	(0.027)	(0.121)
Bangkok Area (dummy)	-3.317***	-1.874*	-2.290***	1.352
	(0.347)	(1.096)	(0.163)	(0.793)
Central & Vicinity Regions (dummy)	-0.188**	0.301	-0.024	1.829
	(0.080)	(0.323)	(0.037)	(1.079)
Northern Region (dummy)	-0.332***	0.436	0.658***	2.299**
	(0.091)	(0.341)	(0.035)	(1.126)
North-eastern Region (dummy)	0.392***	0.351	0.362***	2.360**
	(0.093)	(0.410)	(0.035)	(1.198)
Individual Proprietor (dummy)	-2.687***	-1.302**	-1.141***	-0.541
	(0.199)	(0.586)	(0.029)	(0.335)
Juristic Partnership (dummy)	-5.016***	-2.111***	-2.953***	-1.267***
	(0.349)	(0.659)	(0.092)	(0.352)
Limited & Public limited company (dummy)	-5.997***	-2.659***	-4.213***	-1.556***
	(0.411)	(0.768)	(0.131)	(0.329)
Government & State Enterprises (dummy)	-1.834***	-3.109	0.631***	-5.384
	(0.387)	(1.950)	(0.149)	(4.480)
Cooperatives (dummy)	-2.191***	-11.717	-1.751***	0.533
	(0.237)	(9.582)	(0.149)	(0.995)
Foreign Investment (dummy)	-1.983***	-0.194	-0.380*	-0.289
	(0.289)	(0.168)	(0.211)	(0.191)
Exports (dummy)	-0.239**	N/A	-0.525*	N/A
	(0.118)		(0.270)	
Government Assistance (BOI) (dummy)	0.141	-0.945**	-0.473	-0.096
	(0.151)	(0.397)	(0.296)	(0.970)
Variance Parameters				
Sigma-squared	3.696***	2.258***	1.815***	0.946***
	(0.280)	(0.599)	(0.029)	(0.198)
Gamma	0.805***	0.648***	0.660***	0.239
	(0.015)	(0.097)	(0.006)	(0.232)
Log-likelihood Function	-30449.14	-2715.88	-80691.46	-2346.28
Returns to scale	1.06	0.89	1.22	0.84

Note: Standard errors are in brackets; *, ** and *** indicate that the coefficients are statistically significant at 10%, 5% and 1%, respectively.

SMEs are heavily dependent upon labour in the production process. The low value of capital elasticity in the production function reveals that capital had a low input share in domestic and exporting SME output in 2007. Furthermore, the estimated gamma parameter (γ) of domestic SMEs is 0.660, indicating that all deviations from the model are attributable to technical inefficiency. The estimate of the variance parameter of gamma (γ) in exporting SMEs is 0.239, implying that all deviations from the production function were attributable to noise in 2007 (see Table 6.8).

Table 6.9 exhibits the results for sub-manufacturing sectors classified by SITC: Revision 4 in the years 1997 and 2007. In 1997, the estimated coefficients of capital (β_1) and labour (β_2) are positive and significant at the 1 percent level of significance in all sub-manufacturing sectors. The input elasticities of capital (β_1) and labour (β_2) reveal IRS in three sub-manufacturing sectors, including SITC 1, SITC 2 and SITC 7, whereas SITC 8 shows decreasing returns to scale. In addition, SITC 0, SITC 5 and SITC 6 exhibit CRS. However, there are different elasticities in all sub-manufacturing sectors in 1997. The elasticities of labour (β_2) in the stochastic production functions are much higher than capital (β_1). From Table 4, the elasticities of labour (β_2) range between 0.733 in SITC 0 to 0.917 in SITC 7, while the elasticities of capital (β_1) range from 0.160 in SITC 7 to 0.382 in SITC 1.

Hence, the high values of labour-elasticity signify that all sub-manufacturing sectors are dependent upon labour in the production process. The low value of the capital-elasticity indicates that capital has a low share in all sub-manufacturing sectors. For the gamma parameter (γ), its value ranges from 0.519 in SITC 8 to 0.941 in SITC 7, with the exception of SITC 1. This indicates that the technical inefficiency effects are important in an analysis of the value of output of SITC 0, SITC 2, SITC 5, SITC 6, SITC 7 and SITC 8. However, the value of the gamma parameter (γ) in SITC 7 was only 0.126 (see Table 6.9).

Table 6.9: Maximum Likelihood Estimates for Parameters of the Stochastic Frontier Model and Technical Inefficiency Effects Model by SITC: Revision 4

Years	Pre-Crisis (1997) Period							Post-Crisis (2007) Period						
Variable	SITC 0	SITC 1	SITC 2	SITC 5	SITC 6	SITC 7	SITC 8	SITC 0	SITC 1	SITC 2	SITC 5	SITC 6	SITC 7	SITC 8
Number of Observations	3070	538	1481	2569	6631	2793	5565	12080	1765	4608	4833	17541	3892	11646
	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Stochastic Frontier Model														
Constant	5.362***	3.755***	6.168***	6.378***	6.143***	6.657***	7.146***	4.610***	4.249***	5.757***	5.770***	5.703***	6.657***	6.311***
	(0.152)	(0.312)	(0.223)	(0.197)	(0.086)	(0.099)	(0.117)	(0.058)	(0.154)	(0.108)	(0.095)	(0.059)	(0.141)	(0.069)
Capital	0.322***	0.382***	0.210***	0.236***	0.214***	0.160***	0.168***	0.266***	0.316***	0.197***	0.271***	0.206***	0.170***	0.168***
	(0.014)	(0.031)	(0.020)	(0.015)	(0.008)	(0.010)	(0.008)	(0.006)	(0.017)	(0.009)	(0.008)	(0.005)	(0.012)	(0.005)
Labour	0.733***	0.815***	0.887***	0.785***	0.833***	0.917***	0.854***	1.060***	0.928***	0.995***	0.812***	0.994***	0.857***	0.923***
	(0.034)	(0.077)	(0.042)	(0.035)	(0.018)	(0.022)	(0.019)	(0.014)	(0.035)	(0.022)	(0.021)	(0.010)	(0.024)	(0.014)
Technical Inefficiency Effects Model														
Constant	4.153***	-0.438	2.919***	2.219***	3.823***	-6.795***	3.715***	3.076***	3.280***	2.568***	2.492***	2.406***	3.297***	3.757***
	(0.389)	(0.643)	(0.949)	(0.326)	(0.280)	(1.720)	(0.226)	(0.172)	(0.332)	(0.256)	(0.245)	(0.125)	(0.384)	(0.139)
Firm Size (dummy)	-1.168***	0.497	0.955	-0.237	-0.143	-0.776**	-0.117	-0.500***	-1.783***	-0.029	0.104	-0.217**	0.005	-0.765***
	(0.392)	(0.319)	(0.596)	(0.270)	(0.170)	(0.314)	(0.137)	(0.162)	(0.329)	(0.218)	(0.184)	(0.095)	(0.126)	(0.125)
Firm Age (years)	-0.005	0.018***	-0.009	-0.027**	-0.023***	-0.003	-0.012***	-0.025***	-0.001	0.007*	-0.029***	0.004**	-0.000	-0.000
	(0.007)	(0.007)	(0.014)	(0.013)	(0.007)	(0.009)	(0.004)	(0.003)	(0.010)	(0.004)	(0.006)	(0.001)	(0.002)	(0.002)
Skilled Labour (ratio)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-0.979***	-1.210***	-1.388***	-0.717***	-0.630***	-0.655***	-0.869***
								(0.083)	(0.207)	(0.109)	(0.122)	(0.033)	(0.091)	(0.055)
Municipality (dummy)	0.208	-0.576**	0.420	-0.423	-0.011	0.706***	-0.378***	-0.543***	-0.235	-0.384***	-0.162	-0.250***	-0.039	-0.384***
	(0.168)	(0.233)	(0.367)	(0.299)	(0.094)	(0.186)	(0.103)	(0.069)	(0.149)	(0.105)	(0.130)	(0.029)	(0.054)	(0.042)
Bangkok (dummy)	-1.032**	-0.673	-3.626**	0.328	-3.700***	-10.168***	-0.986***	-4.279***	-3.569***	-3.156***	-1.764***	-1.123***	-0.725***	-1.957***
	(0.465)	(0.509)	(1.787)	(0.467)	(0.707)	(2.328)	(0.150)	(0.423)	(1.182)	(0.580)	(0.291)	(0.153)	(0.118)	(0.184)
Central & Vicinity Regions (dummy)	-0.243	0.255	-0.336	0.675*	0.315**	0.328	-0.502***	-0.134	-0.437*	0.198	-0.035	0.092	-0.119	-0.066
	(0.202)	(0.366)	(0.279)	(0.408)	(0.130)	(0.298)	(0.121)	(0.101)	(0.265)	(0.144)	(0.188)	(0.059)	(0.082)	(0.075)
Northern Region (dummy)	0.044	0.162	-0.812*	1.014**	-0.543***	-2.143***	-0.467***	0.687***	0.250	0.794***	1.946***	0.668***	0.265***	0.404***
	(0.215)	(0.295)	(0.463)	(0.489)	(0.175)	(0.713)	(0.130)	(0.086)	(0.195)	(0.138)	(0.183)	(0.062)	(0.098)	(0.071)
North-eastern Region (dummy)	-0.128	1.225***	0.376	0.761	-0.265*	-2.767***	-0.695***	-0.047	0.265	0.873***	0.538***	0.569***	0.550***	0.218***
	(0.235)	(0.288)	(0.415)	(0.559)	(0.144)	(0.873)	(0.151)	(0.091)	(0.233)	(0.137)	(0.172)	(0.061)	(0.098)	(0.070)
Individual proprietor (dummy)	-3.146***	0.658	-3.381***	-1.137**	-3.650***	1.514***	-1.354***	-1.950***	-1.352***	-0.962***	-0.906***	-0.763***	-1.291***	-1.031***
	(0.601)	(0.531)	(1.015)	(0.470)	(0.402)	(0.547)	(0.188)	(0.074)	(0.191)	(0.087)	(0.125)	(0.038)	(0.363)	(0.055)
Juristic partnership (dummy)	-5.194***	-0.752	-4.410***	-1.905***	-5.251***	-1.539**	-2.141***	-5.861***	-1.622***	-3.305***	-3.428***	-2.090***	-2.169***	-2.625***
	(1.117)	(0.539)	(1.293)	(0.559)	(0.590)	(0.681)	(0.233)	(0.454)	(0.263)	(0.314)	(0.277)	(0.104)	(0.378)	(0.154)
Limited & Public limited company (dummy)	-5.538***	-0.345	-5.368***	-2.367***	-6.458***	-2.838***	-2.551***	-5.982***	-3.817***	-4.716***	-4.349***	-2.885***	-2.807***	-3.711***
	(1.262)	(0.545)	(1.608)	(0.635)	(0.766)	(0.831)	(0.251)	(0.259)	(0.599)	(0.408)	(0.252)	(0.156)	(0.396)	(0.178)
Government & State enterprises (dummy)	-4.321***	0[23]	-4.655	0	-3.433***	-3.932***	-0.021	-0.994	-2.574**	2.096***	-2.495**	0.688**	0	0.682***
	(1.187)	(1)	(3.741)	(1)	(0.835)	(1.224)	(0.389)	(0.921)	(1.112)	(0.428)	(0.990)	(0.301)	(1)	(0.224)
Cooperatives (dummy)	-5.958***	0	-0.186	0.306	-1.761**	0	-3.514***	-2.025***	-0.193	0.237	-3.583***	0.001	0	-0.352
	(2.100)	(1)	(1.402)	(0.276)	(0.801)	(1)	(1.352)	(0.426)	(0.327)	(0.998)	(0.472)	(0.470)	(1)	(0.369)
Foreign Investment (dummy)	-0.080	-1.271	-0.837	-0.501	-3.801***	-2.745***	0.058	0.473	-1.004	-3.299***	-3.803***	-1.437*	0.460**	0.176
	(0.726)	(1.008)	(0.671)	(0.341)	(0.854)	(0.594)	(0.206)	(0.975)	(1.068)	(0.854)	(1.145)	(0.856)	(0.196)	(0.322)
Exports (dummy)	-1.243**	-0.105	0.641	-0.545*	-0.336*	0.715***	-0.168	0.100	1.274	-1.182*	-2.142***	-0.322	-0.585	-0.505*
	(0.550)	(0.430)	(0.416)	(0.287)	(0.186)	(0.253)	(0.117)	(0.694)	(1.308)	(0.721)	(0.747)	(0.328)	(0.431)	(0.291)
Government Assistance (BOI) (dummy)	-0.430	0.530	0.374	-0.422	0.228	-1.045**	-0.290	0.665	-3.463*	0.829	0.231	-0.182	-1.911	-0.116
	(0.471)	(0.389)	(0.500)	(0.388)	(0.298)	(0.452)	(0.237)	(0.795)	(1.886)	(0.734)	(0.774)	(0.394)	(2.653)	(0.341)
Variance Parameters														
Sigma-squared	2.875***	1.040***	3.053***	1.701***	3.324***	8.824***	1.122***	2.341***	1.780***	2.162***	2.352***	1.295***	0.954***	1.593***
	(0.550)	(0.091)	(1.030)	(0.305)	(0.430)	(1.923)	(0.087)	(0.055)	(0.111)	(0.091)	(0.073)	(0.027)	(0.042)	(0.048)
Gamma	0.630***	0.126	0.743***	0.556***	0.776***	0.941***	0.519***	0.648***	0.671***	0.754***	0.748***	0.522***	0.190***	0.702***
	(0.074)	(0.148)	(0.086)	(0.087)	(0.029)	(0.013)	(0.037)	(0.011)	(0.024)	(0.014)	(0.009)	(0.018)	(0.074)	(0.011)
Log-likelihood Function	-4862.96	-746.03	-2202.91	-3721.19	-9819.93	-3733.74	-7274.33	-18794.07	-2452.07	-7100.19	-6810.46	-25027.20	-5243.74	-16295.76
Returns to scale	1.05	1.20	1.10	1.02	1.05	1.08	0.98	1.33	1.24	1.19	1.08	1.20	1.10	1.09

Note: Standard errors are in brackets; *, ** and *** indicate that the coefficients are statistically significant at 10%, 5% and 1%, respectively. SITC 0: Food and live animals, SITC 1: Beverages and tobacco, SITC 2: Crude materials, inedible, except fuels, SITC 5: Chemicals and related products, SITC 6: Manufactured goods classified by material, SITC 7: Machinery and transport equipment, SITC 8: Miscellaneous manufactured articles.

[23] The estimated coefficients and standard errors shown for government and state enterprises and cooperatives for SITC 1, SITC 5 and SITC 7 in 1997 and SITC 7 in 2007 are all insignificant, due to the very small number of observations in these categories.

6.4.1.2 Results for the Simple Average and the Weighted Average Technical Efficiency Levels of Thai Manufacturing SMEs (utilising SFA)

Table 6.10 presents and compares the simple[24] average and the weighted[25] average technical efficiency scores of Thai manufacturing SMEs in the periods 1997 and 2007. It is important to note that the simple average technical efficiency may not be an appropriate performance indicator due to the different sizes of firms (such as medium or small) and which should not be given equal weighting in the calculation of overall technical efficiency. For instance, if most medium enterprises are technically efficient and most small enterprises are inefficient, then the simple average technical efficiency can be underestimated. On the other hand, if most medium enterprises are inefficient and most small enterprises are technically efficient, then the simple average technical efficiency can be overestimated (Phan, 2004). Thus, this study has also used weighted average technical efficiency from the SFA approach as the preferred performance indicator in the analysis.

As presented in Table 6.10 the weighted average technical efficiency in all SME categories decreased in 2007 compared to 1997, with the exceptions of medium-sized SMEs, SITC 5 and SITC 7. Aggregate manufacturing, small, domestic and export oriented SMEs, SITC 0, SITC 1, SITC 2, SITC 6 and SITC 8 in 2007 have experienced a decline in their technical efficiency levels. SITC 7 in 2007 has remained the same in its technical efficiency compared to 1997. Overall, weighted average technical efficiency declined from 60 percent in 1997 to 54 percent in 2007. This also signifies that overall Thai manufacturing SMEs experienced a high level of technical inefficiency in their production process in both 1997 and 2007, and that this efficiency performance has actually declined further in 2007.

However, medium-sized and SITC 5 SMEs have experienced improvement in their technical efficiency performance, while SITC 7 has experienced maintenance of its technical efficiency. The biggest concern relates to small enterprises and domestic market oriented SMEs which predominate in the Thai economy. Thus, it will be essential for SME policy makers to focus upon this component of the SME sector if a

[24] The SFA simple average technical efficiency is calculated as the sum of technical efficiency scores with respect to the total number of firms in each category.

[25] The SFA weighted average technical efficiency is calculated by using value added as a weight. That is, each individual firm's technical efficiency is multiplied by its weight in overall value added. The aggregate for all firms is then divided by the total number of firms.

major improvement in technical efficiency is to be achieved and this will be discussed in more detail in a later section of this chapter.

Table 6.10: The Simple Average and the Weighted Average Technical Efficiency Levels of Thai Manufacturing SMEs (utilising SFA)

Years	Pre-Crisis (1997) Period		Post-Crisis (2007) Period	
Categories	**Simple Average SFA**	**Weighted Average SFA**	**Simple Average SFA**	**Weighted Average SFA**
Aggregate manufacturing SMEs	0.59	0.61	0.44	0.51
Small Enterprises	0.58	0.60	0.42	0.48
Medium Enterprises	0.62	0.63	0.65	0.67
Domestic SMEs	0.58	0.60	0.44	0.50
Exporting SMEs	0.64	0.65	0.63	0.63
SITC 0	0.58	0.60	0.48	0.53
SITC 1	0.54	0.59	0.54	0.57
SITC 2	0.58	0.60	0.36	0.44
SITC 5	0.55	0.57	0.55	0.61
SITC 6	0.57	0.59	0.39	0.45
SITC 7	0.63	0.64	0.59	0.64
SITC 8	0.53	0.54	0.42	0.48
Overall Simple Average and Weighted Average Technical Efficiency Scores	**0.58**	**0.60**	**0.49**	**0.54**

Note: SITC 0: Food and live animals, SITC 1: Beverages and tobacco, SITC 2: Crude materials, inedible, except fuels, SITC 5: Chemicals and related products, n.e.s., SITC 6: Manufactured goods classified chiefly by material, SITC 7: Machinery and transport equipment, SITC 8: Miscellaneous manufactured articles.

6.4.2 Empirical Results from the DEA Approach

This section provides empirical results obtained from the first step of the two-stage DEA approach for Thai manufacturing SMEs in the years 1997 and 2007. The estimates of the DEA model, as specified by equation 6.4, were estimated utilising the DEAP Version 2.1 developed by Coelli (1996b). The DEA results using DEAP 2.1 are reported in Tables 6.11, 6.12, 6.13, 6.14, 6.15, 6.16 and 6.17, respectively.

6.4.2.1 Results from the First step of the Two-Stage DEA Model

This section presents results for technical efficiency using the DEA approach. The output-orientated DEA model under the assumption of variable returns to scale (VRS) is utilised, assuming fixed input quantities and maximised output production. Two inputs (capital and labour) and one output (value added), as previously utilised for the SFA approach in Section 6.4.1, are also used to estimate the DEA technical efficiency scores. The technical efficiency scores are predicted by the output-orientated VRS DEA model, as specified by equation 6.4. In addition, the multi-stage DEA in DEAP Version 2.1, is the method used to measure VRSTE scores for the first-stage DEA approach (Coelli, 1996b; Coelli *et al.*, 2005; Amornkitvikai, 2011), as discussed in Section 6.2.2. DEAP 2.1 provides three different types of technical efficiency scores: (1) constant returns to scale technical efficiency (CRSTE), (2) variable returns to scale technical efficiency (VRSTE), and (3) scale efficiency.

This study, however, only uses the VRSTE[26] scores for a comparison between the DEA and SFA approaches, since these[27] scores estimated by DEAP 2.1 for the DEA approach is equivalent to pure technical efficiency scores predicted by FRONTIER 4.1 for the SFA approach (Minh and Long, 2005; Minh *et al.*, 2007; Amornkitvikai and Harvie, 2010; Amornkitvikai, 2011). A number of empirical studies have utilised the VRSTE scores in their analysis (Sharma *et al.*, 1997; Minh *et al.*, 2007; O'Donnell *et al.*, 2009; Kontodimopoulos *et al.*, 2010; Amornkitvikai, 2011).

Table 6.11 summarises the average VRSTE scores of aggregate manufacturing SMEs and by size of manufacturing SMEs (small and medium) in 1997 and 2007. Aggregate manufacturing SMEs had 66 percent mean VRSTE in 1997. In 2007, the average VRSTE of aggregate manufacturing SMEs decreased to 62 percent. In terms of the size of manufacturing SMEs, small manufacturing SMEs in 2007 had 62 percent mean VRSTE, showing a decrease of 2 percent from 1997. Medium-sized manufacturing SMEs had 75 percent mean VRSTE in 1997. In 2007, the average VRSTE of medium manufacturing SMEs decreased to 74 percent (see Table 6.11). From Table 6.12, the mean VRSTE of domestic manufacturing SMEs was 66 percent in 1997. In 2007, the average VRSTE of domestic manufacturing SMEs declined to 62 percent. In 1997, exporting manufacturing SMEs had 74 percent mean VRSTE. In 2007, the mean VRSTE of exporting manufacturing SMEs increased to 77 percent (see Table 6.12).

Table 6.13 exhibits the average VRSTE of sub-manufacturing sectors classified by SITC: Revision 4 in 1997 and 2007. The average VRSTE of SITC 0

[26] The VRSTE scores are predicted by the output-orientated DEA model, as specified by Equation 6.4.
[27] The VRSTE scores will also be used for a two-limit Tobit model in Chapter 7.

decreased to 62 percent in 2007, showing a decrease of 10 percent in the average VRSTE over 1997. SITC 1 had 68 percent mean VRSTE in 2007, representing a decrease of 6 percent over 1997. SITC 2 had 66 percent mean VRSTE in 2007, a decrease of 7 percent from 1997. SITC 3 had 87 percent mean VRSTE in 2007, an increase of 1 percent from 1997. SITC 4 had 73 percent mean VRSTE, a decrease of 1 percent from 1997. The average VRSTE of SITC 6 declined to 65 percent, a decrease of 1 percent over 1997. SITC 7 had 70 percent mean VRSTE in 2007, a decrease of 7 percent from 1997. Finally, the average VRSTE of SITC 8 declined to 68 percent, a decrease of 5 percent from 1997 (see Table 6.13).

Table 6.11: Results from Estimates of Technical Efficiency Scores for the First-step of the Two-stage DEA Approach by Aggregate Manufacturing SMEs and Size of Manufacturing SMEs (small and medium)

Years	Pre-Crisis (1997) Period					Post-Crisis (2007) Period				
Categories	Mean	Max	Min	Std.Dev.	Obs	Mean	Max	Min	Std.Dev.	Obs
Aggregate manufacturing SMEs										
Constant Returns to Scale Technical Efficiency (CRSTE)	0.37	1.00	0.03	0.07	22,685	0.34	1.00	0.02	0.13	56,441
Variable Returns to Scale Technical Efficiency (VRSTE)	0.66	1.00	0.06	0.08	22,685	0.62	1.00	0.03	0.11	56,441
Scale Efficiency (SCALE)	0.57	1.00	0.37	0.09	22,685	0.56	1.00	0.24	0.22	56,441
Size of Manufacturing SMEs										
Small Enterprises										
Constant Returns to Scale Technical Efficiency (CRSTE)	0.38	1.00	0.03	0.07	18,214	0.35	1.00	0.02	0.13	49,835
Variable Returns to Scale Technical Efficiency (VRSTE)	0.64	1.00	0.06	0.08	18,214	0.62	1.00	0.03	0.11	49,835
Scale Efficiency (SCALE)	0.60	1.00	0.39	0.08	18,214	0.58	1.00	0.27	0.22	49,835
Medium Enterprises										
Constant Returns to Scale Technical Efficiency (CRSTE)	0.72	1.00	0.20	0.07	4,471	0.70	1.00	0.12	0.08	6,606
Variable Returns to Scale Technical Efficiency (VRSTE)	0.75	1.00	0.20	0.07	4,471	0.74	1.00	0.14	0.08	6,606
Scale Efficiency (SCALE)	0.97	1.00	0.85	0.03	4,471	0.95	1.00	0.59	0.04	6,606

Table 6.12: Results from Estimates of Technical Efficiency Scores for the First-step of the Two-stage DEA Approach by Domestic and Exporting SMEs

Years	Pre-Crisis (1997) Period					Post-Crisis (2007) Period				
Categories	Mean	Max	Min	Std.Dev.	Obs	Mean	Max	Min	Std.Dev.	Obs
Export Intensity										
Domestic SMEs										
Constant Returns to Scale Technical Efficiency (CRSTE)	0.38	1.00	0.03	0.07	20,791	0.34	1.00	0.02	0.13	54,676
Variable Returns to Scale Technical Efficiency (VRSTE)	0.66	1.00	0.06	0.08	20,791	0.62	1.00	0.03	0.11	54,676
Scale Efficiency (SCALE)	0.58	1.00	0.35	0.09	20,791	0.56	1.00	0.24	0.22	54,676
Exporting SMEs										
Constant Returns to Scale Technical Efficiency (CRSTE)	0.55	1.00	0.32	0.09	1,894	0.55	1.00	0.31	0.08	1,765
Variable Returns to Scale Technical Efficiency (VRSTE)	0.74	1.00	0.37	0.08	1,894	0.77	1.00	0.47	0.07	1,765
Scale Efficiency (SCALE)	0.74	1.00	0.57	0.08	1,894	0.71	1.00	0.55	0.08	1,765

Table 6.13: Results from Estimates of Technical Efficiency Scores for the First-step of the Two-stage DEA Approach by SITC: Revision 4

Years	Pre-Crisis (1997) Period					Post-Crisis (2007) Period				
Categories	Mean	Max	Min	Std.Dev.	Obs	Mean	Max	Min	Std.Dev.	Obs
Sub-manufacturing Sectors										
SITC 0: Food and live animals										
Constant Returns to Scale Technical Efficiency (CRSTE)	0.45	1.00	0.13	0.07	3,070	0.36	1.00	0.04	0.14	12,080
Variable Returns to Scale Technical Efficiency (VRSTE)	0.72	1.00	0.18	0.09	3,070	0.62	1.00	0.05	0.12	12,080
Scale Efficiency (SCALE)	0.62	1.00	0.44	0.06	3,070	0.61	1.00	0.22	0.24	12,080
SITC 1: Beverages and tobacco										
Constant Returns to Scale Technical Efficiency (CRSTE)	0.62	1.00	0.28	0.09	538	0.45	1.00	0.13	0.14	1,765
Variable Returns to Scale Technical Efficiency (VRSTE)	0.74	1.00	0.35	0.12	538	0.68	1.00	0.19	0.10	1,765
Scale Efficiency (SCALE)	0.85	1.00	0.64	0.07	538	0.66	1.00	0.26	0.18	1,765
SITC 2: Crude materials, inedible, except fuels										
Constant Returns to Scale Technical Efficiency (CRSTE)	0.61	1.00	0.20	0.09	1,481	0.35	1.00	0.02	0.15	4,608
Variable Returns to Scale Technical Efficiency (VRSTE)	0.73	1.00	0.25	0.09	1,481	0.66	1.00	0.04	0.15	4,608
Scale Efficiency (SCALE)	0.84	1.00	0.60	0.09	1,481	0.55	1.00	0.26	0.25	4,608
SITC 3: Mineral fuels and lubricants										
Constant Returns to Scale Technical Efficiency (CRSTE)	0.75	1.00	0.58	0.12	38	0.84	1.00	0.64	0.10	76
Variable Returns to Scale Technical Efficiency (VRSTE)	0.86	1.00	0.63	0.12	38	0.87	1.00	0.64	0.10	76
Scale Efficiency (SCALE)	0.88	1.00	0.71	0.11	38	0.97	1.00	0.84	0.03	76

Table 6.13: (continue) Results from Estimates of Technical Efficiency Scores for the First-step of the Two-stage DEA Approach by SITC: Revision 4

Years	Pre-Crisis (1997) Period					Post-Crisis (2007) Period				
Categories	Mean	Max	Min	Std.Dev.	Obs	Mean	Max	Min	Std.Dev.	Obs
Sub-manufacturing Sectors										
SITC 5: Chemicals and related products										
Constant Returns to Scale Technical Efficiency (CRSTE)	0.54	1.00	0.26	0.08	2,569	0.44	1.00	0.03	0.09	4,833
Variable Returns to Scale Technical Efficiency (VRSTE)	0.74	1.00	0.35	0.08	2,569	0.73	1.00	0.05	0.13	4,833
Scale Efficiency (SCALE)	0.73	1.00	0.54	0.07	2,569	0.61	1.00	0.40	0.13	4,833
SITC 6: Manufactured goods classified by material										
Constant Returns to Scale Technical Efficiency (CRSTE)	0.39	1.00	0.10	0.08	6,631	0.37	1.00	0.06	0.13	17,541
Variable Returns to Scale Technical Efficiency (VRSTE)	0.66	1.00	0.14	0.09	6,631	0.65	1.00	0.10	0.11	17,541
Scale Efficiency (SCALE)	0.59	1.00	0.35	0.10	6,631	0.58	1.00	0.30	0.20	17,541
SITC 7: Machinery and transport equipment										
Constant Returns to Scale Technical Efficiency (CRSTE)	0.48	1.00	0.17	0.09	2,793	0.50	1.00	0.14	0.08	3,892
Variable Returns to Scale Technical Efficiency (VRSTE)	0.77	1.00	0.30	0.07	2,793	0.70	1.00	0.14	0.09	3,892
Scale Efficiency (SCALE)	0.63	1.00	0.44	0.09	2,793	0.72	1.00	0.44	0.12	3,892
SITC 8: Miscellaneous manufactured articles										
Constant Returns to Scale Technical Efficiency (CRSTE)	0.46	1.00	0.04	0.08	5,565	0.37	1.00	0.04	0.13	11,646
Variable Returns to Scale Technical Efficiency (VRSTE)	0.73	1.00	0.07	0.08	5,565	0.68	1.00	0.04	0.12	11,646
Scale Efficiency (SCALE)	0.64	1.00	0.41	0.08	5,565	0.55	1.00	0.27	0.22	11,646

Furthermore, DEAP Version 2.1 provides three types of returns to scale[28]: (1) constant returns to scale (CRS), (2) decreasing returns to scale (DRS), and (3) increasing returns to scale (IRS). From Table 6.14, it can be observed that aggregate manufacturing SMEs exhibit highly DRS in the periods 1997 and 2007, representing 96.67 percent and 85.17 percent of total firms respectively. Small manufacturing SMEs also operated under DRS in 1997 and 2007, accounting for 99.59 percent and 83.20 percent of all firms respectively. In 2007 medium-sized manufacturing SMEs revealed modest DRS at 52.68 percent of the total firms, whereas about 70.59 percent of medium-sized manufacturing SMEs in 1997 operated under DRS (see Table 6.14).

Table 6.14: Number and Percentage of Aggregate Manufacturing SMEs and Size of Manufacturing SMEs (small and medium), Classified by Types of Returns to Scale

Years	**Pre-Crisis (1997) Period**		**Post-Crisis (2007) Period**	
Categories	Number of Firms	Percentage (%)	Number of Firms	Percentage (%)
Aggregate manufacturing SMEs				
Constant Returns to Scale (CRS)	49	0.22	8373	14.83
Decreasing Returns to Scale (DRS)	22611	99.67	48068	85.17
Increasing Returns to Scale (IRS)	25	0.11	N/A	N/A
Total	22685	100.00	56441	100.00
Size of Manufacturing SMEs				
Small Enterprises				
Constant Returns to Scale (CRS)	49	0.27	8373	16.80
Decreasing Returns to Scale (DRS)	18140	99.59	41462	83.20
Increasing Returns to Scale (IRS)	25	0.14	N/A	N/A
Total	18214	100.00	49835	100.00
Medium Enterprises				
Constant Returns to Scale (CRS)	103	2.30	82	1.24
Decreasing Returns to Scale (DRS)	3174	70.99	3480	52.68
Increasing Returns to Scale (IRS)	1194	26.71	3044	46.08
Total	4471	100.00	6606	100.00

In Table 6.15, domestic manufacturing SMEs reveal highly DRS in the years 1997 and 2007, representing 99.64 percent and 84.69 percent of total firms respectively. Exporting manufacturing SMEs in 1997 and 2007 also exhibit highly DRS, accounting for 99.58 percent and 99.77 percent of total firms, respectively (see Table 6.15). Table 6.16 presents the results of returns to scale of sub-manufacturing sectors classified by SITC: Revision 4.

[28] The results of returns to scale are estimated by the output-orientated VRS DEA model utilising DEAP Version 2.1.

Table 6.15: Number and Percentage of Domestic and Exporting SMEs, Classified by Types of Returns to Scale

Years	Pre-Crisis (1997) Period		Post-Crisis (2007) Period	
Categories	Number of Firms	Percentage (%)	Number of Firms	Percentage (%)
Export Intensity				
Domestic SMEs				
Constant Returns to Scale (CRS)	49	0.24	8371	15.31
Decreasing Returns to Scale (DRS)	20717	99.64	46305	84.69
Increasing Returns to Scale (IRS)	25	0.12	N/A	N/A
Total	20791	100.00	54676	100.00
Exporting SMEs				
Constant Returns to Scale (CRS)	4	0.21	3	0.17
Decreasing Returns to Scale (DRS)	1886	99.58	1761	99.77
Increasing Returns to Scale (IRS)	4	0.21	1	0.06
Total	1894	100.00	1765	100.00

As presented in Table 6.16, it can be seen that all sub-manufacturing sectors experienced highly DRS in both periods. DRS of sub-manufacturing sectors start from 86.84 percent in SITC 3 and reach 99.86 percent in SITC 5 in 1997, whereas DRS range from 77.62 percent in SITC 0 to 96.21 percent in SITC 5 in 2007 (see Table 6.16).

Table 6.16: Number and Percentage of SITC: Revision 4, Classified by Types of Returns to Scale

Years	Pre-Crisis (1997) Period		Post-Crisis (2007) Period	
Categories	Number of Firms	Percentage (%)	Number of Firms	Percentage (%)
Sub-manufacturing Sectors				
SITC 0: Food and live animals				
Constant Returns to Scale (CRS)	5	0.16	2704	22.38
Decreasing Returns to Scale (DRS)	3064	99.80	9376	77.62
Increasing Returns to Scale (IRS)	1	0.03	N/A	N/A
Total	3070	100.00	12080	100.00
SITC 1: Beverages and tobacco				
Constant Returns to Scale (CRS)	5	0.93	261	14.79
Decreasing Returns to Scale (DRS)	533	99.07	1504	85.21
Increasing Returns to Scale (IRS)	N/A	N/A	N/A	N/A
Total	538	100.00	1765	100.00
SITC 2: Crude materials, inedible, except fuels				
Constant Returns to Scale (CRS)	43	2.90	806	17.49
Decreasing Returns to Scale (DRS)	1430	96.56	3802	82.51
Increasing Returns to Scale (IRS)	8	0.54	N/A	N/A
Total	1481	100.00	4608	100.00
SITC 3: Mineral fuels and lubricants				
Constant Returns to Scale (CRS)	3	7.89	11	14.47
Decreasing Returns to Scale (DRS)	33	86.84	65	85.53
Increasing Returns to Scale (IRS)	2	5.26	N/A	N/A
Total	38	100.00	76	100.00

Table 6.16: (continue) Number and Percentage of SITC: Revision 4, Classified by Types of Returns to Scale

Years	Pre-Crisis (1997) Period		Post-Crisis (2007) Period	
Categories	Number of Firms	Percentage (%)	Number of Firms	Percentage (%)
Sub-manufacturing Sectors				
SITC 5: Chemicals and related products				
Constant Returns to Scale (CRS)	2	0.08	182	3.77
Decreasing Returns to Scale (DRS)	2564	99.81	4650	96.21
Increasing Returns to Scale (IRS)	3	0.12	1	0.02
Total	2569	100.00	4833	100.00
SITC 6: Manufactured goods classified by material				
Constant Returns to Scale (CRS)	18	0.27	2204	12.56
Decreasing Returns to Scale (DRS)	6586	99.32	15337	87.44
Increasing Returns to Scale (IRS)	27	0.41	N/A	N/A
Total	6631	100.00	17541	100.00
SITC 7: Machinery and transport equipment				
Constant Returns to Scale (CRS)	12	0.43	363	9.33
Decreasing Returns to Scale (DRS)	2780	99.53	3517	90.36
Increasing Returns to Scale (IRS)	1	0.04	12	0.31
Total	2793	100.00	3892	100.00
SITC 8: Miscellaneous manufactured articles				
Constant Returns to Scale (CRS)	14	0.25	1849	15.88
Decreasing Returns to Scale (DRS)	5546	99.66	9797	84.12
Increasing Returns to Scale (IRS)	5	0.09	N/A	N/A
Total	5565	100.00	11646	100.00

6.4.2.2 Results for the Simple Average and Weighted Average Technical Efficiency Levels of Thai Manufacturing SMEs (using DEA)

Table 6.17 summarises and compares the simple average and the weighted average technical efficiency of Thai manufacturing SMEs in 1997 and 2007. As previously discussed in Section 6.4.1.2, this study utilised the weighted average technical efficiency from the DEA approach as the preferred indicator. From Table 6.17 it can be observed that the weighted average technical efficiency in twelve SME categories, including aggregate manufacturing SMEs, small- and medium-sized enterprises, domestic SMEs, SITC 0, SITC 1, SITC 2, SITC 7 and SITC 8 decreased in 2007 compared to 1997, with the exceptions of exporting SMEs, SITC 5 and SITC 6. Hence, only exporting SMEs have achieved an improvement in technical efficiency. SITC 5 and SITC 6 in 2007 have remained the same in terms of technical efficiency compared to 1997.

The overall weighted average technical efficiency ranges from 72 percent in 1997 to 70 percent in 2007, indicating a deterioration of technical efficiency of Thai manufacturing SMEs (see Table 6.17). Thai manufacturing SMEs experienced a high level of technical inefficiency in their production process in 1997 and 2007, an inefficiency which did not show any signs of abating. This presents major challenges to SME owners operating in the manufacturing sector, as well as government policy makers, that need to be urgently addressed. This will be discussed in the subsequent section of this chapter.

Table 6.17: The Simple Average and Weighted Average Technical Efficiency Levels of Thai Manufacturing SMEs (utilising DEA)

Years	Pre-Crisis (1997) Period		Post-Crisis (2007) Period	
Categories	**Simple Average DEA**	**Weighted Average DEA**	**Simple Average DEA**	**Weighted Average DEA**
Aggregate manufacturing SMEs	0.66	0.67	0.62	0.64
Small Enterprises	0.64	0.65	0.62	0.64
Medium Enterprises	0.75	0.76	0.74	0.75
Domestic SMEs	0.66	0.67	0.62	0.64
Exporting SMEs	0.74	0.75	0.77	0.77
SITC 0	0.72	0.74	0.62	0.65
SITC 1	0.74	0.76	0.68	0.70
SITC 2	0.73	0.74	0.66	0.71
SITC 5	0.74	0.75	0.73	0.75
SITC 6	0.66	0.67	0.65	0.67
SITC 7	0.77	0.78	0.70	0.72
SITC 8	0.73	0.73	0.68	0.71
Overall Simple Average and Weighted Average Technical Efficiency Scores	**0.71**	**0.72**	**0.67**	**0.70**

Note: SITC 0: Food and live animals, SITC 1: Beverages and tobacco, SITC 2: Crude materials, inedible, except fuels, SITC 5: Chemicals and related products, n.e.s., SITC 6: Manufactured goods classified chiefly by material, SITC 7: Machinery and transport equipment, SITC 8: Miscellaneous manufactured articles.

6.5 COMPARING THE EMPIRICAL RESULTS BETWEEN THE SFA AND DEA APPROACHES

This section aims to compare and discuss the empirical results obtained from the SFA and DEA approaches in the periods 1997 and 2007. Due to the technical efficiency differences in the two approaches, Spearman[29] rank correlation coefficients between the technical efficiency scores obtained from the SFA and DEA

[29] The Spearman rank correlation coefficient is a non-parametric correlation test (Minh *et al.*, 2007; Kontodimopoulos *et al.*, 2010; Amornkitvikai, 2011).

approaches (Sharma *et al.*, 1997; Minh *et al.*, 2007; Kontodimopoulos *et al.*, 2010; Amornkitvikai, 2011) were conducted to examine the ranking consistency for Thai manufacturing SMEs in 1997 and 2007, as reported in Tables 6.18, 6.19 and 6.20 respectively. Table 6.18 presents the Spearman rank correlation coefficients of the technical efficiency scores from the two approaches, classified by aggregate manufacturing SMEs and size of manufacturing SMEs. The values of the estimated Spearman rank correlation coefficients for aggregate manufacturing SMEs, small- and medium-sized enterprises are equal to 0.825, 0.877 and 0.819 respectively in 1997, and they are highly significant at the 1 percent level of significance. In 2007, the estimates of Spearman rank correlation coefficients for aggregate manufacturing SMEs, small- and medium-sized enterprises are 0.918, 0.910 and 0.794 respectively, and they are strongly significant at the 1 percent level (see Table 6.18). Thus, it can be specified that the technical efficiency scores obtained from the SFA and DEA approaches are consistent in terms of ranking for aggregate manufacturing SMEs and size of manufacturing SMEs in both 1997 and 2007.

Table 6.19 exhibits the Spearman rank correlation coefficients for domestic and exporting SMEs in the years 1997 and 2007. In 1997, the estimated Spearman rank correlation coefficients of domestic and exporting SMEs are equal to 0.818 and 0.760 respectively, and they are highly significant at the 1 percent level of significance. In 2007, the estimates of the Spearman rank correlation coefficients for domestic and exporting SMEs are equal to 0.919 and 0.127 respectively, and they are strongly significant at the 1 percent level (see Table 6.19). Hence, it can be indicated that the results from both SFA and DEA are consistent in terms of technical efficiency rankings for domestic and exporting SMEs in both periods. Table 6.20 shows the Spearman rank correlation coefficients of the technical efficiency scores for sub-manufacturing sectors classified by SITC: Revision 4 in 1997 and 2007. The estimated Spearman rank correlation coefficients of sub-manufacturing sectors range between 0.725 in SITC 1 to 0.920 in SITC 7 in 1997, while the estimated Spearman rank correlation coefficients range from 0.700 in SITC 7 to 0.926 in SITC 8 in 2007 (see Table 6.20). All estimated correlation coefficients are highly significant at the 1 percent level in all sub-manufacturing sectors for both periods. Thus, it can be stated that the results from the SFA and DEA approaches for sub-manufacturing sectors are consistent in terms of technical efficiency rankings in 1997 and 2007.

Table 6.18: Spearman Rank Correlation Coefficients of the Technical Efficiency Scores from the SFA and DEA approaches, Classified by Aggregate Manufacturing SMEs and Size of Manufacturing SMEs (small and medium)

Years			Pre-Crisis (1997) Period				Post-Crisis (2007) Period	
Aggregate Manufacturing SMEs			**DEA**	**SFA**			**DEA**	**SFA**
Spearman's rho	**DEA**	Correlation Coefficient	1	0.825**	**DEA**	Correlation Coefficient	1	0.918**
		Sig. (2-tailed)	.	0.000		Sig. (2-tailed)	.	0.000
		N	22685	22685		N	56441	56441
	SFA	Correlation Coefficient	0.825**	1	**SFA**	Correlation Coefficient	0.918**	1
		Sig. (2-tailed)	0.000	.		Sig. (2-tailed)	0.000	.
		N	22685	22685		N	56441	56441
Size of Manufacturing SMEs								
Small Enterprises			**DEA**	**SFA**			**DEA**	**SFA**
Spearman's rho	**DEA**	Correlation Coefficient	1	0.877**	**DEA**	Correlation Coefficient	1	0.910**
		Sig. (2-tailed)	.	0.000		Sig. (2-tailed)	.	0.000
		N	18214	18214		N	49835	49835
	SFA	Correlation Coefficient	0.877**	1	**SFA**	Correlation Coefficient	0.910**	1
		Sig. (2-tailed)	0.000	.		Sig. (2-tailed)	0.000	.
		N	18214	18214		N	49835	49835
Medium Enterprises			**DEA**	**SFA**			**DEA**	**SFA**
Spearman's rho	**DEA**	Correlation Coefficient	1	0.819**	**DEA**	Correlation Coefficient	1	0.794**
		Sig. (2-tailed)	.	0.000		Sig. (2-tailed)	.	0.000
		N	4471	4471		N	6606	6606
	SFA	Correlation Coefficient	0.819**	1	**SFA**	Correlation Coefficient	0.794**	1
		Sig. (2-tailed)	0.000	.		Sig. (2-tailed)	0.000	.
		N	4471	4471		N	6606	6606

Note: ** indicate that the correlation coefficients are statistically significant at 1% (2-tailed).

Table 6.19: Spearman Rank Correlation Coefficients of the Technical Efficiency Scores from the SFA and DEA approaches, Classified by Domestic and Exporting SMEs

Years			**Pre-Crisis (1997) Period**				**Post-Crisis (2007) Period**	
Export Intensity			**DEA**	**SFA**			**DEA**	**SFA**
Domestic SMEs								
Spearman's rho	**DEA**	Correlation Coefficient	1	0.818**	**DEA**	Correlation Coefficient	1	0.919**
		Sig. (2-tailed)	.	0.000		Sig. (2-tailed)	.	0.000
		N	20791	20791		N	54676	54676
	SFA	Correlation Coefficient	0.818**	1	**SFA**	Correlation Coefficient	0.919**	1
		Sig. (2-tailed)	0.000	.		Sig. (2-tailed)	0.000	.
		N	20791	20791		N	54676	54676
Exporting SMEs			DEA	SFA			DEA	SFA
Spearman's rho	**DEA**	Correlation Coefficient	1	0.760**	**DEA**	Correlation Coefficient	1	0.127**
		Sig. (2-tailed)	.	0.000		Sig. (2-tailed)	.	0.000
		N	1894	1894		N	1765	1765
	SFA	Correlation Coefficient	0.760**	1	**SFA**	Correlation Coefficient	0.127**	1
		Sig. (2-tailed)	0.000	.		Sig. (2-tailed)	0.000	.
		N	1894	1894		N	1765	1765

Note: ** indicate that the correlation coefficients are statistically significant at 1% (2-tailed).

Table 6.20: Spearman Rank Correlation Coefficients of the Technical Efficiency Scores from the SFA and DEA approaches, Classified by SITC: Revision 4

Years			Pre-Crisis (1997) Period				Post-Crisis (2007) Period	
Sub-manufacturing Sectors								
SITC 0: Food and live animals			**DEA**	**SFA**			**DEA**	**SFA**
Spearman's rho								
	DEA	Correlation Coefficient	1	0.857**	**DEA**	Correlation Coefficient	1	0.878**
		Sig. (2-tailed)	.	0.000		Sig. (2-tailed)	.	0.000
		N	3070	3070		N	12080	12080
	SFA	Correlation Coefficient	0.857**	1	**SFA**	Correlation Coefficient	0.878**	1
		Sig. (2-tailed)	0.000	.		Sig. (2-tailed)	0.000	.
		N	3070	3070		N	12080	12080
SITC 1: Beverages and tobacco			**DEA**	**SFA**			**DEA**	**SFA**
Spearman's rho	**DEA**	Correlation Coefficient	1	0.725**	**DEA**	Correlation Coefficient	1	.843**
		Sig. (2-tailed)	.	0		Sig. (2-tailed)	.	0
		N	538	538		N	1765	1765
	SFA	Correlation Coefficient	0.725**	1	**SFA**	Correlation Coefficient	0.843**	1
		Sig. (2-tailed)	0.000	.		Sig. (2-tailed)	0.000	.
		N	538	538		N	1765	1765
SITC 2: Crude materials, inedible, except fuels			**DEA**	**SFA**			**DEA**	**SFA**
Spearman's rho	**DEA**	Correlation Coefficient	1	0.832**	**DEA**	Correlation Coefficient	1	0.923**
		Sig. (2-tailed)	.	0.000		Sig. (2-tailed)	.	0.000
		N	1481	1481		N	4608	4608
	SFA	Correlation Coefficient	0.832**	1	**SFA**	Correlation Coefficient	0.923**	1
		Sig. (2-tailed)	0.000	.		Sig. (2-tailed)	0.000	.
		N	1481	1481		N	4608	4608

Note: ** indicate that the correlation coefficients are statistically significant at 1% (2-tailed).

Table 6.20: (continued) Spearman Rank Correlation Coefficients of the Technical Efficiency Scores from the SFA and DEA approaches, Classified by SITC: Revision 4

Years			Pre-Crisis (1997) Period				Post-Crisis (2007) Period	
Sub-manufacturing Sectors								
SITC 5: Chemicals and related products			**DEA**	**SFA**			**DEA**	**SFA**
Spearman's rho	**DEA**	Correlation Coefficient	1	0.870**	**DEA**	Correlation Coefficient	1	0.859**
		Sig. (2-tailed)	.	0.000		Sig. (2-tailed)	.	0.000
		N	2569	2569		N	4833	4833
	SFA	Correlation Coefficient	0.870**	1	**SFA**	Correlation Coefficient	0.859**	1
		Sig. (2-tailed)	0.000	.		Sig. (2-tailed)	0.000	.
		N	2569	2569		N	4833	4833
SITC 6: Manufactured goods classified by material			**DEA**	**SFA**			**DEA**	**SFA**
Spearman's rho	**DEA**	Correlation Coefficient	1	0.820**	**DEA**	Correlation Coefficient	1	0.879**
		Sig. (2-tailed)	.	0.000		Sig. (2-tailed)	.	0.000
		N	6631	6631		N	17541	17541
	SFA	Correlation Coefficient	0.820**	1	**SFA**	Correlation Coefficient	0.879**	1
		Sig. (2-tailed)	0.000	.		Sig. (2-tailed)	0.000	.
		N	6631	6631		N	17541	17541
SITC 7: Machinery and transport equipment			**DEA**	**SFA**			**DEA**	**SFA**
Spearman's rho	**DEA**	Correlation Coefficient	1	0.920**	**DEA**	Correlation Coefficient	1	0.700**
		Sig. (2-tailed)	.	0.000		Sig. (2-tailed)	.	0.000
		N	2793	2793		N	3892	3892
	SFA	Correlation Coefficient	0.920**	1	**SFA**	Correlation Coefficient	0.700**	1
		Sig. (2-tailed)	0.000	.		Sig. (2-tailed)	0.000	.
		N	2793	2793		N	3892	3892
SITC 8: Miscellaneous manufactured articles			**DEA**	**SFA**			**DEA**	**SFA**
Spearman's rho	**DEA**	Correlation Coefficient	1	0.831**	**DEA**	Correlation Coefficient	1	0.926**
		Sig. (2-tailed)	.	0.000		Sig. (2-tailed)	.	0.000
		N	5565	5565		N	11646	11646
	SFA	Correlation Coefficient	0.831**	1	**SFA**	Correlation Coefficient	0.926**	1
		Sig. (2-tailed)	0.000	.		Sig. (2-tailed)	0.000	.
		N	5565	5565		N	11646	11646

Note: ** indicate that the correlation coefficients are statistically significant at 1% (2-tailed).

Table 6.21 summarises the results of returns to scale from the SFA and DEA approaches for 1997 and 2007. As presented in Table 6.21 the results from both SFA and DEA are found to be quite inconsistent in terms of types of returns to scale. Based upon a stochastic production function (the SFA approach) it can be observed that almost all Thai manufacturing SME categories have experienced IRS in 2007 compared to CRS in 1997, with the exceptions of aggregate manufacturing SMEs, medium-sized enterprises and exporting SMEs. However, the results of returns to scale from the output-orientated VRS DEA model (the DEA approach) shows that all manufacturing SME categories experienced DRS in both 1997 and 2007.

As previously discussed in Section 4.2.1 of Chapter 4, DEA precludes the possibility of evaluating the marginal products and the elasticity of substitution of the production technology. DEA produces no standard errors with deviations from a frontier treated as technical inefficiency, leaving no provision for random shocks of any type (Coelli *et al.*, 2005; Cooper *et al.*, 2006; Arunsawadiwong, 2007; Assaf, 2007). On the other hand SFA is employed because of its superior conceptual treatment of noise. This approach takes into account measurement errors as well as other random factors, such as the effect of weather, and luck on the value of output variables, together with the combined effects of unspecified input variables in the production function (Coelli, 1996a; Wadud, 2003; Coelli *et al.*, 2005).

Table 6.21: Results of Returns to Scale from the SFA and DEA Approaches

Years	Pre Crisis (1997) Period		Post Crisis (2007) Period	
Categories	**SFA**	**DEA**	**SFA**	**DEA**
Aggregate manufacturing SMEs	IRS	DRS	DRS	DRS
Small Enterprises	CRS	DRS	IRS	DRS
Medium Enterprises	IRS	DRS	DRS	DRS
Domestic SMEs	IRS	DRS	IRS	DRS
Exporting SMEs	DRS	DRS	DRS	DRS
SITC 0	CRS	DRS	IRS	DRS
SITC 1	IRS	DRS	IRS	DRS
SITC 2	IRS	DRS	IRS	DRS
SITC 5	CRS	DRS	IRS	DRS
SITC 6	CRS	DRS	IRS	DRS
SITC 7	IRS	DRS	IRS	DRS
SITC 8	DRS	DRS	IRS	DRS

Note: CRS is Constant Returns to Scale, DRS is Decreasing Returns to Scale, IRS is Increasing Returns to Scale, SITC 0: Food and live animals, SITC 1: Beverages and tobacco, SITC 2: Crude materials, inedible, except fuels, SITC 5: Chemicals and related products, n.e.s., SITC 6: Manufactured goods classified chiefly by material, SITC 7: Machinery and transport equipment, SITC 8: Miscellaneous manufactured articles.

As shown in Table 6.22 the overall weighted average technical efficiency scores[30] obtained from the SFA approach are slightly lower than those obtained from the DEA approach in both 1997 and 2007, due to SFA making adjustments for a statistical noise variance (Coelli *et al.*, 2005; O'Donnell *et al.*, 2009). There may be no measurement error as well as other random factors in cross-sectional firm-level data from 1997 and 2007 industrial censuses. Thus, the cause of a statistical noise may arise from the misspecification of a stochastic production function (Coelli *et al.*, 2005; O'Donnell *et al.*, 2009). Unlike the DEA approach, the SFA approach does not guarantee that a firm will select a riskless production plan (O'Donnell *et al.*, 2009). The finding from this study is consistent with many other empirical studies.

For instance, Kalaitzandonakes and Dunn (1995) found that the average technical efficiency level under the CRS DEA model is higher than that estimated from a stochastic production function for corn producers in Guatemala; while Wadud (2003) found that the mean technical efficiency scores based upon the CRS and VRS models are slightly higher than those obtained from the stochastic production function for sample farms in Bangladesh. O'Donnell *et al.* (2009) similarly found that the mean technical efficiency from the VRS DEA model is larger than that obtained from the stochastic frontier model.

Table 6.22: The Weighted Average Technical Efficiency Scores from the SFA and DEA Approaches

Years	Pre-Crisis (1997) Period		Post-Crisis (2007) Period	
Categories	**Weighted Average SFA**	**Weighted Average DEA**	**Weighted Average SFA**	**Weighted Average DEA**
Aggregate manufacturing SMEs	0.61	0.67	0.51	0.64
Small Enterprises	0.60	0.65	0.48	0.64
Medium Enterprises	0.63	0.76	0.67	0.75
Domestic SMEs	0.60	0.67	0.50	0.64
Exporting SMEs	0.65	0.75	0.63	0.77
SITC 0	0.60	0.74	0.53	0.65
SITC 1	0.59	0.76	0.57	0.70
SITC 2	0.60	0.74	0.44	0.71
SITC 5	0.57	0.75	0.61	0.75
SITC 6	0.59	0.67	0.45	0.67
SITC 7	0.64	0.78	0.64	0.72
SITC 8	0.54	0.73	0.48	0.71
Overall Weighted Average Technical Efficiency Scores	**0.60**	**0.72**	**0.54**	**0.70**

[30] The SFA and DEA approaches report a similar conclusion: that the weighted technical efficiency scores in all SME categories decreased in 2007, compared to 1997. This indicates that overall, Thai manufacturing SMEs experienced no improvement in their technical efficiency in the Post-Crisis period after 1997.

Furthermore, the empirical results from both SFA and DEA suggest that the technical efficiency performance of most Thai manufacturing SMEs has deteriorated in 2007 (see Table 6.22), and that the government's first SME promotion plan, covering the period 2002-2006, aimed at improving the efficiency and capacity of SMEs has proven to be largely ineffective[31], as previously discussed in Section 2.4.8 of Chapter 2. Empirical evidence from the stochastic frontier production functions (the SFA approach) indicates the high value of labour-elasticity in all SME categories in 1997 and 2007, and the importance of labour input in the production function. The low capital elasticity value in all categories emphasises that capital has a low share in the production function.

This also suggests that the deterioration in technical efficiency across most SME categories has been due to the adoption of inappropriate factor proportions in production, with too much reliance on low-cost unskilled workers rather than investment in higher-cost capital, technology and employment of high-cost skilled workers. Thus, specific policy recommendations are essential to improve the technical efficiency of all categories of manufacturing SMEs. Policy will also require the provision of more skilled workers, in conjunction with greater access to capital and technology by SMEs.

Therefore, it is imperative that relevant government agencies have to be well equipped to play an effective role in order to promote and improve the quality of manufacturing SMEs both qualitatively and quantitatively. This involves improving coordination at both the national and sub-national levels, improving the procedure and structure of government agencies and developing the qualifications of human resources in the public sector (OSMEP, 2007a, 2007b; OSMRJ, 2008). Furthermore, the Thai government should place more emphasis on policies concerning a durable collaboration between public and private sectors, such as the promotion of manufacturing SME growth and integration, cross-border linkages, on-

[31] The first SME promotion plan from 2002 to 2006 aimed to provide a strategic direction for developing SMEs. The objective of the plan was to develop more entrepreneurs and facilitate SMEs in meeting international quality standards. The plan also aimed to enhance the efficiency and capacity of SME operators with the objective of enhancing the international competitiveness of SMEs (Mephokee, 2003; OSMEP, 2003; Punyasavatsut, 2007). However, the plan was not accomplished, as it was not implemented effectively and lacked a powerful driving force from the policy level to the operational level. Government agencies were also not well-integrated to be capable of supporting SMEs in accordance with the promotion plan (Punyasavatsut, 2007; Sahakijpicharn, 2007; OSMEP, 2008).

going learning and innovation (Hallberg, 2000; Asasen *et al.*, 2003; Harvie and Lee, 2005b; OSMRJ, 2008; Hussain *et al.*, 2009).

6.6 SUMMARY

This chapter has aimed to compare and analyse the technical efficiency performance of Thai manufacturing SMEs in the periods 1997 and 2007, by using the SFA and DEA approaches to test for the robustness of the results. The SFA and DEA approaches have a number of advantages as well as disadvantages. There is no approach that is strictly preferable to any other (Murillo-Zamorano, 2004; Coelli *et al.*, 2005; Seelanatha, 2007). Thus, many empirical studies in the technical efficiency literature suggest that it is practical to predict a firm's technical efficiency utilising both SFA and DEA to cross-check the results (Kalaitzandonakes and Dunn, 1995; Sharma *et al.*, 1997; Wadud, 2003; Minh *et al.*, 2007; O'Donnell *et al.*, 2009; Amornkitvikai, 2011). For the SFA approach, the maximum likelihood estimates of the parameters of the stochastic frontier and technical inefficiency effects models were estimated simultaneously using the FRONTIER Version 4.1. With respect to the DEA approach, the estimates of the output-orientated VRS model were estimated by utilising DEAP Version 2.1.

In comparing between the SFA and DEA approaches, due to the differences in the SFA and DEA technical efficiency scores, Spearman rank correlation coefficients were conducted to examine the ranking consistency for Thai manufacturing SMEs in 1997 and 2007. The values of the estimated Spearman rank correlation coefficients for all manufacturing SME categories in both periods are highly significant at the 1 percent level. Hence, it can be stated that the technical efficiency scores obtained from the SFA and DEA approaches are consistent in terms of ranking for all categories of manufacturing SMEs in 1997 and 2007.

The SFA and DEA approaches have shown inconsistent results in terms of types of returns to scale. The finding from the SFA approach has revealed that almost all Thai manufacturing SME categories have experienced IRS in 2007 compared to CRS in 1997, with the exceptions of aggregate manufacturing SMEs, medium enterprises and exporting SMEs. In contrast, the results of returns to scale from the DEA approach have presented that all Thai manufacturing SME categories have been operating under DRS in both 1997 and 2007. Thus, it can be concluded that the results of types of returns to scale from both SFA and DEA are found to be inconclusive.

The overall weighted average technical efficiency scores of Thai manufacturing SMEs based on the DEA approach are much higher than those obtained from SFA in 1997 and 2007. The reason for this is that the SFA approach makes adjustments for statistical noise (Coelli *et al.*, 2005; O'Donnell *et al.*, 2009). A disturbing result from both SFA and DEA is the deterioration in the technical efficiency performance of manufacturing SMEs in 2007. Despite concerns arising from the financial and economic crisis of 1997 and the need to bring about a sustainable improvement in SME performance, government measures appear to have largely failed. The empirical evidence from the two approaches is that there is considerable technical inefficiency in operations across all categories for Thai manufacturing SMEs in 1997 and 2007.

Manufacturing SMEs do not appear to have benefited greatly from reforms and promotional plans despite their importance to the economy. Manufacturing SMEs remain heavily dependent upon labour input, predominantly unskilled, and are engaged in the production of low value adding products. Capital input remains of lesser importance but it will be critical, if manufacturing SMEs are to become more efficient, competitive and to move into higher value adding areas of activity, that they adopt higher levels of technology and are more innovative in their activities (i.e., prepared and able to introduce new product standards, processes, managerial and technological upgrading, marketing and management) (Dhanani and Scholtès, 2002; Chirasirimongkol and Chutimaskul, 2005; Punyasavatsut, 2007; OSMEP, 2007a, 2007b; OSMRJ, 2008; Thai Industrial Standards Institute, 2009).

Following on from the empirical analysis of Thai manufacturing SMEs presented in this chapter, the following chapter will present and discuss results obtained from the technical inefficiency effects model in the SFA approach and the second step of the two-stage DEA approach (a Tobit model) with firm-specific factors and explanatory variables. The following chapter will also present an interpretation of the empirical results and policy implications.

CHAPTER 7
FIRM-SPECIFIC FACTORS CONTRIBUTING TO TECHNICAL INEFFICIENCY AND POLICY IMPLICATIONS

7.1 INTRODUCTION

The primary objective of this chapter is to analyse the empirical results obtained from the technical inefficiency effects model (using the SFA approach) and the second step of the two-stage DEA approach (utilising a two-limit Tobit model) and compare the robustness of the results. Specifically, this chapter empirically investigates firm-specific factors and explanatory variables influencing the technical inefficiency of Thai manufacturing SMEs in the pre-(1997) and post-(2007) Asian financial crisis of 1997. This chapter also empirically investigates firm-specific factors and explanatory variables influencing the technical inefficiency of Thai manufacturing SMEs in these periods in six categories: by aggregate manufacturing SMEs; by small; by medium; by domestic market intensity; by export intensity; and by sub-manufacturing sectors.

Data for each of six categories of manufacturing SMEs are utilised to examine individually whether technical efficiency is positively or negatively related to firm-specific factors including firm size; firm age; skilled labour; firm location; region; type of ownership; foreign ownership or investment; export intensity; and government assistance. This chapter also provides appropriate policy implications and recommendations based upon the empirical evidence of the effect of firm-specific factors on the technical efficiency of Thai manufacturing SMEs. These policies and recommendations aim to improve and promote the technical efficiency performance of Thailand's manufacturing SMEs.

This chapter is structured as follows: The empirical results from the technical inefficiency effects model and a Tobit model for Thai manufacturing SMEs are discussed in Section 7.2. Section 7.3 compares and discusses the empirical results between the SFA and DEA approaches. Section 7.4 provides specific policy implications and recommendations based on the empirical evidence for the technical efficiency performance of Thai manufacturing SMEs. Finally, a summary of key outcomes from this chapter is presented in Section 7.5.

7.2 EMPIRICAL RESULTS FROM ESTIMATION OF THE TECHNICAL INEFFICIENCY EFFECTS MODEL AND THE SECOND STEP OF THE TWO-STAGE DEA APPROACH

This section compares and discusses the empirical results obtained from the technical inefficiency effects model (SFA), and a Tobit model (DEA) in the periods 1997 and 2007. This section also empirically investigates firm-specific factors and explanatory variables influencing the technical inefficiency of Thai manufacturing SMEs.

7.2.1 Results from the Technical Inefficiency Effects Model (Using SFA)

As previously discussed in Section 6.2.1 of Chapter 6, the model defined by Equations (6.1) and (6.2), is estimated simultaneously to obtain results for a technical inefficiency effects model. The estimated results for parameters of the inefficiency effects model are reported in Tables 6.7, 6.8 and 6.9 of Chapter 6, respectively. A summary of the estimated results is also presented in Table 7.1. All negative coefficient signs of the technical inefficiency effects model represent technical efficiency. Hence, all negative signs must be converted to positive for their relationship to technical efficiency.

7.2.2 Results from the Second-step of the Two-stage DEA Approach (Utilising a Tobit Model)

As comprehensively discussed in Section 6.2.2 of Chapter 6, the estimated results of a Tobit model, in terms of the signs of the coefficients and their significance, for Equations (6.5) in Chapter 6, are presented in Tables 7.2, 7.3 and 7.4, respectively. A summary of the estimated results from a Tobit model is also reported in Table 7.5. All negative coefficient signs of a Tobit model represent the relationship relative to technical inefficiency. Thus, negative signs must be converted to positive for technical efficiency.

Table 7.1: Summary of Results from the Technical Inefficiency Effects Model for Thai Manufacturing SMEs (using SFA)

Years	Pre-Crisis (1997) Period											
Technical Inefficiency Effects	SMEs	SE	ME	DOE	EXE	SITC0	SITC1	SITC2	SITC5	SITC6	SITC7	SITC8
Constant	+***	+***	+***	+***	+**	+***	-	+***	+***	+***	-***	+***
Firm Size	-***	N/A	N/A	-***	+**	-***	+	+	-	-	-**	-
Firm Age	-*	+	-***	-	-***	-	+***	-	-**	-***	-	-***
Skilled Labour	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Municipality	-***	-***	+***	-***	-**	+	-**	+	-	-	+***	-***
Bangkok Area	-***	-***	-***	-***	-*	-***	-	-**	+	-***	-***	-***
Central & Vicinity Regions	-**	-*	+	-**	+	-	+	-	+*	+**	+	-***
Northern Region	-***	-***	+*	-***	+	+	+	-*	+**	-***	-***	-***
North-eastern Region	+***	+***	+***	+***	+	-	+***	+	+	-*	-***	-***
Individual Proprietor	-***	-***	-***	-***	-**	-***	+	-***	-***	-***	+***	-***
Juristic Partnership	-***	-***	-***	-***	-***	-***	-	-***	-***	-***	-**	-***
Limited & Public Limited Companies	-***	-***	-***	-***	-***	-***	-	-***	-***	-***	-***	-***
Government and State Enterprises	-***	-***	-***	-***	-	-***	N/A	-	N/A	-***	-***	-
Cooperatives	-***	-***	-***	-***	-	-***	N/A	-	+	-**	N/A	-***
Foreign Investment	-***	-**	-***	-***	-	-	-	-	-	-***	-***	+
Export Intensity	-***	-***	-**	-**	N/A	-**	-	+	-*	-*	+***	-
Government Assistance (BOI)	-	+	-**	+	-**	-	+	+	-	+	-**	-

Years	Post-Crisis (2007) Period											
Technical Inefficiency Effects	SMEs	SE	ME	DOE	EXE	SITC0	SITC1	SITC2	SITC5	SITC6	SITC7	SITC8
Constant	+***	+***	+***	+***	-	+***	+***	+***	+***	+***	+***	+***
Firm Size	-***	N/A	N/A	-***	+	-***	-***	-	+	-**	+	-***
Firm Age	-**	-*	-***	-**	+	-***	-	+*	-***	+**	-	-
Skilled Labour	-***	-***	+	-***	-	-***	-	-***	-	-***	-	-***
Municipality	-***	-***	+***	-***	+	-***	-***	-***	-***	-***	-***	-***
Bangkok Area	-***	-***	-***	-***	+	-***	-***	-***	-***	-***	-***	-***
Central & Vicinity Regions	-	+	-**	-	+	-	-*	+	-	+	-	-
Northern Region	+***	+***	+***	+***	+**	+***	+	+***	+***	+***	+***	-***
North-eastern Region	+***	+***	-	+***	+**	-***	+	+***	+***	+***	+***	+***
Individual Proprietor	-***	-***	-***	-***	-	-***	-***	-***	-***	-***	-***	-***
Juristic Partnership	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***
Limited & Public Limited Companies	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***
Government and State Enterprises	+***	+	+***	+***	-	-	-**	+***	-**	+***	N/A	+***
Cooperatives	-***	-***	-*	-***	+	-***	-	+	-***	+	N/A	-
Foreign Investment	-***	-	-***	-*	-	+	-	-***	-***	-*	+**	+
Export Intensity	-**	-**	-	-*	N/A	+	+	-*	-***	-	-	-*
Government Assistance (BOI)	-	-	-***	-	-	+	-*	+	+	-	-	-

Note: *, ** and *** indicate that the coefficients are statistically significant at 10%, 5% and 1%, respectively. SE: Small Enterprise, ME: Medium Enterprise, DOE: Domestic SMEs, EXE: Exporting SMEs, SITC 0: Food and live animals, SITC 1: Beverages and tobacco, SITC 2: Crude materials, inedible, except fuels, SITC 5: Chemicals and related products, SITC 6: Manufactured goods classified by material, SITC 7: Machinery and transport equipment, SITC 8: Miscellaneous manufactured articles.

Table 7.2: Maximum Likelihood Estimates of the Parameters for a Tobit Model by Aggregate Manufacturing SMEs and Size of Manufacturing SMEs (small and medium)

Years	Pre-Crisis (1997) Period			Post-Crisis (2007) Period		
Categories	**Aggregate Manufacturing SMEs**	**Small Enterprises**	**Medium Enterprises**	**Aggregate Manufacturing SMEs**	**Small Enterprises**	**Medium Enterprises**
Firm-specific Factors	Coefficients	Coefficients	Coefficients	Coefficients	Coefficients	Coefficients
Left Censoring (value) at Zero	12	9	12	9	14	10
Right Censoring (value) at One	0	0	0	0	0	0
Uncensored Observations	22673	18205	4459	56432	49821	6596
Total Observations	**22685**	**18214**	**4471**	**56441**	**49835**	**6606**
Dependent Variable: Variable Return to Scale (VRS) Technical Inefficiency						
Constant	0.451***	0.500***	0.384***	0.447***	0.463***	0.362***
	(0.004)	(0.004)	(0.016)	(0.002)	(0.001)	(0.005)
Firm Size (dummy)	0.049***	N/A	N/A	0.030***	N/A	N/A
	(0.001)			(0.001)		
Firm Age (years)	-0.0004***	-0.0003***	-0.0005***	-0.0001***	-0.0001***	-0.0005***
	(0.00005)	(0.00006)	(0.0001)	(0.00004)	(0.00004)	(0.00008)
Skilled Labour[1] (ratio)	N/A	N/A	N/A	-0.039***	-0.049***	0.004*
				(0.0009)	(0.001)	(0.002)
Municipality (dummy)	-0.002***	-0.005***	0.005**	-0.014***	-0.015***	0.001
	(0.001)	(0.001)	(0.003)	(0.0008)	(0.0009)	(0.002)
Bangkok Area (dummy)	-0.022***	-0.023***	-0.019***	-0.016***	-0.026***	0.006
	(0.002)	(0.002)	(0.005)	(0.001)	(0.001)	(0.004)
Central & Vicinity Regions (dummy)	-0.008***	-0.009***	0.002	-0.004***	-0.006***	0.008**
	(0.001)	(0.002)	(0.004)	(0.001)	(0.001)	(0.003)
Northern Region (dummy)	-0.002	-0.005**	0.017***	0.035***	0.033***	0.072***
	(0.002)	(0.002)	(0.005)	(0.001)	(0.001)	(0.004)
North-eastern Region (dummy)	0.0002	-0.002	0.014***	0.023***	0.021***	0.004
	(0.002)	(0.002)	(0.006)	(0.001)	(0.001)	(0.005)
Individual Proprietor (dummy)	-0.097***	-0.093***	-0.112***	-0.056***	-0.041***	-0.087***
	(0.004)	(0.004)	(0.016)	(0.001)	(0.001)	(0.006)
Juristic Partnership (dummy)	-0.136***	-0.133***	-0.118***	-0.116***	-0.112***	-0.103***
	(0.004)	(0.004)	(0.016)	(0.001)	(0.001)	(0.005)
Limited & Public Limited Company (dummy)	-0.149***	-0.145***	-0.126***	-0.130***	-0.128***	-0.114***
	(0.004)	(0.004)	(0.015)	(0.001)	(0.001)	(0.004)
Government & State Enterprises (dummy)	-0.108***	-0.120***	-0.079***	0.017***	-0.010	0.080***
	(0.012)	(0.019)	(0.021)	(0.008)	(0.011)	(0.010)
Cooperatives (dummy)	-0.090***	-0.085***	-0.204***	-0.105***	-0.108***	-0.004
	(0.007)	(0.007)	(0.032)	(0.005)	(0.006)	(0.016)
Foreign Investment (dummy)	-0.016***	-0.013***	-0.012***	-0.016***	-0.011***	-0.015***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)
Export Intensity (dummy)	-0.010***	-0.013***	0.0006	-0.004*	-0.013***	0.003
	(0.001)	(0.002)	(0.002)	(0.003)	(0.004)	(0.004)
Government Assistance (BOI) (dummy)	-0.016***	-0.017***	-0.011***	-0.015***	-0.009***	-0.015***
	(0.002)	(0.004)	(0.003)	(0.003)	(0.005)	(0.004)
Error Distribution	0.070***	0.071***	0.069***	0.084***	0.089***	0.068***
	(0.0003)	(0.0003)	(0.0007)	(0.0002)	(0.0002)	(0.0005)
Log likelihood	27879.98	22104	5537.434	59211.92	49383.85	8320.466

Note: Standard errors are in brackets; *, ** and *** indicate that the coefficients are statistically significant at 10%, 5% and 1%, respectively.

[1] The NSO did not compile statistics on skilled labour in 1997.

Table 7.3: Maximum Likelihood Estimates of the Parameters for a Tobit Model by Domestic and Exporting SMEs

Years	Pre-Crisis (1997) Period		Post-Crisis (2007) Period	
Categories	**Domestic SMEs**	**Exporting SMEs**	**Domestic SMEs**	**Exporting SMEs**
Firm-specific Factors	Coefficients	Coefficients	Coefficients	Coefficients
Left Censoring (value) at Zero	12	11	9	8
Right Censoring (value) at One	0	0	0	0
Uncensored Observations	22673	1883	54667	1757
Total Observations	**22685**	**1894**	**54676**	**1765**
Dependent Variable: Variable Return to Scale (VRS) Technical Inefficiency				
Constant	0.446***	0.320***	0.448***	0.298***
	(0.004)	(0.030)	(0.002)	(0.016)
Firm Size (dummy)	0.057***	0.013***	0.030***	0.009***
	(0.001)	(0.003)	(0.001)	(0.003)
Firm Age (years)	-0.0003***	-0.0005***	-0.0001***	0.00007
	(0.00005)	(0.0002)	(0.00004)	(0.00017)
Skilled Labour (ratio)	N/A	N/A	-0.041***	0.021***
			(0.001)	(0.004)
Municipality (dummy)	-0.001	-0.012***	-0.014***	-0.005*
	(0.001)	(0.005)	(0.0008)	(0.003)
Bangkok Area (dummy)	-0.024***	0.001	-0.017***	0.020***
	(0.002)	(0.008)	(0.001)	(0.007)
Central & Vicinity Regions (dummy)	-0.010***	0.013*	-0.005***	0.024***
	(0.002)	(0.007)	(0.001)	(0.006)
Northern Region (dummy)	-0.004	0.026***	0.034***	0.048***
	(0.002)	(0.009)	(0.001)	(0.008)
North-eastern Region (dummy)	-0.0007	0.014**	0.022***	0.045***
	(0.002)	(0.010)	(0.001)	(0.009)
Individual Proprietor (dummy)	-0.099***	-0.029	-0.055***	-0.091***
	(0.004)	(0.031)	(0.001)	(0.017)
Juristic Partnership (dummy)	-0.138***	-0.056**	-0.116***	-0.090***
	(0.004)	(0.030)	(0.001)	(0.016)
Limited & Public Limited company (dummy)	-0.151***	-0.064**	-0.130***	-0.107***
	(0.004)	(0.030)	(0.001)	(0.015)
Government & State Enterprises (dummy)	-0.110***	-0.022	0.019***	-0.141***
	(0.012)	(0.079)	(0.008)	(0.065)
Cooperatives (dummy)	-0.092***	-0.085	-0.106***	0.041
	(0.007)	(0.080)	(0.005)	(0.065)
Foreign Investment (dummy)	-0.024***	-0.003	-0.019***	-0.009***
	(0.002)	(0.004)	(0.002)	(0.003)
Export Intensity (dummy)	-0.009***	N/A	-0.003	N/A
	(0.002)	N/A	(0.004)	N/A
Government Assistance (BOI) (dummy)	-0.022***	-0.010***	-0.019***	0.002
	(0.003)	(0.004)	(0.004)	(0.004)
Error Distribution	0.071***	0.073***	0.085***	0.063***
	(0.0003)	(0.001)	(0.0002)	(0.001)
Log likelihood	25227.94	2218.604	56965.94	2332.314

Note: Standard errors are in brackets; *, ** and *** indicate that the coefficients are statistically significant at 10%, 5% and 1%, respectively.

Table 7.4: Maximum Likelihood Estimates of the Parameters for a Tobit Model by SITC: Revision 4

Years	Pre-Crisis (1997) Period							Post-Crisis (2007) Period						
Categories	**SITC 0**	**SITC 1**[2]	**SITC 2**	**SITC 5**	**SITC 6**	**SITC 7**	**SITC 8**	**SITC 0**	**SITC 1**	**SITC 2**	**SITC 5**	**SITC 6**	**SITC 7**	**SITC 8**
Firm-specific Factors	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Left Censoring (value) at Zero	14	N/A	14	11	11	15	17	7	7	8	11	13	9	16
Right Censoring (value) at One	0	N/A	0	0	0	0	0	0	0	0	0	0	0	0
Uncensored Observations	3056	N/A	1467	2558	6620	2778	5548	12073	1758	4600	4822	17528	3883	11630
Total Observations	**3070**	**N/A**	**1481**	**2569**	**6631**	**2793**	**5565**	**12080**	**1765**	**4608**	**4833**	**17541**	**3892**	**11646**
Dependent Variable: Variable Return to Scale (VRS) Technical Inefficiency														
Constant	0.427***	N/A	0.275***	0.319***	0.458***	0.229***	0.411***	0.423***	0.328***	0.345***	0.346***	0.363***	0.460***	0.404***
	(0.011)		(0.029)	(0.010)	(0.009)	(0.037)	(0.011)	(0.005)	(0.015)	(0.008)	(0.007)	(0.003)	(0.025)	(0.004)
Firm Size (dummy)	0.010**	N/A	0.050***	0.002	0.056***	0.008**	0.034***	0.067***	0.057***	0.048***	0.055***	0.044***	0.014***	0.027***
	(0.004)		(0.005)	(0.003)	(0.002)	(0.003)	(0.002)	(0.004)	(0.013)	(0.006)	(0.003)	(0.002)	(0.003)	(0.003)
Firm Age (years)	-0.00005	N/A	-0.0004**	-0.0006***	-0.0004***	0.00007	-0.0003***	-0.0006***	-0.0003*	0.0001	-0.0005***	0.0001*	0.00005	0.00001
	(0.0001)		(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.00009)	(0.0003)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.00009)
Skilled Labour (ratio)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-0.052***	-0.023***	-0.075***	-0.017***	-0.030***	-0.021***	-0.049***
								(0.002)	(0.006)	(0.004)	(0.003)	(0.001)	(0.003)	(0.002)
Municipality (dummy)	0.007**	N/A	0.008	-0.014***	0.0005	0.005	-0.020***	-0.012***	-0.006*	-0.016***	-0.006***	-0.013***	-0.004*	-0.020***
	(0.003)		(0.007)	(0.005)	(0.002)	(0.004)	(0.003)	(0.001)	(0.004)	(0.004)	(0.003)	(0.001)	(0.002)	(0.002)
Bangkok Area (dummy)	-0.025***	N/A	-0.046***	0.015**	-0.028***	-0.039***	-0.054***	-0.037***	-0.039***	-0.012*	0.002	-0.012***	-0.012***	-0.037***
	(0.006)		(0.009)	(0.008)	(0.004)	(0.008)	(0.005)	(0.005)	(0.014)	(0.007)	(0.006)	(0.003)	(0.005)	(0.003)
Central & Vicinity Regions	-0.012***	N/A	-0.014*	0.020***	-0.002	-0.004	-0.035***	-0.014***	-0.011*	0.006	0.011**	0.002	0.002	-0.009***
(dummy)	(0.005)		(0.007)	(0.007)	(0.003)	(0.008)	(0.005)	(0.002)	(0.007)	(0.005)	(0.005)	(0.002)	(0.004)	(0.003)
Northern Region (dummy)	-0.004	N/A	-0.015	0.028***	-0.003	-0.007	-0.026***	0.021***	0.015***	0.050***	0.126***	0.042***	0.041***	0.026***
	(0.005)		(0.009)	(0.012)	(0.004)	(0.010)	(0.006)	(0.002)	(0.006)	(0.005)	(0.007)	(0.002)	(0.006)	(0.003)
North-eastern Region	-0.016***	N/A	-0.002	0.031***	-0.010***	-0.014*	-0.032***	-0.001	0.007*	0.061***	0.037***	0.037***	0.059***	0.016***
(dummy)	(0.005)		(0.012)	(0.012)	(0.004)	(0.009)	(0.006)	(0.002)	(0.007)	(0.005)	(0.006)	(0.002)	(0.006)	(0.003)
Individual Proprietor	-0.123***	N/A	0.011	-0.029***	-0.112***	0.035	-0.066***	-0.061***	-0.057***	-0.012***	-0.071***	-0.033***	-0.114***	-0.044***
(dummy)	(0.010)		(0.028)	(0.013)	(0.008)	(0.036)	(0.010)	(0.002)	(0.007)	(0.004)	(0.004)	(0.002)	(0.025)	(0.002)
Juristic Partnership (dummy)	-0.162***	N/A	-0.012	-0.060***	-0.152***	0.008	-0.116***	-0.149***	-0.068***	-0.121***	-0.137***	-0.091***	-0.169***	-0.110***
	(0.010)		(0.028)	(0.012)	(0.009)	(0.036)	(0.010)	(0.004)	(0.009)	(0.007)	(0.006)	(0.003)	(0.025)	(0.004)
Limited & Public Limited	-0.165***	N/A	-0.033	-0.071***	-0.167***	0.002	-0.117***	-0.152***	-0.091***	-0.138***	-0.146***	-0.109***	-0.189***	-0.129***
Company (dummy)	(0.010)		(0.028)	(0.012)	(0.009)	(0.036)	(0.010)	(0.003)	(0.011)	(0.006)	(0.005)	(0.002)	(0.025)	(0.003)
Government & State	-0.184***	N/A	-0.048	0[3]	-0.135***	0	-0.010	-0.071***	-0.109***	0.119***	-0.143***	0.032*	0	0.036***
Enterprises (dummy)	(0.044)		(0.050)	(1)	(0.023)	(1)	(0.022)	(0.022)	(0.046)	(0.031)	(0.033)	(0.018)	(1)	(0.013)
Cooperatives (dummy)	-0.180***	N/A	0.109*	0.054***	-0.042*	0	-0.139***	-0.123***	0.004	0.019	-0.136***	0.006	0	-0.017
	(0.018)		(0.064)	(0.013)	(0.029)	(1)	(0.030)	(0.014)	(0.018)	(0.056)	(0.010)	(0.032)	(1)	(0.022)
Foreign Investment	-0.004	N/A	-0.007	-0.016***	-0.030***	-0.018***	-0.005*	-0.011*	-0.087***	-0.028**	-0.017***	-0.011***	-0.011***	-0.003
(dummy)	(0.008)		(0.010)	(0.005)	(0.004)	(0.005)	(0.004)	(0.009)	(0.044)	(0.015)	(0.005)	(0.004)	(0.004)	(0.005)
Export Intensity (dummy)	-0.014***	N/A	-0.001	-0.012***	-0.006**	0.007*	-0.0001	-0.011	0.029	-0.035*	-0.006	-0.009*	-0.006	-0.005*
	(0.005)		(0.007)	(0.004)	(0.003)	(0.004)	(0.002)	(0.012)	(0.053)	(0.019)	(0.009)	(0.007)	(0.008)	(0.005)
Government Assistance	-0.023***	N/A	-0.001	-0.003	-0.022***	-0.012*	-0.019***	0.003	-0.103*	0.019	-0.012*	-0.010*	-0.015*	-0.014**
(BOI) (dummy)	(0.008)		(0.012)	(0.005)	(0.006)	(0.006)	(0.005)	(0.013)	(0.058)	(0.020)	(0.009)	(0.008)	(0.008)	(0.006)
Error Distribution	0.086***	N/A	0.082***	0.075***	0.074***	0.072***	0.070***	0.097***	0.092***	0.112***	0.086***	0.084***	0.070***	0.088***
	(0.001)		(0.001)	(0.001)	(0.0006)	(0.0009)	(0.0006)	(0.0006)	(0.001)	(0.001)	(0.0008)	(0.0004)	(0.0008)	(0.0005)
Log Likelihood	3119.2	N/A	1555.6	2959	7756.3	3338	6778	10958	1676.6	3524	4943	18336	4761	11623

Note: Standard errors are in brackets; *, ** and *** indicate that the coefficients are statistically significant at 10%, 5% and 1%, respectively. SITC 0: Food and live animals, SITC 1: Beverages and tobacco, SITC 2: Crude materials, inedible, except fuels, SITC 5: Chemicals and related products, SITC 6: Manufactured goods classified by material, SITC 7: Machinery and transport equipment, SITC 8: Miscellaneous manufactured articles.

[2] The estimation of SITC 1 in 1997 produced insignificant results, due to the perfectly collinear and near-singular matrix error.

[3] It is important to note that the estimated coefficients and standard errors shown for government & state enterprises and cooperatives for SITC 5 and SITC 7 in 1997 and SITC 7 in 2007 are all insignificant, due to the very small number of observations in these categories.

Table 7.5: Summary of Results from a Tobit Model for Thai Manufacturing SMEs (Utilising DEA Approach)

Years	Pre-Crisis (1997) Period											
A Tobit Model	SMEs	SE	ME	DOE	EXE	SITC0	SITC1	SITC2	SITC5	SITC6	SITC7	SITC8
Constant	+***	+***	+***	+***	+***	+***	N/A	+***	+***	+***	-***	+***
Firm Size	+***	N/A	N/A	+***	+***	+**	N/A	+	+***	+**	-**	+***
Firm Age	-***	-***	-***	-***	-***	-	N/A	-**	-***	-***	+	-***
Skilled Labour	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Municipality	-***	-***	+**	-	-***	+**	N/A	+	-***	+	+	-***
Bangkok Area	-***	-***	-***	-***	+	-***	N/A	-***	+**	-***	-***	-***
Central & Vicinity Regions	-***	-***	+	-***	+*	-***	N/A	-*	+***	-	-	-***
Northern Region	-	-**	+***	-	+***	-	N/A	-	+***	-	-	-***
North-eastern Region	+	-	+***	-	+**	-***	N/A	-	+***	-***	-*	-***
Individual Proprietor	-***	-***	-***	-***	-	-***	N/A	+	-***	-***	+	-***
Juristic Partnership	-***	-***	-***	-***	-**	-***	N/A	-	-***	-***	+	-***
Limited & Public Limited Companies	-***	-***	-***	-***	-**	-***	N/A	-	-***	-***	+	-***
Government and State Enterprises	-***	-***	-***	-***	-	-***	N/A	-	N/A	-***	N/A	-
Cooperatives	-***	-***	-***	-***	-	-***	N/A	+*	+***	-*	N/A	-***
Foreign Investment	-***	-***	-***	-***	-	-	N/A	-	-***	-***	-***	-*
Export Intensity	-***	-***	+	-***	N/A	-***	N/A	-	-***	-**	+*	-
Government Assistance (BOI)	-***	-***	-***	-***	-***	-***	N/A	-	-	-***	-*	-***

Years	Post-Crisis (2007) Period											
A Tobit Model	SMEs	SE	ME	DOE	EXE	SITC0	SITC1	SITC2	SITC5	SITC6	SITC7	SITC8
Constant	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***
Firm Size	+***	N/A	N/A	+***	+***	+***	+***	+***	+***	+***	+***	+***
Firm Age	-***	-***	-***	-***	+	-***	-*	+	-***	+*	+	+
Skilled Labour	-***	-***	+*	-***	+***	-***	-***	-***	-***	-***	-***	-***
Municipality	-***	-***	+	-***	-*	-***	-*	-***	-***	-***	-*	-***
Bangkok Area	-***	-***	+	-***	+***	-***	-***	-*	+	-***	-***	-***
Central & Vicinity Regions	-***	-***	+**	-***	+***	-***	-*	+	+**	+	+	-***
Northern Region	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***
North-eastern Region	+***	+***	+	+***	+***	-	+*	+***	+***	+***	+***	+***
Individual Proprietor	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***
Juristic Partnership	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***
Limited & Public Limited Companies	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***
Government and State Enterprises	+***	-	+***	+***	-***	-***	-***	+***	-***	+*	N/A	+***
Cooperatives	-***	-***	-	-***	+	-***	+	+	-***	+	N/A	-
Foreign Investment	-***	-***	-***	-***	-***	-*	-***	-**	-**	-***	-***	-
Export Intensity	-*	-***	+	-	N/A	-	+	-*	-	-*	-	-*
Government Assistance (BOI)	-***	-***	-***	-***	+	+	-*	+	-*	-*	-*	-**

Note: *, ** and *** indicate that the coefficients are statistically significant at 10%, 5% and 1%, respectively. SE: Small Enterprise, ME: Medium Enterprise, DOE: Domestic SMEs, EXE: Export SMEs, SITC 0: Food and live animals, SITC 1: Beverages and tobacco, SITC 2: Crude materials, inedible, except fuels, SITC 5: Chemicals and related products, SITC 6: Manufactured goods classified by material, SITC 7: Machinery and transport equipment, SITC 8: Miscellaneous manufactured articles.

7.3 A COMPARISON OF THE RESULTS FROM THE SFA AND DEA APPROACHES

7.3.1 Firm-specific Factors Contributing to Technical Inefficiency

7.3.1.1 Firm Size

Table 7.6 provides a summary of the estimated results from the technical inefficiency effects model (SFA) and a Tobit model (DEA) in the periods 1997 and 2007. In Table 7.6, the empirical results from the SFA and DEA approaches for firm size are found to produce inconsistent results. The estimated results from SFA present negative and significant signs for aggregate manufacturing SMEs, domestic market oriented SMEs, SITC 0 and SITC 7 in 1997. By 2007, the SFA exhibits significant and negative signs for aggregate manufacturing, domestic SMEs, and SMEs operating in SITC 0, SITC 1, SITC 6 and SITC 8. The results from DEA show negative and significant signs for SITC 7 in 1997. Thus, the negative signs signify that small-sized SMEs are more technically efficient than medium-sized SMEs in these periods. A number of empirical studies have highlighted that small firms are more technically efficient than larger firms due to the flexibility to adjust and diversify their activities in order to become more efficient, and small firms are likely to have a cost advantage relative to medium and large firms (Biggs, 2002; Alvarez and Crespi, 2003; Yang and Chen, 2009; Le, 2010).

On the other hand, the results from SFA exhibit positive and significant signs for exporting SMEs in 1997. The estimated results from DEA show positive and significant signs for almost all manufacturing SME categories in 1997 and 2007. The positive signs indicate that medium-sized SMEs are more technically efficient than small-sized SMEs in both 1997 and 2007 (see Table 7.6). This result is consistent with many empirical studies (Lundvall and Battese, 2000; Admassie and Matambalya, 2002; Yang, 2006; Tran *et al.*, 2008) which demonstrate that large firms are able to obtain new technology faster than small firms, because they have less capital constraints.

7.3.1.2 Firm Age

From Table 7.6, the empirical evidence from the SFA and DEA approaches reveals that the age of a firm negatively impacts its level of efficiency in both the 1997 and

2007 cross sections of firms and within various subgroups of firms in the same cohort. The estimated results from SFA present significant and negative signs for aggregate manufacturing SMEs, medium-sized enterprises, exporting SMEs, SITC 5, SITC 6 and SITC 8 in 1997, and aggregate manufacturing, small, medium, domestic SMEs, SITC 0 and SITC 5 in 2007. The results from DEA show significant and negative signs for aggregate manufacturing, small and medium enterprises, domestic and exporting SMEs, SITC 2, SITC 5, SITC 6 and SITC 8 in 1997. In 2007, DEA presents significant and negative signs for aggregate manufacturing, small-and medium-sized enterprises, domestic SMEs, SITC 0, SITC 1 and SITC 5. Hence, the negative signs indicate that firm age is significantly and positively related to the technical efficiency in these SME categories. A number of empirical studies suggest that firm age has a positive and significant association with its technical efficiency based on the principle of learning by doing and accumulated knowledge (Batra and Tan, 2003; Phan, 2004; Tran *et al.*, 2008; Park *et al.*, 2009).

On the other hand, the age of a firm can have a negative effect upon technical efficiency as older firms are likely to possess older machinery and equipment, while younger firms have just entered the market and are equipped with modern technology (Pasanen, 2007; Tran *et al.*, 2008; Le, 2010). The empirical results from SFA show that the age of a firm is found to have a negative and significant effect upon the technical efficiency of SITC 1 in 1997, and SITC 2 and SITC 6 in 2007. Empirical evidence from DEA also indicates that firm age is negatively and significantly related to the technical efficiency of SITC 6 in 2007 (see Table 7.6).

Table 7.6: Summary of Results from the SFA and DEA Approaches for Thai Manufacturing SMEs

Years	Pre-Crisis (1997) Period																							
Categories	**Aggregate Manufacturing SMEs**		**Small Enterprises**		**Medium Enterprises**		**Domestic SMEs**		**Exporting SMEs**		**SITC 0**		**SITC 1**		**SITC 2**		**SITC 5**		**SITC 6**		**SITC 7**		**SITC 8**	
Approaches	**SFA**	**DEA**	**SFA**	**DEA**	**SFA**	**DEA**	**SFA**	**DEA**	**SFA**	**DEA**	**SFA**	**DEA**	**SFA**	**DEA**	**SFA**	**DEA**	**SFA**	**DEA**	**SFA**	**DEA**	**SFA**	**DEA**	**SFA**	**DEA**
Constant	+	+	+	+	+	+	+	+	+	+	+	+	+	N/A	+	+	+	+	+	+	+	+	+	+
Firm Size	-	+	N/A	N/A	N/A	N/A	-	+	+	+	-	+	0	N/A	0	0	0	+	0	+	-	-	0	+
Firm Age	-	-	0	-	-	-	0	-	-	-	0	0	+	N/A	0	-	-	-	-	-	0	0	-	-
Skilled Labour	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Municipality	-	-	-	-	+	+	-	0	-	-	0	+	-	N/A	0	0	0	-	0	0	+	0	-	-
Bangkok Area	-	-	-	-	-	-	-	-	-	0	-	-	0	N/A	-	-	0	+	-	-	-	-	-	-
Central & Vicinity Regions	-	-	-	-	0	0	-	-	0	+	0	-	0	N/A	0	-	+	+	+	0	0	0	-	-
Northern Region	-	0	-	-	+	+	-	0	0	+	0	0	0	N/A	-	0	+	+	-	0	-	0	-	-
North-eastern Region	+	0	+	0	+	+	+	0	0	+	0	-	+	N/A	0	0	0	+	-	-	-	-	-	-
Individual Proprietor	-	-	-	-	-	-	-	-	-	0	-	-	0	N/A	-	0	-	-	-	-	+	0	-	-
Juristic Partnership	-	-	-	-	-	-	-	-	-	-	-	-	0	N/A	-	0	-	-	-	-	-	0	-	-
Limited & Public Limited Companies	-	-	-	-	-	-	-	-	-	-	-	-	0	N/A	-	0	-	-	-	-	-	0	-	-
Government and State Enterprises	-	-	-	-	-	-	-	-	0	0	-	-	N/A	N/A	0	0	N/A	N/A	-	-	-	N/A	0	0
Cooperatives	-	-	-	-	-	-	-	-	0	0	-	-	N/A	N/A	0	+	0	+	-	-	N/A	N/A	-	-
Foreign Investment	-	-	-	-	-	-	-	-	0	0	0	0	0	N/A	0	0	0	-	-	-	-	-	0	-
Exports	-	-	-	-	-	0	-	-	N/A	N/A	-	-	0	N/A	0	0	-	-	-	-	+	+	0	0
Government Assistance (BOI)	0	-	0	-	-	-	0	-	-	-	0	-	0	N/A	0	0	0	0	0	-	-	-	0	-

Note: - indicates a positive correlation with technical efficiency, + represents a negative correlation with technical efficiency and 0 denotes no correlation with technical efficiency.

Table 7.6: (continued) Summary of Results from the SFA and DEA Approaches for Thai Manufacturing SMEs

Years	Post-Crisis (2007) Period																							
Categories	Aggregate Manufacturing SMEs		Small Enterprises		Medium Enterprises		Domestic SMEs		Exporting SMEs		SITC 0		SITC 1		SITC 2		SITC 5		SITC 6		SITC 7		SITC 8	
Approaches	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA
Constant	+	+	+	+	+	+	+	+	0	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Firm Size	-	+	N/A	N/A	N/A	N/A	-	+	0	+	-	+	-	+	0	+	0	+	-	+	0	+	-	+
Firm Age	-	-	-	-	-	-	-	-	0	0	-	-	0	-	+	0	-	-	+	+	0	0	0	0
Skilled Labour	-	-	-	-	0	+	-	-	0	+	-	-	0	-	-	-	0	-	-	-	0	-	-	-
Municipality	-	-	-	-	+	0	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bangkok Area	-	-	-	-	-	0	-	-	0	+	-	-	-	-	-	-	-	0	-	-	-	-	-	-
Central & Vicinity Regions	0	-	0	-	-	+	0	-	0	+	0	-	-	-	0	0	0	+	0	0	0	0	0	-
Northern Region	+	+	+	+	+	+	+	+	+	+	+	+	0	+	+	+	+	+	+	+	+	+	-	+
North-eastern Region	+	+	+	+	0	0	+	+	+	+	-	0	0	+	+	+	+	+	+	+	+	+	+	+
Individual Proprietor	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juristic Partnership	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limited & Public Limited Companies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Government and State Enterprises	+	+	0	0	+	+	+	+	0	-	0	-	-	-	+	+	-	-	+	+	N/A	N/A	+	+
Cooperatives	-	-	-	-	-	0	-	-	0	0	-	-	0	0	0	0	-	-	0	0	N/A	N/A	0	0
Foreign Investment	-	-	0	-	-	-	-	-	0	-	0	-	0	-	-	-	-	-	-	-	+	-	0	0
Exports	0	-	-	-	0	0	-	0	N/A	N/A	0	0	0	0	-	-	-	0	0	-	0	0	0	-
Government Assistance (BOI)	0	-	0	-	-	-	0	-	0	0	0	0	-	-	0	0	0	-	0	-	0	-	0	-

Note: - indicates a positive correlation with technical efficiency, + represents a negative correlation with technical efficiency and 0 denotes no correlation with technical efficiency.

7.3.1.3 Skilled Labour

In Table 7.6, the empirical results from both SFA and DEA for skilled labour show expected negative signs for almost all manufacturing SME categories in 2007. The results from SFA present significant and negative signs for aggregate manufacturing SMEs, small enterprises, domestic SMEs, SITC 0, SITC 2, SITC 6 and SITC 8. The results from DEA also exhibit significant and negative signs for almost all manufacturing SME categories. From these results, it can be specified that skilled labour has a positive and significant association with technical efficiency for SMEs in these categories. This finding confirms previous studies, which have found that skilled labour is one of the significant factors influencing firm technical efficiency (Regnier, 2000; Huang, 2003; Saleh and Ndubisi, 2008; Punyasavatsut, 2010; Amornkitvikai and Harvie, 2011; Charoenrat and Harvie, 2011). Thus, it is imperative to update the education and training system in order to ensure that there is an adequate pool of skilled workers to meet the needs of the business community, including that of manufacturing SMEs. However, the results from the DEA demonstrate that skilled labour has a negative and significant impact on the technical efficiency of medium-sized SMEs and exporting SMEs in 2007.

7.3.1.4 Firm Location (Municipality)

In Table 7.6, the empirical evidence from both SFA and DEA for municipality (or firm location) presents expected negative signs for the majority of SME categories in 1997 and 2007. The empirical results from SFA present that municipality is positively and significantly related to the technical efficiency of aggregate manufacturing SMEs, small sized SMEs, domestic and exporting SMEs, SITC 1 and SITC 8 in 1997, and in almost all categories of manufacturing SMEs in 2007. The results from DEA reveal that municipality has a positive and significant relationship with the technical efficiency of aggregate manufacturing SMEs, small enterprises, exporting SMEs, SITC 5 and SITC 8 in 1997 and across all SME categories in 2007. Several empirical studies reveal that a municipal location has a positive relationship to firm technical efficiency (Krasachat, 2000; Li and Hu, 2002; Yang, 2006; Park *et al.*, 2009; Le and Harvie, 2010). Consequently, an urban location, with its agglomeration, infrastructure and access to resources advantages, is important for the technical efficiency of manufacturing SMEs.

In addition, Syverson (2007) finds that larger markets imply more intense competition than smaller markets, and force more exits, leading to lower dispersions in the productivity, technical efficiency and price. Bakhtiari (2012) similarly shows that in larger markets the cut-off productivity and technical efficiency are much higher than smaller markets, because more intense competition drives down mark-ups and encourages natural selection of the best firms and forces more inefficient firms out of the market. However, the results from SFA indicate that municipality is negatively and significantly related to the technical efficiency of medium enterprises and SITC 7 in 1997, and medium enterprises in 2007. The results from DEA similarly reveal that a municipal area has a negative and significant impact upon the technical efficiency of medium enterprises and SITC 0 in 1997 (see Table 7.6).

7.3.1.5 Regions

7.3.1.5.1 Bangkok Area

From Table 7.6, the empirical results from the SFA and DEA approaches for location in the Bangkok area show expected negative signs for almost all manufacturing SME categories in 1997 and 2007. The results from SFA demonstrate that the Bangkok area has a significant and positive correlation with technical efficiency of all categories of manufacturing SMEs. Empirical evidence from DEA reveals that the Bangkok area has a significant and positive impact upon the technical efficiency of aggregate manufacturing SMEs, small, medium, domestic SMEs SITC 0, SITC 2, SITC 6, SITC 7 and SITC 8 in 1997, and in aggregate manufacturing, small enterprises, domestic SMEs, SITC 0, SITC 1, SITC 2, SITC 6, SITC 7 and SITC 8 in 2007. The Bangkok area contains the highest density of SMEs in Thailand, accounting for around 30 percent of total SMEs on average, over the period 1994 to 2009. Bangkok is also recognised as the major economic centre of the nation (OSMEP, 2009; ONRCT, 2012). However, the results from the DEA present unexpected and positive signs for SITC 5 in 1997 and exporting SMEs in 2007. This indicates that the Bangkok area has a negative and significant impact on the technical efficiency of these categories.

7.3.1.5.2 Central and Vicinity Regions

In Table 7.6, empirical evidence from the SFA and DEA approaches for the Central and Vicinity regions presents expected negative signs for the majority of manufacturing SME categories in 1997 and 2007. The results from SFA specify that location in Central or Vicinity regions is positively and significantly related to technical efficiency in aggregate manufacturing SMEs, small enterprises and domestic SMEs and SITC 8 in 1997, and in medium-sized enterprises and SITC 1 in 2007. The results from DEA reveal that Central or Vicinity regions have a significant and positive impact upon the technical efficiency of aggregate manufacturing SMEs, small enterprises, domestic SMEs, SITC 0, SITC 2 and SITC 8 in 1997, and in aggregate manufacturing, small-sized SMEs, domestic SME, SITC 0, SITC 1 and SITC 8 in 2007. The Central and Vicinity regions contain many of Thailand's large businesses (OSMEP, 2008). However, the results from the SFA approach reveal that the Central and Vicinity regions have a negative and significant relationship to the technical efficiency of SITC 5 and SITC 6 in 1997. The results from the DEA approach demonstrate that the Central and Vicinity regions have a negative and significant impact on the technical efficiency of exporting SMEs and SITC 5 in 1997 and medium-sized enterprises, exporting SMEs, SITC 5 in 2007 (see Table 7.6).

7.3.1.5.3 Northern Region

From Table 7.6, the empirical results from SFA for the Northern region present significant and negative signs for aggregate manufacturing SMEs, small enterprises, domestic SMEs, SITC 2, SITC 6, SITC 7 and SITC 8 in 1997, and SITC 8 in 2007. The results from DEA for location in the Northern region are found to have significant and negative signs for small enterprises and SITC 8 in 1997. This indicates that location in the Northern region has a positive and significant relationship with SME technical efficiency in these categories. The Northern region had 311,681 SMEs equivalent to 17 percent of all SMEs on average during 1994 to 2008 (OSMEP, (2001-2008)). On the other hand, empirical evidence from SFA reveals that location in the Northern region had a positive and significant sign for medium-sized enterprises and SITC 5 in 1997 and in almost all categories of manufacturing SMEs in 2007. The results from DEA for the Northern region show positive and significant signs for medium-sized enterprises, exporting SMEs and

SITC 5 in 1997 and across all SME categories in 2007. Thus, it can be stated that the positive signs imply that location in the Northern region has a negative and significant relationship with SME technical efficiency in these categories. This suggests noticeable regional disadvantage for manufacturing firms located in this region.

7.3.1.5.4 North-eastern Region

In Table 7.6, the empirical results from SFA for the North-eastern region exhibit negative and significant signs for SITC 6, SITC 7 and SITC 8 in 1997 and SITC 0 in 2007. The results from DEA show a negative and significant sign for SITC 0, SITC 6, SITC 7 and SITC 8 in 1997. The negative signs imply that location in the North-eastern has a positive and significant correlation with the technical efficiency of these categories. The North-eastern region has the highest population in the country and occupies the largest land area in the nation (ONRCT, 2012). However, the results from SFA indicate a positive and significant sign for aggregate manufacturing SMEs, small, medium, domestic SMEs and SITC 1 and in almost all categories of manufacturing SMEs. The results from DEA exhibit a positive and significant sign for medium-sized enterprises, exporting SMEs and SITC 5 in 1997, across all manufacturing SME categories in 2007. Hence, the positive signs reveal that location in the North-eastern region is negatively related to technical efficiency, again suggesting major locational disadvantage for manufacturing SMEs in regional Thailand when it comes to technical efficiency.

7.3.1.6 Types of Ownership

7.3.1.6.1 Individual Proprietor Ownership

From Table 7.6, empirical evidence from both SFA and DEA for the type of manufacturing SME ownership (individual proprietor, juristic partnership, public and limited company) presents expected and negative signs for almost all categories of SMEs in the period 1997 and 2007, with the exception of SITC 7 for individual proprietor for the case of the SFA approach. The results from both SFA and DEA indicate that individual proprietor has a positive and significant relationship with the technical efficiency of almost all categories of manufacturing SMEs. The advantages of being an individual proprietorship are as follows: (1) complete control within the parameters of the law and decision-making power over a business, (2) an inexpensive and easy form of starting a business, and (3) absolute authority over business decisions (Ward and Dolan, 1998; Buranajarukorn, 2006; Cooper and Dunkelberg, 2006; Fernández and Nieto, 2006; Ha, 2006).

7.3.1.6.2 Juristic Partnership Ownership

Both SFA and DEA confirm that the juristic partnership form of ownership in 1997 and 2007 was positively and significantly related with SME technical efficiency in all SME categories (see Table 7.6). As compared to an individual proprietorship, a juristic partnership has the benefits of allowing the owner to draw on resources and expertise of co-partners. It can be easily formed by an oral agreement between two or more people. Within a juristic partnership, partners share risk and management and jointly solve barriers to doing business (Cooper and Dunkelberg, 2006; Fernández and Nieto, 2006; Ha, 2006).

7.3.1.6.3 Limited and Public Limited Companies

The empirical results from both SFA and DEA specify that limited and public limited companies are positively and significantly related to technical efficiency in all SME categories (see Table 7.6). A number of studies have emphasised the advantages of limited and public limited companies: (1) it has a legal existence which separates management from shareholders, (2) it can continue despite the resignation or bankruptcy of management and its members, and (3) members can draw up their own contract that allows flexibility in responsibility and management. They also have greater access to finance that can facilitate firm growth and development (Cooper and Dunkelberg, 2006; Fernández and Nieto, 2006; Ha, 2006).

7.3.1.6.4 Government and State Ownership

In 1997, the empirical results from SFA for government and state ownership reveal negative and significant signs for aggregate manufacturing SMEs, small, medium, domestic SMEs, SITC 0, SITC 6 and SITC 7 in 1997, and SITC 1 and SITC 5 in 2007. The results from DEA also show negative and significant signs for aggregate manufacturing, small, medium, domestic SMEs, SITC 0 and SITC 6 in 1997, and in exporting SMEs, SITC 0, SITC 1 and SITC 5 in 2007. This reveals that government and state ownership has a positive and significant impact on the technical efficiency of these SME categories. On the other hand, empirical evidence from SFA reveals that government and state ownership has a significant and negative relationship with the technical efficiency of aggregate manufacturing SMEs, medium-sized enterprises, domestic SMEs, SITC 2, SITC 6 and SITC 8 in 2007. The results from DEA also indicate that this form of ownership has a negative and significant correlation with the technical efficiency of aggregate manufacturing SMEs, medium enterprises, domestic SMEs, SITC 2, SITC 6 and SITC 8 in 2007.

7.3.1.6.5 Cooperative Ownership

From Table 7.6, both SFA and DEA confirm that cooperative ownership had a positive and significant correlation with technical efficiency in the majority of manufacturing SME categories in 1997 and 2007. The empirical results from SFA demonstrate that cooperative ownership is positively and significantly related to the technical efficiency of aggregate manufacturing, small- and medium-sized enterprises, domestic SMEs, SITC 0, SITC 6 and SITC 8 in 1997 and in aggregate manufacturing, small, medium, domestic SMEs, SITC 0 and SITC 5 in 2007. Empirical evidence from DEA indicates that cooperative ownership has a positive and significant effect upon the technical efficiency of aggregate manufacturing, small- and medium-sized SMEs, domestic, SITC 0, SITC 6 and SITC 8 in 1997, and aggregate manufacturing SMEs, small-sized SMEs, domestic SMEs, SITC 0 and SITC 5 in 2007. The reasons for this would require a more detailed sectoral analysis. A number of studies emphasise the benefits of being a cooperative for the following reasons: (1) a cooperative serves the interest of members rather than the capital invested, (2) shareholders have an equal vote at general meetings regardless of their shareholding or involvement in the cooperative, and (3) it can be considered as one of the most stable forms of business (Cooper and Dunkelberg, 2006; Ha, 2006; Thuvachote, 2007). However, only empirical results from DEA show that cooperative ownership had a negative and significant relationship with the technical efficiency of SITC 5 and SITC 2 in 1997.

7.3.1.7 Foreign Investment

In Table 7.6, the results from both SFA and DEA for foreign investment (via foreign ownership) present expected and significant signs for the majority of manufacturing SMEs in 1997 and 2007. Empirical evidence from SFA indicates that foreign investment is positively and significantly correlated to the technical efficiency of aggregate manufacturing SMEs, small- and medium-sized SMEs, domestic SMEs, SITC 6 and SITC 7 in 1997, and to that of aggregate manufacturing, medium-sized SMEs, domestic SMEs, SITC 2, SITC 5 and SITC 6 in 2007. The empirical results from DEA demonstrate that foreign investment has a significant and positive relationship with the technical efficiency of aggregate manufacturing SMEs, medium-sized SMEs, domestic SMEs, SITC 2, SITC 5 and SITC 6 in 1997 and across all categories of manufacturing SMEs in 2007. Many studies have found that foreign investment (via foreign ownership) has a positive correlation with technical efficiency (Fukuyama *et al.*, 1999; Goldar *et al.*, 2003; Bottasso and Sembenelli, 2004). However, there are unexpected positive signs for SITC 7 in 1997 for the case of DEA, meaning that foreign investment has a potentially negative and significant impact on the technical efficiency of SITC 7.

7.3.1.8 Export Intensity

From Table 7.6, empirical evidence from SFA for export intensity present expected and negative signs for aggregate manufacturing SMEs, small- and medium-sized SMEs, domestic SMEs, SITC 0, SITC 5 and SITC 6 in 1997 and for aggregate manufacturing, small-sized SMEs, domestic, SITC 2 and SITC 5 in 2007. The results from DEA also exhibit expected and negative signs for aggregate manufacturing SMEs, small-sized SMEs, domestic SMEs, SITC 0, SITC 5 and SITC 6 in 1997 and for aggregate manufacturing, small enterprises, SITC 2, SITC 6 and SITC 8 in 2007. The negative signs imply that export intensity has a positive and significant impact upon the technical efficiency of these SME categories. Many empirical studies have found that exporting has a positive association with technical efficiency (Rankin, 2001; Bigsten *et al.*, 2002; Kim, 2003; Granér and Isaksson, 2009; Amornkitvikai and Harvie, 2010), however, this is not supported for all sectors in this study. However, the results from both SFA and DEA show unexpected and positive signs for SITC 7 in 1997. Positive signs indicate that export intensity is potentially negatively related to the technical efficiency of SITC 7.

7.3.1.9 Government Assistance

In Table 7.6, the empirical results from SFA for government assistance (via the Office of the Board of Investment (BOI)) show negative and significant signs for medium-sized enterprises, exporting SMEs and SITC 7 in 1997, and medium-sized enterprises and SITC 1 in 2007. The results from DEA also present negative and significant signs for aggregate manufacturing SMEs, small, medium, domestic and exporting SMEs, SITC 0, SITC 6, SITC 7 and SITC 8 in 1997 and for aggregate manufacturing, small- and medium-sized SMEs, domestic SMEs, SITC 1, SITC 5, SITC 6, SITC 7 and SITC 8 in 2007. Negative signs imply that government assistance has a positive and significant relationship with technical efficiency. A number of empirical studies have found that government assistance has a positive and significant impact upon a firm's technical efficiency (Vu, 2003; Tran *et al.*, 2008; Le and Harvie, 2010). However, this is not supported for all sectors in this study.

7.4 INTERPRETATION AND POLICY IMPLICATIONS

Firm-specific factors contributing to technical efficiency or inefficiency provide enlightening results. The empirical results from the SFA approach for firm size are quite variable across the manufacturing SME categories and across 1997 and 2007. Small-sized SMEs are found to be more efficient than medium sized SMEs in aggregate manufacturing, domestic SMEs, SITC 0 and SITC 7 in 1997 and in aggregate manufacturing SMEs, domestic SMEs, SITC 0, SITC 1, SITC 6 and SITC 8 in 2007. Small-sized SMEs benefit from having greater flexibility in adjusting and diversifying their activities in the wake of market changes, which can improve their business performance (Biggs, 2002; Yang and Chen, 2009; Le, 2010). These results suggest that policy should encourage the growth and development of new manufacturing SMEs by improving their technology, innovation and entrepreneurial capacity.

On the other hand, the SFA approach finds that for export-intensive SMEs, small-sized SMEs are less technically efficient than medium-sized enterprises in

1997. Medium-sized SMEs are able to obtain new technology faster than small-sized SMEs and are in a stronger position to enter export markets, because they have less capital constraints (Lundvall and Battese, 2000; Admassie and Matambalya, 2002; Yang, 2006; Tran *et al.*, 2008). This result would suggest that policy should also encourage an increase in firm size, specifically for exporting SMEs, so that they can gain benefits in terms of economies of scale and scope over small firms, which can lead to a reduction in production costs and result in greater competitiveness in domestic and international markets (Kim, 2003; Phan, 2004; Amornkitvikai and Harvie, 2011; OECD, 2011).

Empirical evidence from the DEA approach is more definitive. Medium-sized SMEs are more technically efficient than small-sized SMEs for almost all categories of manufacturing SMEs in the periods 1997 and 2007, except for SITC 7 in 1997. Increased firm size and growth, therefore, needs to be encouraged, since larger size can result in economies of scale and scope, reduced production costs, improved efficiency and competitiveness (Phan, 2004; Le, 2010; Amornkitvikai, 2011). This has important policy implications in terms of access to inputs including finance and skilled labour to facilitate firm growth[4].

Empirical results from the SFA approach indicate that firm age is important for the technical efficiency of aggregate manufacturing SMEs, medium-sized enterprises, exporting SMEs, SITC 5, SITC 6 and SITC 8 in 1997 and aggregate manufacturing SMEs, small and medium-sized enterprises, domestic SMEs, SITC 0 and STIC 5 in 2007. The empirical evidence from the DEA approach indicates that firm age has a significant and positive correlation with the technical efficiency of aggregate manufacturing SMEs, small-and medium-sized enterprises, domestic and exporting SMEs, SITC 2, SITC 5, SITC 6 and SITC 8 in 1997 and for aggregate manufacturing, small-and medium-sized SMEs, domestic SMEs, SITC 0, SITC 1 and SITC 5 in 2007.

However, empirical evidence from the SFA approach exhibits that firm age had a negative and significant impact on the technical efficiency of SITC 1 in 1997, and SITC 2 and SITC 6 in 2007. The empirical results from the DEA approach show

[4] The second Thai SME promotion plan (2007-2011) aimed to create a conducive environment which would increase the number of new entrepreneurs, and support entrepreneurs to enhance their performance and create business value in order to compete in niche markets (OSMEP, 2007).

that firm age is negatively and significantly related to the technical efficiency of SITC 6 in 2007. Consequently, firm longevity does not guarantee improved technical efficiency. The major exceptions to this are SITC 1, SITC 2 and SITC 6. The latter could be a reflection of the fact that with rapidly changing technology and market demand in some sectors, and the growth of high tech firms, the age of a firm is not necessarily an advantage in these categories. For some sectors, firm age and experience may actually impact negatively upon technical efficiency, and this is most likely to be the case in those sectors where technology, products and processes change rapidly. In these circumstances, continual updating of knowledge and technology, as well as the encouragement of new market entrants could be key policy strategies. It suggests that older firms can have an advantage over younger firms in some sectors where superior management experience and knowledge, learning-by-doing, and possessing advanced technology lock-in and equipment are important sources of competitiveness (Pasanen, 2006; Amornkitvikai and Harvie, 2010; Le and Harvie, 2010). However, younger firms have the advantage in sectors where rapidly developing technology and market demands make flexibility and adaptability the key to competitiveness. The results presented for both the SFA and DEA suggest, however, that the importance of firm age for technical efficiency is quite limited.

The empirical results from SFA indicate that a higher skilled labour ratio is positively and significantly related to technical efficiency for almost all categories of manufacturing SMEs in the period 2007, including aggregate manufacturing SMEs, small-sized SMEs, domestic SMEs, SITC 0, SITC 2, SITC 6 and SITC 8. Empirical evidence from DEA indicates that skilled labour has a significant and positive correlation with the technical efficiency of all categories of manufacturing SMEs in 2007, with the exception of medium-sized SMEs and exporting SMEs for the case of DEA. The negative impact of the skilled labour ratio on technical efficiency is a puzzle for medium-sized SMEs and exporting SMEs. This may be due to a mismatch of labour skills and the capital or technology being used by these categories of SMEs, which have experienced increased dependence on capital in the production process. These results indicate that policy measures, in general, should focus on improving the knowledge and skills of human resources in manufacturing SMEs.

SME policy[5], therefore, should place emphasis on the acquisition of knowledge and skills by the workforce in manufacturing SMEs through the provision of appropriate educational and training facilities (OSMEP, 2007b; OECD, 2011). Without access to a skilled workforce, the improvement in technical efficiency of Thai SMEs will be difficult to achieve.

The importance of location in a municipality for SME technical efficiency is variable. Empirical evidence from the SFA approach demonstrates that municipality is positively and significantly related to the technical efficiency of aggregate manufacturing SMEs, small enterprises, domestic and exporting SMEs and SMEs in sub-sectors SITC 1 and SITC 8 in 1997, but negatively related to technical efficiency for medium-sized SMEs and SITC 7. By 2007, the SFA approach specifies that a municipal location is positively associated with the technical efficiency of all categories of manufacturing SMEs, with the exception of medium-sized SMEs in 2007. The empirical results from the DEA approach indicate that a municipal location has a significant and positive correlation with the technical efficiency of aggregate manufacturing SMEs, small enterprises, exporting SMEs, SITC 5 and SITC 8 in 1997, while a municipal location is negatively related to the technical efficiency of medium-sized SMEs and SITC 0. In 2007, the DEA approach presents that a municipal location is positively and significantly associated with the technical efficiency of all SME categories.

Location in Bangkok is found to be very important for the technical efficiency of most SME categories. Empirical evidence from SFA indicates that the Bangkok area has a positive and significant correlation with the technical efficiency of all categories of manufacturing SMEs in both 1997 and 2007. The empirical results from DEA show that the Bangkok area is significantly and positively related to the technical efficiency of aggregate manufacturing SMEs, small-and medium-sized SMEs, domestic SMEs as well as SMEs in SITC 0, SITC 2, SITC 6, SITC 7 and SITC 8 in 1997. In 2007, DEA indicates that location in Bangkok has a positive and significant correlation with the technical efficiency of aggregate manufacturing SMEs, small-sized SMEs, domestic SMEs, SITC 0, SITC 1, SITC 2, SITC 6, SITC 7 and SITC 8. These results suggest that there are significant agglomeration benefits

---

[5] The second Thai SME promotion plan (2007-2011) aimed to implement strategies that would improve the knowledge and skills base of SME personnel in order to facilitate technology upgrading (OSMEP, 2009).

from urban location, which is likely to make it difficult to encourage SME development in non-municipal or rural areas. This has the potential to further exacerbate the rural-urban income, unemployment and political divide (Yang, 2006; OSMEP, 2007b; Le, 2010; Le and Harvie, 2010), unless specific policy measures are implemented to enhance the development of SMEs in the rural sector.

Furthermore, empirical evidence from the DEA approach presents that a Bangkok location for SITC 5 in 1997 and exporting SMEs in 2007 does not appear to be significantly related to technical efficiency, and in the case of Bangkok the relationship is not of the expected sign. Bangkok appears to provide a good location for domestic market oriented SMEs but not for export oriented SMEs. Therefore, the empirical results from both SFA and DEA approaches indicate that there are clearly many advantages for SMEs based in municipalities, and in Bangkok in particular, that are conducive for technical efficiency. Good infrastructure, knowledge spill-overs, access to skilled workers and a large domestic market are clear advantages of such locations.

The empirical results for location in the Central or Vicinity regions are variable. Empirical evidence from SFA indicates that location in Central or Vicinity regions has a positive and significant effect on the technical efficiency of aggregate manufacturing SMEs, small-sized SMEs, domestic SMEs and SITC 8 in 1997, whereas there is a negative and significant correlation between the technical efficiency of SITC 5 and SITC 6. In 2007, the SFA approach shows that Central or Vicinity regions is positively and significantly related to the technical efficiency of medium-sized SMEs and SITC 1. The empirical results from the DEA approach indicate that location in the Central or Vicinity regions offers benefits for the technical efficiency of aggregate manufacturing SMEs, small-sized enterprises, domestic SME, SITC 0, SITC 2 and SITC 8 in 1997, location in these regions is negatively related to the technical efficiency of exporting SMEs and SITC 5. In 2007, the DEA approach indicates that Central or Vicinity regions are positively and significantly associated with the technical efficiency of aggregate manufacturing SMEs, small-sized SMEs, domestic SMEs, SITC 0, SITC 1 and SITC 8, whereas medium-sized SMEs, exporting SMEs and SITC 5 have a negative and significant correlation between their technical efficiency and location in these regions in 2007. Thus, the empirical results from the DEA-approach indicate that manufacturing

SMEs located in Central or Vicinity regions appear to be at a technical efficiency disadvantage if they were export intensive and operated in SITC 5 in 1997, and were medium-sized enterprises, exporting SMEs, and operating in SITC 5 in 2007.

A notable problem relates to the technical efficiency of manufacturing SMEs located in the Northern and North-eastern regions. The results from the SFA approach indicate that aggregate manufacturing SMEs, small-sized SMEs, domestic SMEs, SITC 2, SITC 6, SITC 7 and SITC 8 SMEs located in the Northern region had a significant and positive relationship with technical efficiency, while medium-sized SMEs and those in SITC 5 had a significant and negative relationship with technical efficiency in 1997. The situation changed completely by 2007, when almost all categories of SMEs located in the Northern region had a significant and negative association with technical efficiency, with the exception of SITC 8 in 2007. The empirical results from the DEA approach indicate that the Northern region has a positive and significant correlation with the technical efficiency of small-sized SMEs and SITC 8 in 1997, but is negatively and significantly related to the technical efficiency of medium-sized SMEs, exporting SMEs and SITC 5. In 2007, the DEA approach signifies that the Northern region has a negative and significant correlation with the technical efficiency of all categories of manufacturing SMEs.

For the North-eastern provinces, empirical evidence from the SFA approach indicates that SMEs in SITC 6, SITC 7 and SITC 8 had a positive correlation with technical efficiency, while aggregate manufacturing SMEs, small-and medium-sized enterprises, domestic SMEs and those in SITC 1 had a negative correlation with technical efficiency in 1997. By 2007, the situation had deteriorated. SMEs in almost all manufacturing categories located in the North-eastern provinces had a negative and significant correlation with technical efficiency, with the exception of SMEs in SITC 0. The empirical results from the DEA approach specify that the North-eastern region had a significant and positive correlation with the technical efficiency of SMEs in SITC 0, SITC 6, SITC 7 and SITC 8 in 1997, while location in the North-eastern region was negatively and significantly related to the technical efficiency of medium sized SMEs, exporting SMEs and SITC 5. In 2007, the DEA approach signifies that the North-eastern region is negatively and significantly associated with the technical efficiency of all SME categories.

Thus, empirical evidence from both SFA and DEA concludes that the technical efficiency performance of manufacturing SMEs located in the Northern and North-eastern provinces suggests considerable disadvantage[6]. This needs to be addressed as a matter of priority, in order to identify the specific problems afflicting these regions. From a regional equity perspective it can be recommended that the government give more emphasis to the promotion of SMEs in the regions and localities by: supporting SME networks, promoting local communities and products, encouraging technology upgrading (including that of information and communications technology), enhancing the skills and capabilities of the local workforce and entrepreneurs and improving local infrastructure (OSMEP, 2007b; OECD, 2011). In addition, it is imperative that the Thai government provide assistance such as human resource development, information technology (IT), appropriate supply of quality inputs, market access and better infrastructure if regional SMEs are to enhance their competitiveness, efficiency and growth.

The empirical results from both the SFA and DEA approaches suggest that the type of manufacturing SME ownership (individual proprietor, juristic partnership, public and limited company) are all positively and significantly correlated with technical efficiency for almost all categories of manufacturing SMEs in the periods 1997 and 2007. The only exception to this is SITC 7 in 1997 for individual proprietor for the case of SFA. The public and limited company type of ownership has the largest correlation with the technical efficiency of SMEs in all SME categories, in both 1997 and 2007. From a policy perspective, these results suggest that the government should actively encourage the public and limited type of ownership for SMEs, followed by juristic partnerships and then individual ownership. Increased public and limited ownership, however, can only be achieved if SMEs have greater access to stock markets. But this can be prohibitively expensive for small-sized SMEs in particular. Reducing the costs of this type of ownership should be addressed. This type of ownership, therefore, has the potential to facilitate greater access to finance and other resources for medium-sized SMEs in particular, which can facilitate their access to capital, technology and skilled labour and enable them to

---

[6] This finding is consistent with the SME promotion plan for 2007 to 2011, which contains strategies to promote SMEs in the regions and localities; support the creation of networks and connectivity of SMEs in the regions; encourage their employment of technology; and develop their capabilities and business management skills (OSMEP, 2007b).

achieve faster growth, benefit from economies of scale and scope and improve their technical efficiency. Government policy should also focus on encouraging greater access to financial markets by SMEs to encourage limited and public limited forms of ownership through initial public offerings (IPOs), which will also facilitate the growth and size of SMEs. Encouraging the juristic and individual types of ownership is more prevalent for small-sized SMEs. Policy should ensure that the costs of establishing these types of firm ownership are reduced and that adequate funding is available for new firm start-ups and entrepreneurs. In this context, the establishment of venture capital markets would be important (OSMEP, 2007b; OECD, 2011).

Furthermore, it is suggested that an SME development strategy should focus more on a private sector development strategy, because government polices to support SMEs may be underprovided in distorted and segmented markets. The public sector plays an important role in sustaining an equitable pattern of economic, social and SME development. The government should provide policies concerning a durable collaboration between public and private sectors, such as the promotion of SME growth and integration, cross-border linkages and on-going learning and innovation. The public and private partnership program should apply to the provision of SME development services and is equally applicable in other contexts (Asasen *et al.*, 2003; OSMEP, 2007b; Hussain *et al.*, 2009; OECD, 2011).

The empirical results from the SFA approach indicate that government and state ownership of SMEs has a positive and significant correlation with the technical efficiency of aggregate manufacturing SMEs, small-and medium-sized SMEs, domestic SMEs, and SMEs in SITC 0, SITC 6 and SITC 7 in 1997, and for SITC 1 and SITC 5 in 2007. However, this form of ownership had a significant and negative relationship with technical efficiency for aggregate manufacturing SMEs, medium enterprises, domestic SMEs, SITC 2, SITC 6 and SITC 8 in 2007.

Empirical evidence from the DEA approach demonstrates that government and state ownership had a positive and significant effect on the technical efficiency of aggregate manufacturing SMEs, small-and medium-sized SMEs, domestic SMEs, SITC 0 and SITC 6 in 1997. In 2007, the DEA approach shows that government and state ownership is positively and significantly related to the technical efficiency of exporting SMEs, and SMEs in SITC 0, SITC 1 and SITC 5, whereas there is a negative and significant correlation between the technical efficiency of aggregate manufacturing SMEs, medium-sized SMEs, domestic SMEs, SITC 2, SITC 6 and SITC 8. Hence, the empirical results from the SFA and DEA indicate that the contribution of government and state ownership to SME technical efficiency deteriorated in 2007. This may be due to the fact that with the process of reform, the privatisation of viable enterprises occurred, leaving only the most technically inefficient SMEs in government or state ownership. The most profitable and efficient firms have been sold off, while the least profitable and inefficient firms remained in public ownership.

Empirical evidence from SFA specifies that cooperative ownership had a significant and positive effect upon the technical efficiency of aggregate manufacturing SMEs, small, medium, domestic SMEs, SITC 6, SITC 6 and SITC 8 in 1997. By 2007, SFA reveals that cooperative ownership is positively and significantly associated with the technical efficiency of aggregate manufacturing, small, medium, domestic SMEs, SITC 0 and SITC 5. The empirical results from DEA indicate that cooperatives have a significant and positive impact on the technical efficiency of aggregate manufacturing, small, medium, domestic, SITC 0, SITC 6 and SITC 8 SMEs and those in SITC 2 and SITC 5 had a negative correlation with technical efficiency in 1997. In 2007, DEA shows that cooperatives are positively and significantly related to the technical efficiency of aggregate manufacturing, small enterprises, domestic SMEs, SITC 0 and SITC 5. Thus, it can be suggested that government policy can usefully support the development of SME cooperatives in all categories of manufacturing SMEs. From a policy perspective, encouraging the cooperative ownership of SMEs in the rural sector and regional areas in targeted types of activity could be beneficial for SME technical efficiency (OSMEP, 2007a; OSMEP, 2007b; OECD, 2011).

Empirical results from the SFA approach indicate that foreign investment in local SMEs is found to have a significant and positive relationship with the technical efficiency of aggregate manufacturing SMEs, small, medium, domestic SMEs, SITC 6 and SITC 7 in 1997, and aggregate manufacturing, medium, domestic SMEs, SITC 2, SITC 5 and SITC 6 in 2007. The results from the DEA approach reveal that foreign investment had a positive and significant correlation with the technical efficiency of aggregate manufacturing, medium, domestic SMEs, SITC 2, SITC 5 and SITC 6 in 1997, but a negative and significant impact on the technical efficiency of SMEs in SITC 7. In 2007, DEA shows that foreign investment is positively and significantly correlated to technical efficiency across all categories of manufacturing SMEs. Consequently, these results suggest that from a policy perspective foreign ownership has the potential to improve SME technical efficiency and it should be encouraged, but it needs to be targeted to have the biggest impact on SME technical efficiency, as not all SMEs in all categories necessarily benefit from it. The government should, however, continue to relax foreign ownership controls and encourage foreign investment in Thai SMEs in an attempt to promote technological upgrading, managerial skills and knowledge, good corporate governance and good networking with foreign markets (Okuda and Rungsomboon, 2006; Kimura and Kiyota, 2007; Amornkitvikai and Harvie, 2011).

Empirical evidence from the SFA approach indicate that export intensity is positively and significantly correlated to the technical efficiency of aggregate manufacturing SMEs, small, medium, domestic SMEs, SITC 0, SITC 5 and SITC 6 in 1997, but negatively related to the technical efficiency of SMEs in SITC 7. By 2007, SFA shows that export intensity has a positive and significant impact upon the technical efficiency of aggregate manufacturing, small, domestic, SITC 2 and SITC 5. The empirical results from DEA reveal that export intensity had a positive and significant association with the technical efficiency of aggregate manufacturing, small, domestic SMEs, SITC 0, SITC 5 and SITC 6 in 1997, whereas there is a negative and significant correlation with the technical efficiency of SITC 7. In 2007, DEA shows that there is a positive and significant correlation between the technical efficiency of aggregate manufacturing, small, SMEs operating in SITC 2, SITC 6 and SITC 8 in 2007. These results also suggest that policy should focus on creating higher value-added activity in manufacturing SMEs, enhance quality standards and the capability of SMEs to meet market demands, increase differentiation and the competitiveness of SMEs, particularly in industrial products (OSMEP, 2007b). Government policy should also encourage greater export activity through encouraging higher value added activities, enhancing quality standards and the international competitiveness of these SMEs (OSMEP, 2007b; OECD, 2011; Reynolds and Curtin, 2011).

Finally, the empirical results from the SFA approach signify that government assistance via BOI is found to have had a significant and positive effect on the technical efficiency of medium sized SMEs, exporting SMEs and SITC 7 in 1997. In 2007, government assistance had a significant and positive relationship with the technical efficiency of medium-sized enterprises and SITC 1. Empirical evidence from the DEA approach indicates that government assistance is positively and significantly related to the technical efficiency of aggregate manufacturing SMEs, small and medium sized SMEs, domestic and exporting SMEs, and SMEs in SITC 0, SITC 6, SITC 7 and SITC 8 in 1997. In 2007, government assistance has a significant and positive effect upon the technical efficiency of the majority of manufacturing SMEs, including aggregate manufacturing SMEs, small and medium sized enterprises, domestic SMEs, SITC 1, SITC 5, SITC 6, SITC 7 and SITC 8. Thus, the empirical results from the SFA and DEA approaches suggests that a policy priority of improving the technical efficiency performance of manufacturing SMEs will require a major overhaul of existing policy measures, and the adoption of a more targeted approach. Some of the results presented previously can provide solid guidance as to what factors need to be addressed by appropriate policy measures.

7.5 SUMMARY

This chapter has compared empirical results obtained from the technical inefficiency effects model (SFA) and a Tobit model (DEA) aimed at analysing their robustness. This chapter has investigated firm-specific factors and explanatory variables influencing the technical inefficiency of Thai manufacturing SMEs in the periods 1997 and 2007 in six categories. These categories of manufacturing SMEs were estimated individually, to examine the question of whether technical efficiency is positively or negatively related to firm-specific factors. The empirical evidence from the SFA approach suggests that small-sized SMEs are likely to be more technically efficient than medium-sized SMEs for the majority of SME categories in 1997 and 2007. On the other hand, the empirical evidence from the DEA approach signify that medium-sized SMEs are found to be more technically efficient than small-sized SMEs for all manufacturing SME categories in 1997 and 2007.

Empirical results from the SFA and DEA approaches conclude that firm age can be correlated with technical efficiency but that these results are not universal for all SME categories. Skilled labour is a consistently important variable for SME technical efficiency, with the surprising exception of medium-sized SMEs and exporting SMEs. There also appear to be location factors involved in SME technical efficiency. Location in a municipality (town or city), and in particular Bangkok, carries with it major advantages for the attainment of technical efficiency. On the other hand, location in regional and rural areas presents SMEs with challenges in terms of technical efficiency. A more proactive regional development policy will be required to tackle factors contributing to regional growth and development disparities, particularly in the context of SME technical efficiency.

All forms of SME ownership are statistically significantly correlated with technical efficiency. The limited and public limited form of ownership produces the biggest benefit for technical efficiency, but accessing stock markets is costly and beyond the reach of many small SMEs which make up the majority of SMEs. The results for government and state ownership are mixed, while cooperative ownership appears to be still important for both small- and medium-sized SMEs and for a number of SME categories including those firms involved in rural sector activities. Foreign investment can bring with it advantages in terms of new technology, managerial skills and market opportunities, but this tends to be outside the realms of possibility for the vast majority of SMEs. Engaging in export activity can also produce beneficial outcomes for manufacturing SMEs, but this is restricted to a relatively small number of firms and these tend to be of medium size. The costs of participating in export activity can be prohibitively high and risky for many small SMEs whose owners lack the necessary knowledge and experience.

This chapter has provided valuable policy implications based upon the empirical evidence of the effect of firm-specific factors on the technical efficiency of Thai manufacturing SMEs. To improve the technical efficiency performance of Thai manufacturing SMEs, specific policy emphasis should be placed on: (1) increasing the size of manufacturing SMEs by increasing their access to finance and other resources so that they can benefit from economies of scale and scope. Targeted financial and other assistance to SMEs in sub-manufacturing sectors would also be appropriate, (2) encouraging access to and continual updating of the knowledge base and technology of existing SMEs and encourage new SME start-ups, (3) ensuring an adequate pool of skilled workers to meet the needs of SMEs. The latter will be critical as the current relatively high price of such labour will encourage the usage of lower cost unskilled labour and lower quality capital and associated technology. This will simply maintain SME activities in low skill low value adding activities, (4) addressing regional and rural sector disadvantages which create inequity in SME operations and impede the attainment of technical efficiency (e.g. via improving infrastructure, upgrading technology acquisition and especially that of information and communication technology (ICT)), (5) encouraging diversity in SME ownership, particularly that of public and limited ownership, which will require great access to stock markets and investors, and encouraging cooperative ownership in the rural sector and in the regions, (6) providing knowledge and information on market opportunities, improving the quality and competency of SME employees and entrepreneurs, and providing greater regional development equity through extensive regional infrastructure development, (7) continuing the process of privatisation of manufacturing SMEs, (8) encouraging foreign investment in general but target this, wherever possible, towards medium-sized SMEs operating in key sectors, (9) encouraging greater export activity by small SMEs and particularly SMEs in key sectors, and (10) conducting a major overhaul of existing SME policy measures so that they are more targeted and capable of meeting the specific needs of both small- and medium-sized SMEs and broader manufacturing sectors in the economy, and, therefore, more likely to produce better technical efficiency outcomes (Brimble *et al.*, 2002; Huang, 2003; Mephokee, 2003; Arunsawadiwong, 2007; OSMEP, 2007b; OSMEP, 2008; Le, 2010; OECD, 2011; Reynolds and Curtin, 2011).

Furthermore, the government should place more focus upon the encouragement of public and private partnerships at the local level, in order to 1) improve the business environment for SMEs with continual monitoring and assessment of existing policy measures and enhancing the effectiveness of their delivery, 2) expand the coverage and the impact of government programs by utilising the private sector to distribute services, and focus on scarce public resources in an attempt to facilitate market transactions and 3) invest in public goods with major positive externalities (Hallberg, 2000; Asasen *et al.*, 2003; Harvie and Lee, 2005b; Hussain *et al.*, 2009; OECD, 2011; Reynolds and Curtin, 2011). In addition, ensure that relevant government agencies have the requisite support, unity of purpose and knowledge to effectively carry out these policy measures.

The next, and final, chapter will present and discuss the major conclusions from the thesis, limitations of this study and possibilities for future research.

CHAPTER 8
CONCLUSIONS

8.1 INTRODUCTION

The importance of small- and medium-sized enterprises (SMEs) to the economic and social development of developing, emerging market and developed economies is increasingly recognised in the literature. An entrepreneurially vibrant, innovative and efficient SME sector can provide a solid foundation for sustainable growth and development. In the context of Thailand, SMEs have also played a pivotal role in accelerating the country's economic and social development. In this context, it is a moot point to analyse whether the performance of the SME sector in the wake of the Asian financial and economic crisis of 1997 and subsequent reforms has improved. The measure of SME performance used throughout this thesis has been that of technical efficiency.

The primary motivation of this thesis has, therefore, been to measure, compare and analyse the technical efficiency performance of Thai manufacturing SMEs in the pre-(before 1997) and post-(after 2007) Asian financial crisis periods. Such an empirical analysis has not been conducted previously for Thai manufacturing SMEs. The main research objectives of this thesis have been to: (1) empirically estimate the level of technical efficiency of Thai manufacturing SMEs in the periods 1997 and 2007 in six categories: by aggregate manufacturing SMEs; by small-sized firms; by medium-sized firms; by domestic market intensity; by export intensity; and by sub-manufacturing sectors classified by the Standard International Trade Classification (SITC) Revision 4 (see Section 6.5 of Chapter 6), (2) empirically examine firm-specific factors and explanatory variables influencing the technical inefficiency of Thai manufacturing SMEs in 1997 and 2007 for each of the above six categories (see Section 7.3 of Chapter 7). Firm-specific factors contributing to the technical inefficiency of Thai manufacturing SMEs were drawn from the literature and include: firm size; firm age; skilled labour; firm location; region location; type of ownership; foreign ownership or investment; export intensity; and government assistance (via the Broad of Investment (BOI)), and (3) identify appropriate policies to improve the technical efficiency performance of Thailand's manufacturing SMEs (see Section 6.5 of Chapter 6).

The major research questions emphasised in relation to the above main research objectives have been: (1) how do Thai manufacturing SMEs in in the pre-(1997) and post-(2007) Asian financial crisis periods perform in terms of technical efficiency?; (2) how can the overall technical efficiency performance of Thai manufacturing SMEs be improved?; and (3) what are the firm-specific factors contributing to the technical efficiency of Thai manufacturing SMEs in the pre-(1997) and post-(2007) Asian financial crisis periods?

A number of sub-research questions can be derived from the three major research questions above as follows: (1) how does firm size influence the technical efficiency performance of Thai manufacturing SMEs?; (2) how does firm age impact upon the technical efficiency of Thai manufacturing SMEs?; (3) how does the employment of skilled labour affect the technical efficiency of Thai manufacturing SMEs?; (4) how important is location (i.e., municipal and Bangkok areas, Central and Vicinity regions, Northern and North-eastern regions) for manufacturing SME technical efficiency?; (5) how do various types of manufacturing SME ownership (individual proprietor, juristic partnership, public and limited company) affect the technical efficiency of Thai manufacturing SMEs?; (6) how does government and state ownership influence the technical efficiency of Thai manufacturing SMEs?; (7) how does cooperative ownership impact upon the technical efficiency of Thai manufacturing SMEs?; (8) how does foreign ownership or investment affect the technical efficiency of Thai manufacturing SMEs?; (9) how does exporting influence the technical efficiency of Thai manufacturing SMEs?; (10) how does government assistant (via the Board of Investment (BOI)) impact on the technical efficiency of Thai manufacturing SMEs?; and (11) how can Thai government policy towards manufacturing SMEs be made to improve the efficiency and competitiveness readiness of Thai manufacturing SMEs?

The remainder of this chapter proceeds as follows. In the following section, a summary of the major contributions of this thesis to the literature is provided. Section 8.3 summarises the major findings relating to the major research questions and the sub-research questions identified for this thesis in chapter 1. Finally, limitations of the current study and suggestions for further research are presented in Section 8.4.

8.2 CONTRIBUTION TO THE LITERATURE

The thesis has made several significant contributions to the study of Thai manufacturing SMEs and their performance as follows: (1) this thesis is the first empirical study using firm-level data from the 1997 and 2007 industrial censuses conducted by the National Statistical Office of Thailand (NSO) of Thailand to apply data envelopment analysis (DEA) and stochastic frontier analysis (SFA) approaches. Only the study of Arunsawadiwong (2007) utilise aggregate industrial-level data from Thai manufacturing surveys for the period 1990 to 2002, and by doing so found that utilising the SFA approach the overall technical efficiency of the Thai manufacturing sector improved in the post-crisis period. This thesis, using firm-level data, has found that by introducing firm size into the analysis the results can be different. Thus, this is a major contribution of this study, (2) the thesis is the first empirical study to measure and compare the technical efficiency of Thai manufacturing SMEs in the pre-(1997) and post-(2007) financial crisis periods using the most substantive and the most recently available cross-sectional firm-level data from 1997 and 2007 industrial censuses, (3) the thesis is the first empirical study to identify significant firm-specific factors and explanatory variables contributing to the technical inefficiency (or efficiency) of Thai manufacturing SMEs in 1997 and 2007, covering six categories: by aggregate manufacturing; by small; by medium; by SME export intensity; by domestic market intensity; and by sub-manufacturing sectors, (4) this thesis is the first empirical study to employ the SFA approach and two-stage DEA approach (a two-limit Tobit model) to estimate and compare the technical efficiency performance of Thai manufacturing SMEs in the periods 1997 and 2007 for each of the above six categories, (5) the thesis evaluates and analyses the technical efficiency performance of SMEs in the manufacturing sector of Thailand, and how this has changed since the financial and economic crisis of 1997, (6) it highlights the role, contribution and significance of SMEs in Thailand's manufacturing sector to the economic development of the Thai economy, and how this contribution could be made even more effective in the future, (7) the thesis identifies the key barriers, challenges and capacity constraints impacting upon the performance of Thai manufacturing SMEs in terms of technical efficiency specifically, (8) the thesis provides empirical evidence of the competitiveness readiness of Thai manufacturing SMEs, as measured by their technical efficiency, and key areas of weakness that will need to be tackled to facilitate a more effective participation of Thai manufacturing SMEs in both the domestic and international market place, (9) the thesis provides evidence-based guidelines for SMEs policy-makers in Thailand on how to make SME-related policies more effective in enhancing the technical efficiency of Thai manufacturing SMEs, and (10) the research findings of the thesis will provide guidelines for SME policy makers in Thailand to make SME-related policies more effective in achieving desired industrial restructuring, employment growth, export growth, regional development, alleviation of poverty, economic growth and effective SME participation in the increasingly integrated regional and global economies.

8.3 KEY RESEARCH FINDINGS

8.3.1 Findings for the Major Research Questions

In chapter 1 of this thesis, three major research questions and eleven sub-research questions were highlighted as the focus of this study. The three major research questions focus upon estimating and comparing the technical efficiency performance of Thai manufacturing SMEs in the periods 1997 and 2007, examining the significance of firm-specific factors contributing to the technical inefficiency performance of SMEs, as well as identifying key policy priorities for Thai policy makers concerned with enhancing the technical efficiency performance of Thailand's manufacturing SMEs. The key results for these research questions are summarised in an appendix and now briefly discussed:

How do Thai manufacturing SMEs in the pre-(1997) and post-(2007) Asian financial crisis periods perform in terms of technical efficiency?

In answering this question, the SFA approach and two-stage DEA approach (a Tobit model) were utilised. The analysis was carried out using cross-sectional firm-level data from industrial censuses conducted in 1997 and 2007 by the NSO of Thailand. Data for twelve categories of Thai manufacturing SMEs were used to individually measure their technical efficiency, as presented in Section 5.2 of Chapter 5. The empirical results from the SFA and DEA approaches indicate that the overall weighted average technical efficiency scores of Thai manufacturing SMEs based on the DEA approach are much higher than that obtained from the SFA approach in the period 1997 and 2007, as shown in Section 6.5 of Chapter 6. The main reasons are that the SFA approach can make the adjustments for a statistical noise and the cause of a statistical noise may come from the misspecification of a stochastic frontier production function.

However, the SFA and DEA approaches produced similar results, in that the overall weighted technical efficiency scores in all categories of Thai manufacturing SMEs decreased in the post-crisis (2007) period as compared to the pre-crisis (1997) period, as presented in Section 6.5 of Chapter 6. According to the overall weighted technical efficiency scores predicted by the SFA and DEA approaches, Thai manufacturing SMEs in both 1997 and 2007 operated at a low level of technical efficiency, specifying a high degree of technical inefficiency in their operation, as presented in Section 6.5 of Chapter 6. It is also indicated that the technical efficiency performance of most categories of manufacturing SMEs deteriorated in 2007, with no apparent improvement in firm productivity and efficiency. The policy measures implemented in the wake of the financial and economic crisis of 1997 aimed at improving the technical efficiency of SMEs appear, therefore, to have been largely ineffective.

The empirical evidence from both estimation approaches revealed inconsistent results in terms of types of returns to scale. Findings from the SFA approach indicated that almost all categories of Thai manufacturing SMEs experienced increasing returns to scale (IRS) in 2007 as compared to constant returns to scale (CRS) in 1997. By contrast, the DEA approach indicated that all categories of Thai manufacturing SMEs have been operating under decreasing returns to scale (DRS) in both 1997 and 2007. Thus, it can be concluded that the results of types of returns to scale from both SFA and DEA approaches are found to be inconclusive, as shown in Section 6.5 of Chapter 6.

The SFA approach indicates a high labour input elasticity in all categories of Thai manufacturing SMEs in the pre-(1997) and post-(2007) crisis periods, and the dependence on labour input in the production process by manufacturing SMEs in all categories. The low capital input elasticity in all SME categories in 1997 and 2007 indicates that capital is less important in production. Thai manufacturing SMEs in both 1997 and 2007 relied upon labour intensive technology using unskilled labour in low value-adding activities, and this pattern intensified in the post-crisis period, as shown in Section 6.4.1 of Chapter 6. These results suggest that the deterioration in technical efficiency across most SME categories has been due to the adoption of inappropriate factor proportions in production, with too much reliance on low-cost unskilled workers rather than investment in higher-cost capital and technology and employment of high-cost skilled workers.

As a middle income economy Thailand needs to move to more knowledge and skill intensive areas of activity. It cannot continue to rely on low labour costs as the key source of competitiveness. This will hold back the country's further development. Policy will require the provision of more skilled workers, in conjunction with greater access to capital and technology by SMEs. A critical policy issue will be how best to facilitate and encourage the uptake of capital and technology in SME production with the objective of enhancing technical efficiency.

How can the overall technical efficiency performance of Thai manufacturing SMEs be improved?

The second major research question aims to identify key policy priorities for Thai policy makers concerned with enhancing the technical efficiency of Thailand's manufacturing SMEs. From the empirical results discussed in Section 8.2.1.1, a number of evidence-based policy implications and recommendations can be obtained. While the importance of firm size for technical efficiency appears to be ambiguous, there is no doubt that there is a need to encourage more entrepreneurial activity in Thailand, irrespective of whether this relates to the establishment of new enterprises or encouraging the growth of existing enterprises. How to encourage more and better entrepreneurial activity, therefore, should be a high policy priority.

A firm's technical efficiency can be increased from an improvement in the education and skill of the labour force. Therefore, it is suggested that selective policy interventions could be useful in improving SME efficiency, SME development, and employment creation (Admassie and Matambalya, 2002; Batra and Tan, 2003; Le, 2010; Charoenrat and Harvie, 2011). SMEs need a more skilled labour force that will enable usage of technology, enable them to become more innovative, and that will give them a competitive edge in the national and regional marketplace.

From a policy perspective, based upon the empirical results summarised above, it is recommended that the Thai government encourage the development of manufacturing SMEs through: (1) improving input efficiencies to enable firms to operate on their most efficient production frontier given the current state of technology, (2) shifting the existing frontier outward through utilisation of improved technology, (3) providing greater market access, greater access to credit facilities, promoting the utilisation of information and communication technology (ICT), and providing financial assistance to avoid management risks and financial problems, (4) providing appropriate targeted financial and other assistance to SMEs in sub-manufacturing sectors (5) encouraging greater usage of capital and technology in the production process of SMEs, (6) encouraging access to and continual updating of the knowledge base and technology of existing SMEs and encourage new SME start-ups, (7) providing knowledge and information on market opportunities, and improving the quality and competency of SME employees and entrepreneurs, (8) upgrading skills by means of targeted training programs for employees and entrepreneurs, (9) ensuring an adequate pool of skilled workers to meet the needs of SMEs. This will be critical as the current relatively high price of such labour will encourage the usage of lower cost unskilled labour and lower quality capital and associated technology. This will simply maintain SME activities in low-skill, low value-adding activities; and (10) ensuring that relevant government agencies encourage and facilitate innovative activity through firm collaboration and networking.

Furthermore, conduct a major overhaul of existing SME policy measures so that they are more targeted and able to meet the specific needs of both small- and medium-sized SMEs and broader manufacturing sectors in the Thai economy, and, therefore, more likely to produce better technical efficiency outcomes. In addition, ensure that relevant government agencies have the requisite support, unity of purpose and knowledge to effectively carry out these policy measures.

What are the firm-specific factors contributing to the technical efficiency of Thai manufacturing SMEs in the pre-(1997) and post-(2007) Asian financial crisis periods?

The third major research question aims to identify firm-specific factors influencing the technical inefficiency of Thai manufacturing SMEs in the periods 1997 and 2007. The major findings from this research question are also useful in the conduct of appropriate policy implications and recommendations to improve the technical efficiency performance of Thailand's manufacturing SMEs. The thesis has identified potential firm-specific factors contributing to the technical inefficiency of Thai manufacturing SMEs based upon the literature, these being: firm size; firm age; skilled labour; firm location; type of ownership; foreign ownership or investment; exporting activity; and government assistance.

Using the SFA approach, maximum likelihood estimates of the parameters of the stochastic frontier production and technical inefficiency effects models were estimated simultaneously using the computer programme FRONTIER Version 4.1. With the two-stage DEA approach (a Tobit model) estimates of the output-orientated variable returns to scale (VRS) model were estimated utilising the computer program DEAP Version 2.1. From Section 7.3 of Chapter 7, empirical results from the technical inefficiency effects model (SFA) suggested that small-sized SMEs are more technically-efficient than medium-sized SMEs for the majority of manufacturing categories in 1997 and 2007. In contrast, the two-stage DEA approach indicated that medium-sized SMEs are generally more technically-efficient than small-sized SMEs for all manufacturing SME categories in 1997 and 2007. These ambiguous results indicate the need for further research on the importance of firm size for technical efficiency.

Both approaches find that firm age can be correlated with technical efficiency but these results are not universal for all categories. Access to skilled labour can make a significant contribution to technical efficiency. Location can also contribute to poor technical efficiency, unless firms are located in the more congested and expensive Bangkok area. On the other hand, location in regional and rural areas presents SMEs with challenges in terms of technical efficiency. A more proactive regional development policy will be required to tackle factors contributing to regional growth and development disparities, particularly in the context of SME technical efficiency. All forms of SME ownership are statistically significantly correlated with technical efficiency (Section 7.3 of Chapter 7).

Government and state ownership of SMEs produced mixed results, while cooperative ownership appeared to be significant for both small- and medium-sized enterprises and for a number of SME categories, particularly those firms involved in rural sector activities. The impact of foreign investment on technical efficiency is also mixed, but on balance has an important role to play. Foreign investment can bring with it advantages in terms of new technology, managerial skills and market opportunities, but this tends to be outside the realms of possibility for the vast majority of SMEs. Participation in export activity benefits the technical efficiency of small SMEs and SMEs in some other categories, but does not guarantee improved technical efficiency performance. The costs of participating in export activity can be prohibitively high and risky for many small SMEs whose owners lack the necessary knowledge and experience. Government assistance towards SMEs has a positive and significant association with SME technical efficiency but is likely to be more effective when targeted towards medium-sized and exporting SMEs (Section 7.3 of Chapter 7).

Therefore, the empirical results from the technical inefficiency effects and Tobit model indicate that firm size (economies of scale and scope), age (learning by doing), proportion of workforce which is skilled, location in towns and cities and particularly location in Bangkok, type of ownership, whether limited and public limited companies or juristic partnerships, foreign ownership or investment and export activity, are the important firm-specific factors contributing to the technical efficiency of Thai manufacturing SMEs in both 1997 and 2007.

8.3.2 Findings for the Sub-research Questions

In addition to the analysis of Thai manufacturing SMEs in the periods 1997 and 2007 in six categories as specified above, the thesis has also provided important insights into the technical efficiency performance of manufacturing SMEs, key factors contributing to technical inefficiency and policy priorities to tackle this. This section provides answers to eleven sub-research questions identified in Section 1.4 of Chapter 1. The conclusions for each of these sub-research questions are discussed and summarised below.

How does firm size influence the technical efficiency of Thai manufacturing SMEs?

Empirical results from the SFA and two-stage DEA approaches for firm size are found to produce inconsistent results, as presented in Section 7.3 of Chapter 7. The results from the SFA approach present a negative sign for the majority of categories of manufacturing SMEs in 1997 and 2007. The negative signs for these categories are strongly significant at the 1 percent level (see Section 7.2.1.1 of Chapter 7). This signifies that small-sized SMEs are more technically-efficient than medium-sized SMEs in 1997 and 2007. On the other hand, the two-stage DEA approach exhibits a positive sign for almost all manufacturing SME categories in the periods 1997 and 2007, and they are highly significant at the 1 percent level. This indicates that medium-sized SMEs are more technically efficient than small-sized SMEs in 1997 and 2007.

How does firm age impact upon the technical efficiency of Thai manufacturing SMEs?

Empirical evidence from the SFA and two-stage DEA approaches reveals that firm age is positively and significantly related to the technical efficiency of most categories of manufacturing SMEs in both 1997 and 2007, as shown in Section 7.3 of Chapter 7. A number of empirical studies suggest that firm age has a positive and significant association with its technical efficiency, based on the principle of learning by doing and accumulated knowledge. Older firms may have greater management experience. They have learned from past mistakes, and are more likely to achieve higher efficiency because of 'learning by doing', and improved managerial skills. On the other hand, firm age can have a negative effect upon technical efficiency. Empirical results from the SFA approach show that firm age has a negative and significant effect upon the technical efficiency of SITC 1 in 1997, and SITC 2 and SITC 6 in 2007 (see Section 7.2.1.1 of Chapter 7). Older firms may have more experience but this can be offset by greater inertia through possession of older machinery, equipment, office appliances and software, while younger firms are aggressive and vigorous in the market having access to modern plant, equipment and technology. Hence we need to understand the characteristics of a particular sector before concluding that firm age is good for efficiency.

How does the employment of skilled labour affect the technical efficiency of Thai manufacturing SMEs?

Both the SFA and two-stage DEA approaches reveal that skilled labour has a positive and significant relationship with technical efficiency for almost all manufacturing SME categories in 2007, as presented in Section 7.3 of Chapter 7. However, the empirical results for the two-stage DEA approach present an unexpected positive sign for medium-sized SMEs and exporting SMEs in 2007 as shown in Section 7.2.2.1 of Chapter 7. This result demonstrates that skilled labour has a potentially negative and significant impact on technical efficiency in these categories. While this is not what would be expected, it could reflect the fact that such firms are working with out-of-date or labour-intensive technology, where additional skilled labour simply exacerbates existing production and technology inefficiencies.

How important is location (i.e., municipal and Bangkok areas, Central and Vicinity regions, Northern and North-eastern regions) for SME performance?

The SFA and the two-stage DEA approaches confirm that location in a municipal area has a positive and significant relationship with technical efficiency for the majority of SME categories in the periods 1997 and 2007, as presented in Section 7.3 of Chapter 7. A number of empirical studies also confirm that location in a municipal area has a positive impact on firm technical efficiency. A metropolitan location efficiency effect is suggestive of agglomeration economies in the private sector, as a consequence of better availability of educated workers and managers, and market opportunities in metropolitan locations relative to non-metropolitan locations. However, the results from the SFA approach indicate that a municipal area is negatively and significantly related to the technical efficiency of medium enterprises and SITC 0 in 1997 (see Section 7.2.1.1 of Chapter 7). Results from the two-stage DEA approach similarly reveal that a municipal area has a negative and significant impact upon the technical efficiency of medium enterprises and SITC 7 in 1997 and exporting SMEs in 2007 (see Section 7.2.2.1 of Chapter 7).

Location in the Bangkok area is found to be very important for the technical efficiency of most SME categories in both 1997 and 2007. Empirical evidence from the SFA and two-stage DEA approaches reveal that the Bangkok area is positively and significantly correlated with technical efficiency across all manufacturing SME categories in 1997 and 2007, as presented in Section 7.3 of Chapter 7. In the Bangkok area there are many clear advantages for SMEs that are conducive to technical efficiency: good infrastructure, knowledge spill-overs, access to skilled workers and a large domestic market (Office of Small and Medium Enterprises Promotion (OSMEP), 2001-2009). However, only empirical results from the two-stage DEA approach show that the Bangkok area has a negative and significant impact upon the technical efficiency of exporting SMEs in 2007 as shown in Section 7.2.2.1 of Chapter 7.

Empirical results from the SFA and the two-stage DEA approaches confirm that location in Central and Vicinity regions are positively and significantly related with the technical efficiency of the majority of manufacturing SME categories in the years 1997 and 2007, as presented in Section 7.3 of Chapter 7. However, empirical evidence from the SFA approach indicates that the Central and Vicinity regions have a negative and significant relationship to the technical efficiency of SITC 5 and SITC 6 in 1997 (see Section 7.2.1.1 of Chapter 7). The results from a two-stage DEA approach specify that Central and Vicinity regions have a negative and significant impact on the technical efficiency of exporting SMEs and SITC 5 in 1997, and medium-sized SMEs, exporting SMEs and SITC 5 in 2007 (see Section 7.2.2.1 of Chapter 7).

In the pre-crisis (1997) period the empirical results from the SFA and the two-stage DEA approaches indicate that location in the Northern region has a positive and significant relationship with technical efficiency for the majority of categories of manufacturing SMEs, as presented in Section 7.3 of Chapter 7. However, the results from the SFA approach show that the Northern region has a negative and significant impact upon the technical efficiency of medium-sized SMEs and SITC 5 in 1997 (see Section 7.2.1.1 of Chapter 7). The results from the two-stage DEA approach similarly reveal that location in the Northern region has a negative and significant relationship with the technical efficiency of medium-sized SMEs, exporting SMEs and SITC 5 in 1997 (see Section 7.2.2.1 of Chapter 7).

In the post-crisis period (2007) empirical evidence from both estimation approaches confirm that location in the Northern region is negatively and significantly related to SME technical efficiency across all categories, except for the SFA approach which indicates that the Northern region has a positive and significant effect on the technical efficiency of SITC 8 in 2007 (see Section 7.2.1.1 of Chapter 7). Thus, location in the Northern region is generally significantly and negatively related to the technical efficiency of manufacturing SME for almost all categories in both periods, suggesting a location problem for SMEs in these categories that require to be addressed.

The SFA and the two-stage DEA approaches reveal that the North-eastern region has a negative and significant correlation with the technical efficiency of the majority of manufacturing SME categories in 1997 and 2007, except for SMEs in SITC 0, SITC 6, SITC 7 and SITC 8 in 1997, and SITC 0 in 2007 (see Section 7.3 of Chapter 7). The empirical results from the SFA approach indicate that the North-eastern region has a positive and significant association with the technical efficiency of SITC 6, SITC 7 and SITC 8 in 1997 (see Section 7.2.1.1 of Chapter 7). The two-stage DEA approach indicates that the Northern-eastern region only has a positive and significant correlation with the technical efficiency of SITC 0, SITC 6 and SITC 8 and SITC 7 in 1997 (see Section 7.2.2.1 of Chapter 7). Thus, it is implied that the location of an SME in the North-eastern region by 2007 is negatively related to technical efficiency, and that there are significant efficiency disadvantages for SMEs in most categories located in this region that require to be urgently understood and addressed.

How do various types of manufacturing SME ownership - individual proprietor, juristic partnership, public and limited company - affect the technical efficiency of Thai manufacturing SMEs?

The SFA and the two-stage DEA approaches confirm that there is a positive and significant relationship between individual proprietor ownership and technical efficiency in most SME categories in the periods 1997 and 2007 (see Section 7.3 of Chapter 7), except for the SFA approach, which indicates that individual proprietor ownership has a negative and significant relationship with the technical efficiency of SITC 7 in 1997 (see Section 7.2.1.1 of Chapter 7).

The empirical results from both estimation approaches suggest that juristic partnership ownership has a positive and significant relationship with technical efficiency in all categories of manufacturing SMEs in both 1997 and 2007, as presented in Section 7.3 of Chapter 7.

Both estimation approaches confirm that limited and public limited company ownership in 1997 and 2007 are positively and significantly related with SME technical efficiency in all categories of manufacturing SMEs, as shown in Section 7.3 of Chapter 7.

How does government and stage ownership influence the technical efficiency of Thai manufacturing SMEs?

The SFA and two-stage DEA approaches suggest that government and state ownership of manufacturing SMEs has a significant and positive impact on technical efficiency in almost all categories of Thai manufacturing SMEs in both 1997 and 2007, as presented in Section 7.3 of Chapter 7. However, this form of ownership has a significant and negative relationship with technical efficiency for the majority of SME categories in 2007 (see Section 7.3 of Chapter 7). This may be due to the fact that with the process of reform, the privatisation of viable enterprises occurred, leaving only the most technically inefficient SMEs in government or state ownership.

In addition, the results from the SFA approach demonstrate that government and state ownership has a positive and significant effect on the technical efficiency of SITC 1 and SITC 5 in 2007 (see Section 7.2.1.1 of Chapter 7). The results from a two-stage DEA approach indicate that government and state ownership is positively and significantly related with technical efficiency in exporting SMEs, SITC 1 and SITC 5 in 2007 (see Section 7.2.2.1 of Chapter 7).

How does cooperative ownership impact upon the technical efficiency of Thai manufacturing SMEs?

The SFA and two-stage DEA approaches confirm that cooperative ownership has a positive and significant correlation with technical efficiency in the majority of categories of manufacturing SMEs in both 1997 and 2007, as presented in Section 7.3 of Chapter 7. However, only the empirical results from a two-stage DEA approach show that cooperative ownership has a negative and significant relationship with the technical efficiency of SITC 5 and SITC 2 in 1997 (see Section 7.2.2.1 of Chapter 7).

How does foreign ownership or investment affect the technical efficiency of Thai manufacturing SMEs?

The SFA and the two-stage DEA approaches reveal a positive and significant association between foreign investment and technical efficiency in most manufacturing SME categories in the periods 1997 and 2007, as presented in Section 7.3 of Chapter 7, except for the SFA approach, which specifies that foreign investment has a potentially negative and significant impact on the technical efficiency of SITC 7 in 2007 (see Section 7.2.1.1 of Chapter 7). Foreign investment can promote technological upgrading, managerial skill and knowledge, good corporate governance and good networking with foreign markets

How does exporting influence the technical efficiency of Thai manufacturing SMEs?

The SFA and two-stage DEA approaches indicate that exports have a significant and positive correlation with the technical efficiency of manufacturing SMEs across all categories in both 1997 and 2007, as presented in Section 7.3 of Chapter 7. However, both estimation approaches imply that exports were negatively related to the technical efficiency of SITC 7 in 1997.

How does government assistance (via the Broad of Investment (BOI)) impact on the technical efficiency of Thai manufacturing SMEs?

The SFA and the two-stage DEA approaches reveal that government assistance has a positive and significant relationship with technical efficiency for the majority of SME categories in the periods 1997 and 2007, as presented in Section 7.3 of Chapter 7. Government assistance can be in the form of financial support (i.e., credit assistance, income tax exemption or reduction, and duty privileges) and non-financial assistance (i.e., managerial and technical assistance, and training assistance)

How can Thai government policy towards manufacturing SMEs be made to improve the efficiency and competitiveness readiness of Thai manufacturing SMEs?

Empirical evidence from this thesis has shown that the weighted average technical efficiency levels in almost all categories of manufacturing SMEs in 1997 and 2007 are low, indicating high levels of technical inefficiency. Thai manufacturing SMEs have remained predominantly labour-intensive, and focused on low-skill, low value-adding activities in the pre- and post-crisis periods. Consequently, policy measures adopted in the wake of the Asian financial crisis to improve SME performance and competitiveness appear to have largely failed. Significant policy measures that can assist in improving the technical efficiency of manufacturing SMEs are: an adequate supply of inputs; market access; access to credit facilities; undertaking extensive infrastructural development and training from government agencies; promoting the utilisation of information and communication technology (ICT); providing financial assistance to avoid management risks and financial problems; providing knowledge and information on market opportunities; improving the quality and competency of SME employees and entrepreneurs; and providing greater regional development equity through extensive regional infrastructure development.

Furthermore, government agencies should play a more effective role in assisting and promoting SMEs performance to enable them to be more competitive in the domestic and international market place. The Thai government should address public policies and regulations that hinder SMEs and give more emphasis to correcting bureaucratic fragmentation and conflict in the provision of SME assistance. It should promote a partnership between government and the private sector in order to enhance SME growth. The government should play an important role in promoting market-oriented SME interventions for improving SME development and the elimination of policy biases.

The empirical results for firm-specific factors contributing to technical inefficiency provide enlightening results. The results for the relationship between firm size and technical efficiency are mixed. The empirical results from the SFA approach indicate that small-sized SMEs are likely to be more technically efficient than medium-sized SMEs for the majority of categories of manufacturing SMEs in 1997 and 2007. This result suggests that policy should encourage new technology, innovation and firm formation and training programs for workers. Targeted financial and other assistance to SMEs in these manufacturing SMEs may also be more appropriate. On the other hand, the empirical evidence from a two-stage DEA approach specifies that medium-sized SMEs are found to be more technically efficient than small-sized SMEs for all manufacturing SME categories in 1997 and

2007. Increased firm size and growth of manufacturing SMEs, therefore, needs to be encouraged, since larger firm size can result in economies of scale and scope, reduced production costs, improved efficiency and competitiveness. Increased firm size means greater access to inputs such as skilled labour, capital (credit) and technology.

The importance of firm age and learning by doing for technical efficiency is also mixed. Results from the SFA and two-stage DEA approaches indicate that firm age is positively and significantly correlated with technical efficiency for most categories of manufacturing SMEs in both 1997 and 2007. This has important policy implications in terms of SME access to inputs including finance and skilled labour to facilitate firm growth. Evidence of diverging outcomes by sector outcome is partially due to differing sector characteristics, as firm age is likely to be less important in sectors subject to rapid market and technology change. In such sectors, policy should give more emphasis to new firm start-ups. On the other hand, firm longevity does not guarantee improved technical efficiency. The major exception to this is SITC 1 in 1997, and SITC 2 and SITC 6 in 2007. For some manufacturing sectors, firm age and experience may actually have a negative impact upon technical efficiency, and this is most likely to be the case in those sectors where technology, products and processes change rapidly. In these circumstances, continual updating of knowledge and technology as well as the encouragement of new market entrants could be key policy strategies.

A higher skilled labour ratio is positively and significantly related to technical efficiency for all categories of manufacturing SMEs with the exception of medium-sized SMEs and exporting SMEs in 2007, where is it negatively related to technical efficiency. The negative impact of the skilled labour ratio on technical efficiency is a puzzle for medium-sized SMEs and exporting SMEs. This may be due to a mismatch of labour skills and the capital or technology being used by these categories of SME, which have experienced increased dependence on capital in the production process. These results indicate that policy measures, in general, should focus on improving the knowledge and skills of human resources in manufacturing SMEs. SME policy, therefore, should give emphasis to the acquisition of knowledge and skills by the workforce in manufacturing SMEs through the provision of appropriate educational and training programs and facilities.

Location can be an important firm-specific factor contributing to technical efficiency. There are clear advantages for manufacturing SMEs located in municipal area, Central or Vicinity regions and in the Bangkok area in particular for technical efficiency. Thus, policy measures should improve infrastructure and build upon agglomeration economies that are apparent in municipal areas, Central or Vicinity regions and Bangkok area. Policy measures, however, are also required to address regional and rural sector disadvantages which create inequity in SME operations and impede the attainment of technical efficiency, by such means as: providing regional infrastructure development; encouraging and facilitating innovative activity; facilitating firm collaboration and networking; facilitating greater access to and uptake of technology; promoting local communities and products; enhancing the skills and capabilities of the local workforce and entrepreneurs; improving information and communications technology infrastructure; and enhancing access to finance. The Northern and North-eastern regions, in particular, appear to suffer from considerable disadvantage for SMEs in terms of technical efficiency which requires urgent attention.

Ownership characteristics – individual proprietor, juristic partnership and public limited company – have a significant and highly positive relationship with the technical efficiency of virtually all categories of manufacturing SMEs in 1997 and 2007. From a policy perspective, these results suggest that, based upon the numerical value of the coefficients for each of these forms of firm ownership, that the government should actively encourage the public and limited type of ownership for SMEs, followed by juristic partnerships and then individual ownership. Increased public and limited ownership, however, can only be achieved if SMEs have greater access to stock markets. But this can be prohibitively expensive for small SMEs in particular. Reducing the costs of this type of ownership should be addressed. This type of ownership, therefore, has the potential to facilitate greater access to finance and other resources for medium-sized SMEs in particular, which can facilitate their access to capital, technology and skilled labour and enable them to achieve faster growth, benefit from economies of scale and scope and improve their technical efficiency. Encouraging the juristic and individual types of ownership is more prevalent for small SMEs. Policy should ensure that the costs of establishing these types of firm ownership are reduced and that adequate funding is available for new firm start-ups and entrepreneurs. In this context the establishment of venture capital markets would be important. Encouraging greater access to finance through initial public offerings (IPOs), such policies should be suitably adapted for differences across manufacturing sub-sectors and by size of SME.

Government and state ownership of SMEs had a significant and positive impact on the technical efficiency of almost all categories of Thai manufacturing SMEs in the pre-crisis (1997) period. However, in the post-crisis (2007) period, a negative and significant correlation with the technical efficiency for a majority of categories of manufacturing SMEs is found. As mentioned previously, this may be due to privatisation of SMEs during this period. The most profitable and efficient firms have been sold off, while the least profitable and inefficient firms remained in public ownership. Reform in these SME categories, including that of ownership reform, should be an important policy priority. Government policy should also enhance the efficiency of state owned manufacturing enterprises, which could consist of privatisation, and continue the process of privatisation of manufacturing SMEs.

Cooperative ownership had a significant and positive effect upon the technical efficiency of all categories of Thai manufacturing SMEs in both 1997 and 2007, except for SMEs in SITC 5 and SITC 2 in 1997. This result suggests that government policy can usefully support the development of SME cooperatives in all categories of manufacturing SMEs, and should encourage cooperative ownership of manufacturing SMEs in non-municipal localities and the Northern and North-eastern regions in targeted types of activity which could be beneficial for SME technical efficiency.

The impact of foreign investment on SME technical efficiency is found to be significant and have a positive relationship with the technical efficiency of all categories of Thai manufacturing SMEs in both 1997 and 2007, with the exception of SITC 7 in 2007. The Thai government should continue to relax foreign ownership controls and encourage foreign investment in manufacturing SMEs in order to promote technological upgrading, managerial skills and knowledge, good corporate governance and good networking with foreign markets.

The extent of export involvement appears to be significant for the technical efficiency of manufacturing SMEs across all categories in both 1997 and 2007, except only SMEs in SITC 7 in 1997. These results suggest that policy should focus on creating higher value added activity in manufacturing SMEs, enhancing quality standards and the capability of SMEs to meet market demands both domestic and international, increasing product differentiation and the competitiveness of SMEs particularly in industrial products. Government assistance (via BOI) to manufacturing SMEs is significantly and positively correlated with the technical efficiency for the majority of categories of manufacturing SMEs in both 1997 and 2007. If a policy priority is to improve the technical efficiency performance of manufacturing SMEs, then this will require a major overhaul of existing measures. Some of the results presented previously can provide solid guidance as to what factors need to be addressed by appropriate policy measures.

8.4 LIMITATIONS OF THE CURRENT STUDY AND FUTURE RESEARCH

Despite the theoretical and empirical merits of this thesis, it contains a number of limitations that offers possibilities for further research, as follows:

(1) This thesis utilises cross-sectional firm-level data from industrial censuses for 1997 and 2007 compiled by the NSO of Thailand. This study, however, only focuses on Thai manufacturing SMEs. Large enterprises from the 1997 and 2007 industrial censuses are excluded from this thesis. For future research, large enterprises should be included in the analysis in order to reach a broader understanding about the technical efficiency performance of all Thai manufacturing SMEs.

(2) Due to data limitations it is not possible to identify individual firms in 1997 and 2007, and to observe changes in them over time. The analysis of this thesis is static and firm technical efficiency is obtained at a point in time and not over time. Consequently this thesis cannot conduct a balanced panel data analysis. However, many empirical studies have estimated and compared technical efficiency between periods using unbalanced panel data (Vu, 2003; Arunsawadiwong, 2007; Tran *et al.*, 2008; Le, 2010; Le and Harvie, 2010).

(3) The 1997 and 2007 industrial censuses comprise enterprises engaged in manufacturing activities which are classified by manufacturing industry (category D International Standard Industrial Classification of All Economic Activities; ISIC:

Revision 3). However, ISIC has 23 sub-manufacturing sectors in both industrial censuses. To keep the analysis tractable, this thesis adopted SITC Revision 4 which consists of only 8 sectors. Furthermore, the 1997 and 2007 industrial censuses do not cover SITC 4: Animal, vegetable oils and waxes. Further research could analyse the technical efficiency of all 23 sub-manufacturing sectors.

(4) For skilled labour, the National Statistics Office of Thailand did not compile the statistic on skilled labour in the 1997 industrial census.

(5) The unavailability of variables in both the 1997 and 2007 industrial censuses such as those relating to finance, innovation, and information and communication technology (ICT) prevented an analysis of their impact upon the technical inefficiency of Thai manufacturing SMEs.

(6) Focusing on the two-stage Data Envelopment Analysis (DEA) approach, it would be interesting to estimate the technical efficiency of Thai manufacturing SMEs in 1997 and 2007 by using the two-stage Bootstrap DEA approach developed by Simar and Wilson (Simar and Wilson, 2007; Wilson, 2009). This can be considered for future research.

(7) With respect to the Stochastic Frontier Analysis (SFA) approach, it would be useful to apply a meta-frontier production function model developed by Battese *et al.* (2004), to measure the technical efficiency of Thai manufacturing SMEs in future research. The meta-frontier model can be utilised to calculate comparable technical efficiencies for firms with different production technologies (Le, 2010; Amornkitvikai, 2011).

(8) Focusing on the production functional form, future research should consider estimating the production function with variable returns to scale as suggested by Griffiths and O'Donnell (2005). Their study utilised generalised and Cobb-Douglas production functions and applied Bayesian estimation of stochastic frontiers in their analysis. This paper focuses upon a production function, returns to scale and firm efficiency. However, this thesis has only focused upon firm technical efficiency and a technical inefficiency effects model (the SFA approach). It is important to emphasise that the framework of Griffiths and O'Donnell (2005) does not fit well in this thesis and is unable to estimate technical efficiency and technical inefficiency effects model in a one-step process. Nevertheless, this can be considered for future research.

(9) In terms of capital input (*K*), the most popular method for measuring capital input is the perpetual inventory method (PIM) (Phan, 2004; Coelli *et al.*, 2005; Le, 2010). However, the PIM is not available in both the 1997 and 2007 industrial censuses. An alternative method is the net value of fixed assets. A number of empirical studies have used the value of net fixed assets as the capital input in their analysis (Wiboonchutikula, 2002; Kim, 2003; Hossain and Karunaratne, 2004; Phan, 2004; Yang, 2006; Arunsawadiwong, 2007; Minh *et al.*, 2007; Zahid and Mokhtar, 2007; Pham *et al.*, 2009), which is an aggregate of the book value of land, buildings, machinery, tools, transport and office equipment.

(10) For labour input (*L*), in the economic literature, the total number of hours worked is the best indicator of labour input (Phan, 2004; Coelli *et al.*, 2005). However, due to data constraint in the 1997 and 2007 industrial censuses, the total number of hours worked cannot be calculated in this study. The other indicator is to utilise the total number of workers, which is adopted as the measurement of labour input in this research (Phan, 2004). Many empirical studies have utilised the total number of employees as the labour input in their empirical analysis (Lundvall and Battese, 2000; Batra and Tan, 2003; Kim, 2003; Hossain and Karunaratne, 2004; Phan, 2004; Arunsawadiwong, 2007; Minh *et al.*, 2007; Pham *et al.*, 2009).

(11) Future research should focus on other sectors in relation to Thailand's SMEs, such as the trade, service, wholesale and retail sectors in order to examine overall categories of SMEs. In addition, future work should integrate with the field study of finance, accounting, and marketing with the purpose of evaluating and assessing the performance of SMEs from various perspectives. Therefore, study on these topics will make an important contribution to further understanding Thailand's SMEs.

In conclusion, all of the above limitations are worthy of consideration but they are beyond of the scope of the current study, and, therefore, have been left for future research.

APPENDIX A: SUMMARY OF THE MAJOR RESEARCH QUESTIONS AND SUB-RESEARCH QUESTIONS AND CONCLUSIONS

Appendix A: Summary of the Major Research Questions and Sub-Research Questions and Conclusions

Major research and sub-research questions	Sections and Chapters	Conclusions
1. How do Thai manufacturing SMEs in the pre-(1997) and post-(2007) Asian financial crisis periods perform in terms of technical efficiency?	Section 6.5 of Chapter 6	• The SFA and DEA approaches produced similar results, in that the overall weighted technical efficiency scores in all categories of Thai manufacturing SMEs decreased in the post-crisis (2007) period as compared to the pre-crisis (1997) period. • According to the overall weighted technical efficiency scores predicted by the SFA and DEA approaches, Thai manufacturing SMEs in both 1997 and 2007 operated at a low level of technical efficiency, specifying a high degree of technical inefficiency in their operation. • It is also indicated that the technical efficiency performance of most categories of manufacturing SMEs deteriorated in 2007, with no apparent improvement in firm productivity and efficiency. • The SFA approach indicates a high labour input elasticity in all categories of Thai manufacturing SMEs in the pre-(1997) and post-(2007) crisis periods, and the dependence on labour input in the production process by manufacturing SMEs in all categories. The low capital input elasticity in all SME categories in 1997 and 2007 indicates that capital is less important in production. Thai manufacturing SMEs in both 1997 and 2007 relied upon labour intensive technology using unskilled labour in low value-adding activities, and this pattern intensified in the post-crisis period.
2. How can the overall technical efficiency performance of Thai manufacturing SMEs be improved?	Section 6.5 of Chapter 6 and Section 7.4 of Chapter	• A firm's technical efficiency can be increased from an improvement in the education and skill of the labour force. Therefore, it is suggested that selective policy interventions could be useful in improving SME efficiency, SME development, and employment creation. • SMEs need a more skilled labour force that will enable usage of technology, enable them to become more innovative, and that will give them a competitive edge in the national and regional marketplace. • Provide greater market access, greater access to credit facilities. • Provide financial assistance to avoid management risks and financial problems. • Ensure that relevant government agencies encourage and facilitate innovative activity through firm collaboration and networking.

Appendix A: (continued) Summary of the Major Research Questions and Sub-Research Questions and Conclusions

Major research and sub-research questions	Sections and Chapters	Conclusions
3. What are the firm-specific factors contributing to the technical efficiency of Thai manufacturing SMEs in the pre-(1997) and post-(2007) Asian financial crisis periods?	Section 7.3 of Chapter 7	• Empirical results from the technical inefficiency effects model (SFA) suggested that small-sized SMEs are more technically-efficient than medium-sized SMEs for the majority of manufacturing categories in 1997 and 2007. In contrast, the two-stage DEA approach indicated that medium-sized SMEs are generally more technically-efficient than small-sized SMEs for all manufacturing SME categories in 1997 and 2007. • The empirical results from the technical inefficiency effects and Tobit model indicate that firm size (economies of scale and scope), age (learning by doing), proportion of workforce which is skilled, location in towns and cities and particularly location in Bangkok, type of ownership, whether limited and public limited companies or juristic partnerships, foreign ownership or investment and export activity, are the important firm-specific factors contributing to the technical efficiency of Thai manufacturing SMEs in both 1997 and 2007.
4. How does firm size influence the technical efficiency of Thai manufacturing SMEs?	Section 7.3 of Chapter 7	• Empirical results from the SFA and two-stage DEA approaches for firm size are found to produce inconsistent results. The results from the SFA approach present a negative and significant signs for the majority of categories of manufacturing SMEs in 1997 and 2007. This signifies that small-sized SMEs are more technically-efficient than medium-sized SMEs in 1997 and 2007. • On the other hand, the two-stage DEA approach exhibits a positive and significant signs for almost all manufacturing SME categories in the periods 1997 and 2007. This indicates that medium-sized SMEs are more technically efficient than small-sized SMEs in 1997 and 2007.
5. How does firm age impact upon the technical efficiency of Thai manufacturing SMEs?	Section 7.3 of Chapter 7	• Empirical evidence from the SFA and two-stage DEA approaches reveals that firm age is positively and significantly related to the technical efficiency of most categories of manufacturing SMEs in both 1997 and 2007. • On the other hand, firm age can have a negative effect upon technical efficiency. Empirical results from the SFA approach show that firm age has a negative and significant effect upon the technical efficiency of SITC 1 in 1997, and SITC 2 and SITC 6 in 2007.

Appendix A: (continued) Summary of the Major Research Questions and Sub-Research Questions and Conclusions

Major research and sub-research questions	Sections and Chapters	Conclusions
6. How important is location (i.e., municipal and Bangkok areas, Central and Vicinity regions, Northern and North-eastern regions) for SME performance?	Section 7.3 of Chapter 7	• The SFA and the two-stage DEA approaches confirm that location in a municipal area has a positive and significant relationship with technical efficiency for the majority of SME categories in the periods 1997 and 2007. • However, the results from the SFA approach indicate that a municipal area is negatively and significantly related to the technical efficiency of medium enterprises and SITC 0 in 1997. • Results from the two-stage DEA approach similarly reveal that a municipal area has a negative and significant impact upon the technical efficiency of medium enterprises and SITC 7 in 1997 and exporting SMEs in 2007. • Location in the Bangkok area is found to be very important for the technical efficiency of most SME categories in both 1997 and 2007. Empirical evidence from the SFA and two-stage DEA approaches reveal that the Bangkok area is positively and significantly correlated with technical efficiency across all manufacturing SME categories in 1997 and 2007. • However, only empirical results from the two-stage DEA approach show that the Bangkok area has a negative and significant impact upon the technical efficiency of exporting SMEs in 2007. • Empirical results from the SFA and the two-stage DEA approaches confirm that location in Central and Vicinity regions are positively and significantly related with the technical efficiency of the majority of manufacturing SME categories in the years 1997 and 2007. • However, empirical evidence from the SFA approach indicates that the Central and Vicinity regions have a negative and significant relationship to the technical efficiency of SITC 5 and SITC 6 in 1997. • The results from a two-stage DEA approach specify that Central and Vicinity regions have a negative and significant impact on the technical efficiency of exporting SMEs and SITC 5 in 1997, and medium-sized SMEs, exporting SMEs and SITC 5 in 2007. • In the pre-crisis (1997) period the empirical results from the SFA and the two-stage DEA approaches indicate that location in the Northern region has a positive and significant relationship with technical efficiency for the majority of categories of manufacturing SMEs.

Appendix A: (continued) Summary of the Major Research Questions and Sub-Research Questions and Conclusions

Major research and sub-research questions	Sections and Chapters	Conclusions
6. (continued) How important is location (i.e., municipal and Bangkok areas, Central and Vicinity regions, Northern and North-eastern regions) for SME performance?	Section 7.3 of Chapter 7	• However, the results from the SFA approach show that the Northern region has a negative and significant impact upon the technical efficiency of medium-sized SMEs and SITC 5 in 1997. The results from the two-stage DEA approach similarly reveal that location in the Northern region has a negative and significant relationship with the technical efficiency of medium-sized SMEs, exporting SMEs and SITC 5 in 1997. • In the post-crisis period (2007) empirical evidence from both estimation approaches confirm that location in the Northern region is negatively and significantly related to SME technical efficiency across all categories, except for the SFA approach which indicates that the Northern region has a positive and significant effect on the technical efficiency of SITC 8 in 2007. • Thus, location in the Northern region is generally significantly and negatively related to the technical efficiency of manufacturing SME for almost all categories in both periods, suggesting a location problem for SMEs in these categories that require to be addressed. • The SFA and the two-stage DEA approaches reveal that the North-eastern region has a negative and significant correlation with the technical efficiency of the majority of manufacturing SME categories in 1997 and 2007, except for SMEs in SITC 0, SITC 6, SITC 7 and SITC 8 in 1997, and SITC 0 in 2007. • The empirical results from the SFA approach indicate that the North-eastern region has a positive and significant association with the technical efficiency of SITC 6, SITC 7 and SITC 8 in 1997. • The two-stage DEA approach indicates that the Northern-eastern region only has a positive and significant correlation with the technical efficiency of SITC 0, SITC 6 and SITC 8 and SITC 7 in 1997. Thus, it is implied that the location of an SME in the North-eastern region by 2007 is negatively related to technical efficiency.

Appendix A: (continued) Summary of the Major Research Questions and Sub-Research Questions and Conclusions

Major research and sub-research questions	Sections and Chapters	Conclusions
7. How do various types of manufacturing SME ownership - individual proprietor, juristic partnership, public and limited company - affect the technical efficiency of Thai manufacturing SMEs?	Section 7.3 of Chapter 7	• The SFA and two-stage DEA approaches suggest that government and state ownership of manufacturing SMEs has a significant and positive impact on technical efficiency in almost all categories of Thai manufacturing SMEs in both 1997 and 2007. • However, this form of ownership has a significant and negative relationship with technical efficiency for the majority of SME categories in 2007. This may be due to the fact that with the process of reform, the privatisation of viable enterprises occurred, leaving only the most technically inefficient SMEs in government or state ownership. • In addition, the results from the SFA approach demonstrate that government and state ownership has a positive and significant effect on the technical efficiency of SITC 1 and SITC 5 in 2007. • The results from a two-stage DEA approach indicate that government and state ownership is positively and significantly related with technical efficiency in exporting SMEs, SITC 1 and SITC 5 in 2007.
8. How does cooperative ownership impact upon the technical efficiency of Thai manufacturing SMEs?	Section 7.3 of Chapter 7	• The SFA and two-stage DEA approaches confirm that cooperative ownership has a positive and significant correlation with technical efficiency in the majority of categories of manufacturing SMEs in both 1997 and 2007. • However, only the empirical results from a two-stage DEA approach show that cooperative ownership has a negative and significant relationship with the technical efficiency of SITC 5 and SITC 2 in 1997.
9. How does foreign ownership or investment affect the technical efficiency of Thai manufacturing SMEs?	Section 7.3 of Chapter 7	• The SFA and the two-stage DEA approaches reveal a positive and significant association between foreign investment and technical efficiency in most manufacturing SME categories in the periods 1997 and 2007, as presented in, except for the SFA approach, which specifies that foreign investment has a potentially negative and significant impact on the technical efficiency of SITC 7 in 2007.

Appendix A: (continued) Summary of the Major Research Questions and Sub-Research Questions and Conclusions

Major research and sub-research questions	Sections and Chapters	Conclusions
10. How does exporting influence the technical efficiency of Thai manufacturing SMEs?	Section 7.3 of Chapter 7	• The SFA and two-stage DEA approaches indicate that exports have a significant and positive correlation with the technical efficiency of manufacturing SMEs across all categories in both 1997 and 2007. • However, both estimation approaches imply that exports were negatively related to the technical efficiency of SITC 7 in 1997.
11. How does government assistance (via the Broad of Investment (BOI)) impact on the technical efficiency of Thai manufacturing SMEs?	Section 7.3 of Chapter 7	• The SFA and the two-stage DEA approaches reveal that government assistance has a positive and significant relationship with technical efficiency for the majority of SME categories in the periods 1997 and 2007.
12. How can Thai government policy towards manufacturing SMEs be made to improve the efficiency and competitiveness readiness of Thai manufacturing SMEs?	Section 6.5 of Chapter 6, and Sections 7.2, 7.3 and 7.4 of Chapter 7	• The government should play an important role in promoting market-oriented SME interventions for improving SME development and the elimination of policy biases. • It should encourage new technology, innovation and firm formation and training program for workers. • It should increase firm size through greater access to inputs such as skilled labour, capital (credit) and technology. • The policy should give more emphasis to new firm start-ups. • It should focus on improving the knowledge and skills of human resources in manufacturing SMEs. • It should improve infrastructure and building upon agglomeration economies that are apparent in municipal area, central or vicinity regions and Bangkok area. • The government policy give more emphasis to the promotion of SMEs in the regions and rural localities by: supporting SME networks, promoting local communities and products, enhancing the skills and capabilities of the local workforce and entrepreneurs and improving local infrastructure.

Appendix A: (continued) Summary of the Major Research Questions and Sub-Research Questions and Conclusions

Major research and sub-research questions	Sections and Chapters	Conclusions
12. How can Thai government policy towards manufacturing SMEs be made to improve the efficiency and competitiveness readiness of Thai manufacturing SMEs?	Section 6.5 of Chapter 6, and Sections 7.2, 7.3 and 7.4 of Chapter 7	• Encouraging greater access to finance through initial public offerings (IPOs), such policies should be suitably adapted for differences across manufacturing sub-sectors and by size of SME. • The government policy should also enhance the efficiency of state owned manufacturing enterprises, which could consist of privatisation, and continue the process of privatisation of manufacturing SMEs. • It should support the development of SME cooperatives in all categories of manufacturing SMEs, and should be encouraged the cooperative ownership of manufacturing SMEs. • The Thai government should continue to relax foreign ownership controls and encourage foreign investment in manufacturing SMEs in order to promote technological upgrading, managerial skills and knowledge, good corporate governance and good networking with foreign market. • The policy should focus on creating higher value added activity in manufacturing SMEs, enhance quality standards and the capability of SMEs to meet market demands, increase differentiation and the competitiveness of SMEs.

BIBLIOGRAHPY

Ace, ZJ and Audretsch, DB 1990, *Innovation and Small Firms*, MIT Press, Cambridge.

Acs, ZJ 2003, *The Historical Role of the SMEs Sector in Developing and Developed Capitalist States*, Small and Medium Enterprises in Transitional Economies, Robert J. McIntyre and Bruno Dallago (eds), Palgrave Macmillan in Association with the United Nations University/World Institute for Development Economics Research.

Acs, ZJ, Morck, R, Shaver, JM and Yeung, B 1997, 'The Internationalization of Small and Medium-Sized Enterprises: A Policy Perspective', *Small Business Economics*, vol. 9, pp. 7-20.

Acs, ZJ and Preston, L 1997, 'Small and Medium-Sized Enterprises, Technology, and Globalization: Introduction to a Special Issue on Small and Medium-Sized Enterprises in the Global Economy', *Small Business Economics*, vol. 9, no. 1, pp. 1-6.

Adam, L 2006, 'The Economic Role of Formal and Informal Inter-Firm Networks in the Development of Small and Medium Industrial Enterprises: Study of Symbiosis in the Indonesian Garment Industry', PhD Thesis, School of Economics, University of Queensland.

Adlung, R and Soprana, M 2012, 'SMEs in Services Trade - A GATS Perspective, World Trade Organization, Staff Working Paper ERSD-2012-09', pp. 1-30.

Admassie, A and Matambalya, FAST 2002, 'Technical Efficiency of Small-and Medium-Scale Enterprises: Evidence from a Survey of Enterprises in Tanzania', *Eastern Africa Social Science Research Review*, vol. 18, no. 2, pp. 1-29.

Albaladejo, M 2002, *The Determinants of Competitiveness in SME Clusters: Evidence and Policies for Latin America. Small-Scale Enterprises in Developing and Transitional Economies*, Palgrave, Basingstoke and New York.

Alvarez, R and Crespi, G 2003, 'Determinants of Technical Efficiency in Small Firms', *Small Business Economics*, vol. 20, pp. 233-244.

Amornkitvikai, Y 2011, 'Technical Efficiency Performance of Thai Listed Manufacturing Enterprises', PhD Thesis, School of Economics, Faculty of Commerce, University of Wollongong.

Amornkitvikai, Y and Harvie, C 2010, 'Identifying and Measuring Technical Inefficiency Factors: Evidence from Unbalanced Panel Data for Thai Listed Manufacturing Enterprises', *University of Wollongong Economics Working Paper Series 2010*.

Amornkitvikai, Y and Harvie, C 2011, 'Finance, Ownership, Executive Remuneration, and Technical Efficiency: A Stochastic Frontier Analysis (SFA) of

Thai Listed Manufacturing Enterprises', *Australasian Accounting Business and Finance Journal*, vol. 5, no. 1, pp. 35-55.

Amornkitvikai, Y, Harvie, C and Charoenrat, T 2010, *Measuring Technical Efficiency: the Case of Thai Manufacturing and Exporting Small and Medium Size Enterprises (SMEs)*, The 7th SMEs in a Global Economy Conference: Challenges and Prospects, Kuching, Sarawak, Malaysia, 15-17 October.

Amornkitvikai, Y, Harvie, C and Charoenrat, T 2012, *Factors Affecting the Export Participation and Performance of Thai Manufacturing Small and Medium Sized Enterprises (SMEs)*, The 57th International Council for Small Business World Conference, Wellington, New Zealand, 10-13 June.

Anderson, D 1982, 'Small Industry in Developing Countries: A Discussion of Issues', *World Development*, vol. 10, no. 11, pp. 913-948.

Arunsawadiwong, S 2007, 'Productivity Trends in the Thai Manufacturing Sector: The Pre- and Post-Crisis Evidence Relating to the 1997 Economic Crisis', PhD Thesis, School of Economics and Finance, University of St. Andrews.

Asasen, C, Asasen, K and Chuangcham, N 2003, *A Proposed Policy Blueprint for the ASEAN SME Development Decade 2002-2012*, REPSF Project 02/005, Bangkok.

ASEAN Secretariat 2002, *Southeast Asia: A Free Trade Area*, 2010, The Association of Southeast Asian Nations (ASEAN), Bangkok.

ASEAN Secretariat 2009, *Implementing the Roadmap for an Asean Community 2015*, The Association of Southeast Asian Nations (ASEAN), Jakarta.

Asian Development Bank (ADB) 2010, *Key Indicators for Asia and the Pacific 2010*, accessed 30/03/2011, http://www.adb.org/Documents/Books/Key_Indicators/2010/pdf/tha.pdf.

Asian Development Bank (ADB) 2011, *Key Indicators for Asia and the Pacific 2011*, accessed 20/07/2012, http://www2.adb.org/Documents/Books/Key_Indicators/2011/pdf/tha.pdf.

Assaf, AG 2007, 'Modelling the Efficiency of Health Care Foodservice Operations: A Stochastic Frontier Approach', PhD Thesis, University of Western Sydney.

Audretsch, DB 2003, *Introduction: SMEs in the Age of Globalization*, Edward Elgar, Cheltenham, UK, Northhampton, MA.

Audretsch, DB, Grilo, I and Thurik, AR 2012, *Globalisation, Entrepreneurship and the Region*, SCALES, Scientific Analysis of Entrepreneurship and SMEs, Zoetermeer, The Netherlands.

Audretsch, DB, Horst, RVD, Kwaak, T and Thurik, R 2009, *First Section of the Annual Report on EU Small and Medium-sized Enterprises*, The European Commission, Directorate General Enterprise and Industry, EIM Business & Policy Research, Zoetermeer, The Netherlands.

Audretsch, DB and Thurik, AR 1998, *Capitalism and Democracy in the 21st Century from the Managed to the Entrepreneurial Economy*, The 1998 World Conference of the International Joseph a Schumpeter Society, Vienna, 13-16 June.

Audretsch, DB and Thurik, AR 2001, 'What's New About the New Economy? Sources of Growth in the Managed and Entrepreneurial Economies', *Industrial and Corporate Change*, vol. 10, no. 1, pp. 267-315.

Baier, WA 2008, 'An Exploration of the Pre-Development Phase of New Product Development in New Zealand Manufacturing Small and Medium Enterprises', Master Thesis, Massey University.

Baker, M and Rudd, R 2001, 'Relationships between Critical and Creative Thinking', *Journal of Southern Agricultural Education Research*, vol. 51, no. 1, pp. 173-188.

Bakhtiari, S 2012, 'Markets and the Non-monotonic Relation between Productivity and Establishment Size', *Canadian Journal of Economics*, vol. 45, no. 1, pp. 345-372.

Banker, R, Charnes, A and Cooper, W 1984, 'Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis', *Management Science*, vol. 30, no. 9, pp. 1078-1092.

Bartlett, W 2004, 'SME Development Policies in Different Stages of Transition', *Economic Policy in Transitional Economies*, vol. 11, no. 3, pp. 197-204.

Batra, G and Tan, H 2003, *SME Technical Efficiency and Its Correlates: Cross-National Evidence and Policy Implication*, World Bank Institute, Working Paper, Washington DC.

Battese, GE and Coelli, TJ 1992, 'Frontier Production Functions, Technical Efficiency and Panel Data: With Application to Paddy Farmers in India', *Journal of Productivity Analysis*, vol. 3, pp. 153-169.

Battese, GE and Coelli, TJ 1995, 'A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data', *Empirical Economics*, vol. 20, pp. 325-332.

Battese, GE and Corra, GS 1977, 'Estimation of a Production Frontier Model: With Application to the Pastoral Zone of Eastern Australia', *Australian Journal of Agricultural Economics*, vol. 21, pp. 169-179.

Battese, GE, Rao, DSP and O'Donnell, CJ 2004, 'A Metafrontier Production Function for Estimation of Technical Efficiencies and Technology Gaps for Firms Operating Under Different Technologies', *Journal of Productivity Analysis*, vol. 21, no. 1, pp. 90-103.

Beck, T, Demirgüç-Kunt, A and Levine, R 2005, *SMEs, Growth and Poverty*, Working Paper No. 11224, National Bureau of Economic Research, Cambridge.

Berger, AN and Udell, GF 2004, 'A More Complete Conceptual Framework for SME Finance', *World Bank Conference on Small and Medium Enterprises: Overcoming Growth Constraints, World Bank MC 13-121*, pp. 1-38.

Berry, A, Rodriguez, E and Sandee, H 2002, 'Firm and Group Dynamics in the Small and Medium Enterprise Sector in Indonesia', *Small Business Economics*, vol. 18, no. 1-3, pp. 141-161.

Biesebroeck, JV 2005, 'Firm Size Matters: Growth and Productivity Growth in African Manufacturing', *Economic Development and Cultural Change*, vol. 53, no. 3, pp. 545-583.

Biggs, T 2002, *Is Small Beautiful and Worthy of Subsidy?*, International Finance Corporation, Washington DC.

Biggs, T and Shah, MK 2006, 'African SMEs, Networks, and Manufacturing Performance', *Journal of Banking & Finance*, vol. 30, no. 11, pp. 3043-3066.

Bigsten, A, Paul, C, Stefan, D, Marcel, F, Bernard, G, Willem, G, Oduro, A, Oostendorp, R, Pattillo, C, Söderbom, M, Teal, F and Zeufack, A 2002, 'Do African Manufacturing Firms Learn From Exporting? ', *CSAE Working Paper, No WPS/2002-09, Oxford Centre for the Study of African Economies, Oxford University.*

Birch, DL 1981, 'Who Creates Jobs?', *The Public Interest*, vol. 65, pp. 3-14.

Bottasso, A and Sembenelli, A 2004, 'Does Ownership Affect Firm's Efficiency? Panel Data Evidence on Italy', *Empirical Economics*, vol. 29, pp. 769-786.

Brimble, P, Oldfield, D and Monsakul, M 2002, *Policies for SME Recovery in Thailand*, The Role of SMEs in National Economies in East Asia, Charles Harvie and Boon-Chye Lee (eds), Edward Elgar, Cheltenham.

Brooks, A, Collings, S and Gonzales, P 1990, *Accounting for Small Business: A Single entry Approach*, VCTA Publishing, Collingwood.

Buranajarukorn, P 2006, 'Human Aspects of Quality Management in Development Countries: A Case Study and Model Development for Thai Manufacturing SMEs', PhD thesis, School of Mechanical, Materials and Mechatronic Engineering, University of Wollongong.

Bureau of Trade and Economic Indices of Thailand 2010, *Producer Price Index (PPI)*, accessed 25/05/2010, http://www.price.moc.go.th/en/content1.aspx?cid=3.

Burki, AA 1996, 'Production Frontiers and Small Firm Efficiency: A Case Study from Pakistan', PhD Thesis, Department of Economics, Kansas State University.

Cambridge Small Business Research Centre 1992, *The State of British Enterprise*, Department of Applied Economics, University of Cambridge.

Chapelle, K and Plane, P 2005, 'Technical Efficiency Measurement within the Manufacturing Sector in Coˆte d'Ivoire: A Stochastic Frontier Approach', *The Journal of Development Studies*, vol. 41, no. 7, pp. 1303-1324.

Charnes, A, Cooper, WW and Rhodes, E 1978, 'Measuring the Efficiency of Decision Making Units', *European Journal of Operations Research*, vol. 2, pp. 429 - 444.

Charoenrat, T and Harvie, C 2011, *Technical Efficiency of Thai Manufacturing SMEs: A Comparative Study of North-eastern Provinces*, The 40th Australian Conference of Economists, Australian National University, Canberra, July 11-14.

Charoenrat, T and Harvie, C 2012, *Technical Efficiency Performance of Thai Manufacturing Small and Medium Sized Enterprises*, The 41th Australian Conference of Economists, Victoria University, Melbourne, 8-12 July.

Charoenrat, T, Harvie, C and Amornkitvikai, Y 2010, *Technical Efficiency of Thai Manufacturing SMEs: Evidence from a Firm-level Industrial Census*, The 7th SMEs in a Global Economy Conference: Challenges and Prospects, Kuching, Sarawak, Malaysia, 15-17 October.

Charoenrat, T, Harvie, C and Amornkitvikai, Y 2012, *Identifying Technical Inefficiency Factors for Thai Manufacturing Small Enterprises*, the 57th International Council for Small Business World Conference, Wellington, New Zealand, 10-13 June.

Charoenrat, T, Harvie, C and Amornkitvikai, Y 2012, *Identifying Technical Inefficiency Factors for Thai Manufacturing Small Enterprises*, the 57th International Council for Small Business World Conference, Wellington, New Zealand, 10-13 June.

Cheah, H-B and Cheah, M 2005, *Small, Diversified and Sustainable: Small Enterprises in a Sustainable Production System*, Sustaining Growth and Performance in East Asia: the Role of Small and Medium sized Enterprises, Charles Harvie and Boon-Chye Lee (eds), Edward Elgar, Cheltenham.

Chen, X, Zhou, Y and She, J 2007, *A Study of SMEs Growth Evaluation Considering Value at Risk*, International Conference on Service Systems and Service Management, 9-11 June.

Chirasirimongkol, S and Chutimaskul, W 2005, *Information Technology for Thai Leather SME Development*, The Fourth International Conference on eBusiness, Bangkok, 19-20 November

Chirathivat, S 2007, 'Thailand's Strategy toward FTAs in the New Context of East Asian Economic Integration', *Chulalongkorn Journal of Economics*, vol. 19, no. 2, pp. 185-214.

Coase, RH 1937, 'The Nature of the Firm', *Economica*, vol. 4, pp. 386-405.

Coelli, TJ 1995, 'Recent Developments in Frontier Modelling and Efficiency Measurement', *Australian Journal of Agricultural Economics*, vol. 39, no. 3, pp. 219-245.

Coelli, TJ 1996a, *A Guide to FRONTIER Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation*, Working paper 96/07, Centre for Efficiency and Productivity Analysis, Armidale, University of New England.

Coelli, TJ 1996b, *A Guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program*, Working paper 96/08, Centre for Efficiency and Productivity Analysis, Armidale, University of New England.

Coelli, TJ, Rao, DSP and Battese, GE 1998, *An Introduction to Efficiency and Productivity Analysis*, Kluwer Academic Publishers, Boston.

Coelli, TJ, Rao, DSP, O'Donnell, CJ and Battese, GE 2005, *An Introduction to Efficiency and Productivity Analysis, 2nd edn*, Springer, New York.

Cohen, WA 1989, *The Entrepreneur and Small Business Financial Problem Solver*, John Wiley & Sons, New York.

Cooke, P 2001, 'Regional Innovation Systems, Clusters, and the Knowledge Economy', *Industrial and Corporate Change*, vol. 10, pp. 945-974.

Cooper, AC and Dunkelberg, WC 2006, 'Entrepreneurship and Paths to Business Ownership', *Strategic Management Journal*, vol. 7, no. 1, pp. 53-68.

Cooper, WW, Seiford, LM and Tone, K 2006, *Introduction to Data Envelopment Analysis and Its Uses with DEA-Solver Software and References*, Springer, New York.

Coulson-Thomas, C 2007, 'SME Directors and Boards: The Contribution of Directors and Boards to the Growth and Development of Small and Medium-sized Enterprises (SMEs)', *International Journal of Business Governance and Ethics*, vol. 3, pp. 250.

Department of Industrial Promotion of Thailand 2009, accessed 27/05/2009, http: //dip.go.th.

Dhanani, S and Scholtès, P 2002, *Thailand's Manufacturing Competitiveness: Promoting Technology, Productivity and Linkages*, 8, United Nations Industrial Development Organization (UNIDO).

Dilling-Hansen, M, Madsen, ES and Smith, V 2003, 'Efficiency, R&D and Ownership – Some Empirical Evidence', *International Journal of Production Economics*, vol. 83, pp. 85-94.

Doern, R 2009, 'Investigating Barriers to SME Growth and Development in Transition Environments: A Critique and Suggestions for Developing the Methodology', *International Small Business Journal*, vol. 27, no. 3, pp. 275-305.

European Commission 2003, *Internationalisation of SMEs*, Observatory of European SMEs, No.4, Luxembourg.

European Commission 2010, 'Enhancing the Innovativeness of Food SMEs through the Management of Strategic Network Behaviour and Network Learning Performance', *Working Paper on SME Network Learning in Informal Networks*.

European Commission 2010, *Internationalisation of European SMEs*, EIM Business & Policy Research, Zoetermeer, The Netherlands.

Färe, R, Grosskopf, S and Logan, J 1983, 'The Relative Efficiency of Illinois Electric Utilities', *Resources and Energy*, vol. 5, pp. 349-367.

Färe, R and Lovell, CAK 1978, 'Measuring the Technical Efficiency of Production', *Journal of Economic Theory*, vol. 19, no. 150-162.

Farrell, MJ 1957, 'The Measurement of Productive Efficiency', *Journal of the Royal Statistical Society, Series A (General)*, vol. 120, no. 3, pp. 253-290.

Favero, CA and Papi, L 1995, 'Technical Efficiency and Scale Efficiency in the Italian Banking Sector: A Non-parametric Approach', *Applied Economics*, vol. 27, no. 4, pp. 385-395.

Fay, JR 1998, 'What Form of Ownership is Best?', *CPA Journal*, pp. 1-3.

Fernández, Z and Nieto, MJ 2006, 'Impact of Ownership on the International Involvement of SMEs', *Journal of International Business Studies* vol. 37, pp. 340-351.

Fukuyama, H, Guerra, R and Weber, WL 1999, 'Efficiency and Ownership: Evidence from Japanese Credit Cooperatives', *Journal of Economics and Business*, vol. 51, no. 6, pp. 473-487.

Fukuyama, H, Guerra, R and Weber, WL 1999, 'Efficiency and Ownership: Evidence from Japanese Credit Cooperatives', *Journal of Economics and Business*, no. 51, pp. 473–487.

Goh, M 2007, *High-growth, Innovative Asian SMEs for International Trade and Competitiveness: Challenges and Solutions for APO Member Countries*, accessed 25/07/2009, http: //www.apo-tokyo.org/rr_papers/rr2007_11_13.pdf.

Goldar, BN, Renganathan, VS and Banga, R 2003, *Ownership and Efficiency in Engineering Firms in India, 1990-91 to 1999-2000*, Working Paper.

Gomes-Casseres, B 1996, *The Alliance Revolution: The New Shape of Business Rivalry*, Cambridge, MA, Harvard University Press.

Gomes-Casseres, B 1997, 'Alliance Strategies of Small Firms', *Small Business Economics*, vol. 9, no. 1, pp. 33-44.

Granér, M and Isaksson, A 2002, *Export Performance*, Arne Bigsten and Peter K. Kimuyu (eds), Basingstoke, Palgrave.

Granér, M and Isaksson, A 2009, 'Firm Efficiency and the Destination of Exports: Evidence from Kenyan Plant-level Data', *The Developing Economies*, vol. 47, no. 3, pp. 279-306.

Greene, W 2003, 'Simulated Likelihood Estimation of the Normal-Gamma Stochastic Frontier Function', *Journal of Productivity Analysis*, vol. 19, pp. 179-190.

Gregory, G, Havie, C and Lee, HH 2002, 'Korean SMEs in the 21st Century: Strategies, Constraints and Performance in a Global Economy', *Economic papers*, vol. 21, no. 3, pp. 64-79.

Griffiths, WE and O'Donnell, CJ 2005, 'Estimating Variable Returns to Scale Production Frontiers with Alternative Stochastic Assumptions', *Journal of Econometrics*, vol. 126, pp. 385-409.

Griffithsa, WE and O'Donnell, CJ 2005, 'Estimating Variable Returns to Scale Production Frontiers with Alternative Stochastic Assumptions', *Journal of Econometrics*, vol. 126, pp. 385–409.

Ha, TT 2006, 'Entrepreneurial Orientation, Business Strategies and Firm Performance: A Comparative Study of Small and Medium-Scale Enterprises in Vietnam and Thailand', PhD Thesis, Asian Institute of Technology.

Hall, C 2002, *Profile of SMEs and SME Issues in East Asia*, The Role of Small and Medium Sized Enterprises in East Asia, Charles Harvie and Boon-Chye Lee (eds), Edward Elgar, Cheltenham.

Hallberg, K 2000, *A Market-oriented Strategy for Small and Medium-scale Enterprises*, IFC Discussion Paper No. 40, World Bank, Washington DC.

Hart, PE and Oulton, N 1996, 'Growth and Size of Firms ', *The Economic Journal*, vol. 106, no. 438, pp. 1242-1252.

Harvie, C 2002, *The Asian Financial and Economic Crisis and Its Impact on Reginal SMEs*, Globalisation and SMEs in East Asia, Charles Harvie and Boon-Chye Lee (eds), Edward Elgar, Cheltenham.

Harvie, C 2002b, *The Asian Financial and Economic Crisis and Its Impact on Regional SMEs*, Globalisation and SMEs in East Asia, Charles Harvie and Boon-Chye Lee (eds), Edward Elgar, Cheltenham.

Harvie, C 2007, *Economic Growth, Development and Integration in East Asia, the Role and Contribution of SMEs*, The 6th APEF International Conference on Asian Regionalism: Issues, Opportunities, Challenges and Outcomes, Wollongong, Australia, 30 June - 1 July.

Harvie, C 2008, *SME Development Strategy in Vietnam*, Small and Medium Sized Enterprises in East Asia: Sectoral and Regional Dimensions, Charles Harvie and Boon-Chye Lee (eds), Edward Elgar, Cheltenham.

Harvie, C 2010, *SMEs and Regional Production Networks – Framework*, Integrating Small and Medium Enterprises (SMEs) into the More Integrated East Asia, Vo Tri Thanh, Dionisius Narjoko and Sothea Oum (eds), Jakarta.

Harvie, C 2011, *Framework Chapter: SME Access to Finance in Selected East Asian Economies, Small and Medium Enterprises (SMEs) Access to Finance in Selected East Asian Economies*, Charles Harvie, Sothea Oum and Dionisius Narjoko (eds), Jakarta.

Harvie, C and Lee, B-C (eds) 2008, *Introduction and Overview - Small and Medium sized Enterprises: Sectoral and Regional Dimensions*, Small and Medium Sized Enterprises in East Asia, Edward Elgar, Cheltenham.

Harvie, C and Lee, BC (eds) 2002, *The Study of Small and Medium Sized Enterprises in East Asia*, Globalisation and SMEs in East Asia, Edward Elgar, Cheltenham.

Harvie, C and Lee, BC (eds) 2005a, *Introduction: The Role of Small and Medium-sized Enterprises in Achieving and Sustaining Growth and Performance*, Sustaining Growth and Performance in East Asia: The Role of Small and Medium sized Enterprises, Edward Elgar, Cheltenham.

Harvie, C and Lee, BC (eds) 2005b, *Public Policy and SME Development*, Sustaining Growth and Performance in East Asia: The Role of Small and Medium sized Enterprises, Edward Elgar, Cheltenham.

Harvie, C, Narjoko, D and Oum, S 2010, *Firm Characteristic Determinants of SME Participation in Production Networks*, ERIA Discussion Paper 2010-11, Jakarta.

Harvie, C, Oum, S and Narjoko, D (eds) 2011, *Small and Medium Enterprises (SMEs) Access to Finance in Selected East Asian Economies*, ERIA Research Project Report 2010-14, Jakarta.

Havnes, P-A and Senneseth, K 2001, 'A Panel Study of Firm Growth Among SMEs in Networks', *Small Business Economics*, vol. 16, pp. 293-302.

Hayakawa, K, Lee, H-H and Park, D 2010, 'The Role of Home and Host Country Characteristics in FDI: Firm-Level Evidence from Japan, Korea and Taiwan', *IDE Discussion Paper*, no. 267, pp. 1-32.

Hemilä, J and Oinas, M 2009, *How Marketing Affects an SME Firm's Profitability, Growth and Success*, The 20th Annual Conference of the Production and Operations Management Society (POMS), Orlando, Florida, U.S.A., 1-4 May.

Herrero, I and Pascoe, S 2002, 'Estimation of Technical Efficiency: A Review of Some of the Stochastic Frontier and DEA Software', *CHEER Virtual Edition*, vol. 15, no. 1, pp. 1-13.

Ho, S 1980, *Small-Scale Enterprises in Korea and Taiwan*, World Bank, Washington DC.

Hoff, A 2007, 'Second Stage DEA: Comparison of Approaches for Modelling the DEA Score', *European Journal of Operational Research*, vol. 181, pp. 425-435.

Horst, RVD, King-Kauanui, S, Duffy, S and International Council for Small Business (ICSB) (eds) 2005, *Keystones of Entrepreneurship Knowledge*, Blackwell, Malden/Oxford.

Hossain, MA and Karunaratne, ND 2004, 'Trade Liberalisation and Technical Efficiency: Evidence from Bangladesh Manufacturing Industries', *Journal of Development Studies*, vol. 40, no. 3, pp. 87-114.

Hu, MW 2000, 'The Evolution and Adaptability of SMEs: The Case of Taiwan', *Economic Papers*, vol. 19, no. 2, pp. 57-73.

Huang, I-W 2003, 'Importance of SMEs Development in Thailand', *Forum of International Development Studies*, vol. 23, pp. 159-176.

Huggins, R 2009, 'Knowledge Networks in an Uncompetitive Region: SME Innovation and Growth', vol. 40, pp. 227-259.

Humphrey, J 2003, *Opportunities for SMEs in Developing Countries to Upgrade in a Global Economy, Series on Upgrading in Small Enterprise Clusters and Global Value Chains*, International Labour Office, Geneva.

Humphrey, J and Schmitz, H 1995, *Principles for Promoting Clusters and Networks of SMEs. ,*, United Nations Industrial Development Organisation (UNIDO), Vienna.

Hussain, I, Hussain, M, Hussain, S and Si, S 2009, 'Public Private Partnership and SMEs Development; The Case of Azad Jammu and Kashmir (AJ&K) Pakistan', *International Review of Business Research Papers*, vol. 5, no. 5, pp. 37-46.

IMF World Economic Outlook 2009, accessed 03/04/2009, http: //www.econstats.com/weo/CTHA.htm.

Intal, PS 1997, 'Improving Institutional Support to Small and Medium Enterprises', *Philippine Institute for Development Studies*, vol. 97, no. 6, pp. 1-4.

Intarakamnerd, P, Chairatana, P-a and Tangchitpiboon, T 2002, 'National Innovation System in Less Successful Developing Countries: The Case of Thailand', *Research Policy*, vol. 31, pp. 1445-1457.

Iqbal, F and Urata, S 2002, 'Small Firm Dynamism in East Asia: An Introductory Overview', *Small Business Economics*, vol. 18, no. 1-3, pp. 1-12.

Jackson, KE 2001, 'Free Trade, Fair Trade: Trade Liberalisation, Environmental and Labour Standards', *Journal of the UNE Asia Centre*, vol. 4, pp. 21-34.

Jovanovic, B 1982, 'Selection and the Evolution of Industries', *Econometrica*, vol. 50, no. 3, pp. 649-670.

Kalaitzandonakes, NG and Dunn, EG 1995, 'Technical Efficiency, Managerial Ability and Farmer Education in Guatemalan Corn Production: A Latent Variable Analysis', *Agricultural Resource Economic Review*, vol. 24, pp. 36-46.

Kaplinksy, R and Readman, J 2001, *Integrating SMEs in Global Value Chains: Towards Partnership for Development*, UNIDO, Vienna.

Kaplinsky, R and Morris, M 2007, *The Structure of Supply Chains and Their Implications for Export Supply, African Economic Research Consortium*, 1-36 June.

Kawai, H and Urata, S 2002, 'Entry of Small and Medium Enterprises and Economic Dynamism in Japan', *Small Business Economics*, vol. 18, no. 1-3, pp. 41-51.

Kim, S 2003, 'Identifying and Estimating Sources of Technical Inefficiency in Korean Manufacturing Industries', *Contemporary Economic Policy*, vol. 21, no. 1, pp. 132-144.

Kimura, F and Kiyota, K 2007, 'Foreign-Owned Versus Domestically-Owned Firms: Economic Performance in Japan', *Review of Development Economics*, vol. 11, no. 1, pp. 31-48.

Kirby, DA and Watson, A (eds) 2003, *Introduction*, Small Firms and Economic Development in Developed and Transition, Ashgate, Aldershot.

Knight, G 2000, 'Entrepreneurship and Marketing Strategy: The SME Under Globalization', *Journal of International Marketing*, vol. 8, no. 2, pp. 12-33.

Kodde, DA and Palm, FC 1986, 'Wald Criteria for Jointly Testing Equality and Inequality Restrictions ', *Econometrica*, vol. 54, no. 5, pp. 1243-1248

Kontodimopoulos, N, Papathanasiou, ND, Flokou, A, Tountas, Y and Niakas, D 2010, 'The Impact of Non-Discretionary Factors on DEA and SFA Technical Efficiency Differences', *Journal of Medical Systems*, vol. DOI 10.1007/s10916-010-9521-0, pp. 1-9.

Kraipornsak, P 2001, 'How Efficient Was the Thai Economy? Sectoral Comparison During 1970-1996', accessed 01/04/2009, http: //www.econ.chula.ac.th/about/member/paitoon_k/Sect-EfficiencyPaper.pdf.

Krasachat, W 2000, *Measurement of Technical Efficiency in Thai Agricultural Production*, The International Conference on the Chao Praya Delta: Historical Development, Dynamics and Challenges of Thailand's Rice Bowl, Bangkok, Thailand, 2-15 December.

Krasniqi, BA 2007, 'Barriers to Entrepreneurship and SME Growth in Transition: The Case of Kosova', *Journal of Developmental Entrepreneurship*, vol. 12, no. 1, pp. 71-94.

Krugman, P 2001, 'What Happen to Asia?', *Financial Market Integration and International Capital Flows*, pp. 209-218.

Kumbhakar, S and Lovell, CAK 2000, *Stochastic Frontier Analysis*, Cambridge University Press, New York.

Kuwayama, M 2001, *E-Commerce and Export Promotion Policies for Small and Medium-Sized Enterprises: East Asian and Latin American Experiences*, International Trade and Integration Division, Santiago, Chile.

Langlois, RN 2003, 'Schumpeter and the Obsolescence of the Entrepreneur', *Advances in Austrian Economics*, vol. 6, pp. 287-302.

Le, CLV 2010, 'Technical Efficiency Performance of Vietnamese Manufacturing Small and Medium Enterprises', PhD Thesis, School of Economics, Faculty of Commerce, University of Wollongong.

Le, V and Harvie, C 2010, 'Firm Performance in Vietnam: Evidence from Manufacturing Small and Medium Enterprises', *University of Wollongong Economics, Working Paper Series 04-10*, pp. 1-33.

Lee, BL 2011, 'Efficiency of Research Performance of Australian Universities: A Reappraisal Using a Bootstrap Truncated Regression Approach', *Economic Analysis and Policy*, vol. 41, no. 3, pp. 195-203.

Lee, BL 2013, 'Productivity, Technical and Efficiency Change in Singapore's Services Sector, 2005 to 2008 ', *Applied Economics*, vol. 45, no. 15, pp. 2023-2029.

Lertwongsatien, C and Wongpinunwatana, N 2003, 'E-commerce Adoption in Thailand: An Empirical Study of Small and Medium Enterprises (SMEs)', *Journal of Global Information Technology Management*, vol. 6, no. 3, pp. 67-83.

Li, Y and Hu, JL 2002, 'Technical Efficiency and Location Choice of Small and Medium-Sized Enterprises', *Small Business Economics*, vol. 19, pp. 1-12.

Liao, C-S, Yang, C-H and Liu, D 2010, 'Efficiency, Productivity and Ownership Structure for Securities Firms in Taiwan', *Journal of Money, Investment and Banking*, vol. 14, pp. 46-58.

Liedholm, C 2002, 'Small Firm Dynamics: Evidence from Africa and Latin America', *Small Business Economics*, vol. 18, pp. 227-242.

Lim, H and Kimura, F 2009, *The Internationalisation of SMEs in Regional and Global Value Chains*, accessed 12/09/2010, http://www.iadb.org/intal/aplicaciones/uploads/ponencias/i_Foro_LAEBA_2009_07_01_Lim-Kimura.pdf.

Lu, JW and Beamish, PW 2006, 'SME Internationalization and Performance: Growth vs Profitability', *Journal of International Entrepreneurship*, vol. 4, pp. 27-48.

Luetkenhorst, W 2005, 'Private Sector Development: the Support Programmes of the Small and Medium Enterprises Branch', *SME Technical Working Papers Series, the United Nations Industrial Development Organization (UNIDO).*

Lundvall, K and Battese, GE 2000, 'Firm Size, Age and Efficiency: Evidence from Kenyan Manufacturing Firms', *The Journal of Development Studies*, vol. 36, no. 3, pp. 146-163.

Macqueen, D 2005, *Small Scale Enterprise and Sustainable Development: Key Issues and Policy Opportunities to Improve Impact*, International Institute for Environment and Development (IIED), Edinburgh.

Major, I 2008, 'Technical Efficiency, Allocative Efficiency and Profitability in Hungarian Small and Medium-Sized Enterprises: A Model with Frontier Functions', *Europe - Asia Studies*, vol. 60, no. 8, pp. 1371.

Mambula, C 2002, 'Perceptions of SME Growth Constraints in Nigeria', *Journal of Small Business Management*, vol. 40, no. 1, pp. 58.

McDonald, J 1999, 'The Determinants on Firm Profitability in Australia Manufacturing', *The Economic Record*, vol. 75, no. 229, pp. 115-126.

McDonald, J 2009, 'Using Least Squares and Tobit in Second Stage DEA Efficiency Analyses', *European Journal of Operational Research*, vol. 197, pp. 792-798.

McMahon, RGP 2001, 'Business Growth and Performance and the Financial Reporting Practices of Australian Manufacturing SMEs', *Journal of Small Business Management*, vol. 39, no. 2, pp. 152.

Menkhoff, L and Suwanaporn, C 2007, '10 Years After the Crisis: Thailand's Financial System Reform', *Journal of Asian Economics*, vol. 18, pp. 4-20.

Mephokee, C 2003, *The Thai SMEs Development Policies: Country Report*, Thammasat University, Bangkok.

Minh, NK and Long, GT 2005, 'Efficiency of Construction Firms in Vietnam', *Munich Personal RePEc Archive (MPRA) Paper No. 2872*, pp. 44-59.

Minh, NK, Long, GT and Thang, BN 2007, 'Technical Efficiency of Small and Medium Manufacturing Firms in Vietnam: Parametric and Non-Parametric Approaches', *The Korean Economic Review*, vol. 23, no. 1, pp. 187-221.

Moffat, BD 2008, 'Efficiency and Productivity in Botswana's Financial Institutions', PhD Thesis, School of Economics, Faculty of Commerce, University of Wollongong.

Mortimer, D 2002, 'Competing Methods for Efficiency Measurement: A Systematic Review of Direct DEA vs SFA/DFA Comparisons', *Working Paper 136*, pp. 1-19.

Murillo-Zamorano, LR 2004, 'Economic Efficiency and Frontier Techniques', *Journal of Economic Surveys*, vol. 18, no. 1, pp. 33-77.

Newby, R 2006, 'Examining the Goals of Small and Medium Enterprise Owner-Operators', PhD thesis, School of Economics and Commerce, The University of Western Australia.

Nguyen, KM 2001, 'Financial Management and Profitability of Small and Medium Enterprises', DBA Thesis, Southern Cross University.

North, D and Smallbone, D 1995b, *Employment Generation and Small Business Growth in Different Geographical Environments*, Small Firms: Partnerships for Growth, Chittenden, F, Robertson, M, Marshall, I (eds), Paul Chapman, London.

NSO 2011a, *The 1997 Industrial Census, National Statistical Office of Thailand*, accessed 13/05/2010, http://web.nso.go.th/eng/en/stat/indus/indus.htm.

NSO 2011b, *The 2007 Industrial Census, National Statistical Office of Thailand*, accessed 13/05/2010, http://web.nso.go.th/eng/en/stat/indus/indus00.htm.

NSO 2011c, *Executive Summary Report, The 2007 Industrial Census, National Statistical Office of Thailand*, accessed 13/05/2010, http://web.nso.go.th/en/census/indus07.htm.

Nukul's Commission Report 1998, *Analysis and Evaluation on Facts Behind Thailand's Economic Crisis*, The Commission Tasked with Making Recommendations to Improve the Efficiency and Management of Thailand's Financial System.

O'Donnell, CJ, Chambers, RG and Quiggin, J 2009, 'Efficiency Analysis in the Presence of Uncertainty ', *Journal of Productivity Analysis* vol. 33, no. 1, pp. 1-17.

O'Gorman, C 2001, 'The Sustainability of Growth in Small- and Medium-sized Enterprises', *International Journal of Entrepreneurial Behavior & Research*, vol. 7, no. 2, pp. 60-75.

O'Regan, N, Ghobadian, A and Gallear, D 2006, 'In Search of the Drivers of High Growth in Manufacturing SMEs ', *Technovation*, vol. 26, pp. 30-41.

OECD 2000, *Enhancing the Competitiveness of SMEs in Transition Economies and Developing Countries in the Global Economy and their Partnership with SMEs of OECD Countries*, Conference for Ministers Responsible for SMEs and Industry Ministers Bologna, Italy, 14-15 June

OECD 2005, *SME and Entrepreneurship Outlook*, Organisation for Economic Co-operation and Development, Paris.

OECD 2008, *Removing Barriers to SME Access to International Markets*, OECD Working Party on SMEs and Entrepreneurship, APEC Small and Medium Enterprises Working Group, Organisation for Economic Co-operation and Development, Paris.

OECD 2011, *OECD Studies on SMEs and Entrepreneurship Thailand: Key Issues and Policies*, Organisation for Economic Co-operation and Development, Paris.

OECD 2011, *SMEs and Entrepreneurship: Glossary for Barriers to SME Access to International Markets*, Organisation for Economic Co-operation and Development, Paris.

OECD and APEC 2007, *Removing Barriers to SME Access to International Markets*, A Joint OECD-APEC Study Project, APEC Secretariat, Singapore.

Okuda, H and Rungsomboon, S 2006, 'Comparative Cost Study of Foreign and Thai Domestic Banks in 1990-2002: Its Policy Implications for a Desirable Banking Industry Structure', *Journal of Asian Economics*, vol. 17, no. 4, pp. 714-737.

Olutunla, GT and Obamuyi, TM 2008, 'An Empirical Aanalysis of Factors Associated with the Profitability of Small and Medium - Enterprises in Nigeria', *African Journal of Business Management*, vol. 2, pp. 195-200.

ONRCT 2012, *Office of National Research Council of Thailand*, accessed 15/01/2012, http://www.nrct.go.th/index.php.

Organisation for Small & Medium Enterprises and Regional Innovation Japan (SMRJ) 2008, *Small & Medium Enterprise Development Policies in Thailand*, Tokyo.

OSMEP 2001, *Executive Summary of White Paper on SMEs in 2001*, Office of Small and Medium Enterprises Promotion, Bangkok.

OSMEP 2002, *The White Paper on Small and Medium Enterprises of Thailand in 2002 and Trends 2003*, Office of Small and Medium Enterprises Promotion, Bangkok.

OSMEP 2003, *The White Paper on Small and Medium Enterprises of Thailand in 2003 and Trends 2004*, Office of Small and Medium Enterprises Promotion, Bangkok.

OSMEP 2004, *The White Paper on Small and Medium Enterprises of Thailand in 2004 and Trends 2005*, Office of Small and Medium Enterprises Promotion, Bangkok.

OSMEP 2005, *The White Paper on Small and Medium Enterprises of Thailand in 2005 and Trends 2006*, Office of Small and Medium Enterprises Promotion, Bangkok.

OSMEP 2007a, *The White Paper on Small and Medium Enterprises of Thailand in 2007 and Trends 2008*, Office of Small and Medium Enterprises Promotion, Bangkok.

OSMEP 2007b, *The 2nd SME Promotion Plan (2007-2011)*, Office of Small and Medium Enterprises Promotion, Bangkok.

OSMEP 2008, *The White Paper on Small and Medium Enterprises of Thailand in 2008 and Trends 2009*, Office of Small and Medium Enterprises Promotion, Bangkok.

OSMEP 2009, *The White Paper on Small and Medium Enterprises of Thailand in 2009 and Trends 2010*, Office of Small and Medium Enterprises Promotion, Bangkok.

OSMRJ 2008, *Small & Medium Enterprise Development Policies in Thailand*, Organisation for Small & Medium Enterprises and Regional Innovation Japan, Tokyo.

Oum, S, Harvie, C and Narjoko, D 2011, *Small and Medium Enterprises' (SMEs') Access to Finance in Selected East Asian Economies*, Charles Harvie, Sothea Oum, Dionisius Narjoko (eds), Jakarta.

Pangarkar, N 2008, 'Internationalization and Performance of Small- and Medium-sized Enterprises', *Journal of World Business*, vol. 43, pp. 475–485.

Park, Y, Shin, J and Kim, T 2009, 'Firm Size, Age, Industrial Networking and Growth: A Case of the Korean Manufacturing Industry', *Small Business Economics*, vol. 35, pp. 153-168.

Pasanen, M 2006, *SME Growth Strategies: A Comparison of Young and Long-Lived Firms*, International Conference on Business and Information, Singapore, 12-14 July.

Pasanen, M 2007, 'SME Growth Strategies: Organic or Non-Organic?', *Journal of Enterprising Culture*, vol. 15, no. 4, pp. 317.

Peacock, RW 2004, *Understanding Small Business: Practice, Theory and Research*, Scarman Publishing, Adelaide.

Pham, HT, Dao, TL and Reilly, B 2009, 'Technical Efficiency in the Vietnamese Manufacturing Sector', *Journal of International Development*, vol. DOI: 10.1002, no. jid.1588, pp. 1-18.

Phan, P 2004, 'Trade Liberalisation and Manufacturing Performance in Thailand 1990-2000', PhD Thesis, School of Economics, Faculty of Commerce, University of Wollongong.

Pholphirul, P 2005, *Competitiveness, Income Distribution, and Growth in Thailand: What Does the Long-run Evidence Show*, International Economic Relations Program Thailand Development Research Institute.

Pholphirul, P 2008, 'Financial Instability, Banking Crisis, and Growth Volatility: An Investigation of Bi-Directional Relationship', *International Journal of Business and Management Science*, vol. 3, no. 6, pp. 97-100.

Porter, ME 2000, *Locations, Clusters and Company Strategy, The Oxford Handbook of Economic Geography*, Oxford University Press.

Punyasavatsut, C 2007, *SMEs in the Thai Manufacturing Industry: Linking with MNEs*, accessed 15/05/2009, http: //www.eria.org/research/images/pdf/PDF%20No.5/No,5-10-Thai.pdf.

Punyasavatsut, C 2010, *Integrating SMEs into East Asia Production Networks: Thailand*, Integrating Small and Medium Enterprises (SMEs) into the More Integrated East Asia, Vo Tri Thanh, Dionisius Narjoko and Sothea Oum (eds), Jakarta.

Racic, D, Aralica, Z and Redzepagic, D 2008, 'Export Strategies as a Factor of SME Growth in Croatia', *International Journal of Entrepreneurship and Innovation Management*, vol. 8, no. 3, pp. 286.

Rankin, N 2001, *Specialisation, Efficiency and Exports: Some Preliminary Results from South African Manufacturing Firms*, The CSAE and UNIDO International Forum, New Industrial Realities and Firm Behaviour in Africa, Oxford, September 20-22.

Regnier, P 2000, *Small and Medium Enterprises in Distress: Thailand, The East Asian Crisis and Beyond*, Ashgate Publishing, Burlington.

Reynolds, PD and Curtin, RT (eds) 2011, *New Business Creation: An International Overview*, International Studies in Entrepreneurship, Springer, New York.

Robson, PJA and Bennett, RJ 2000, 'SME Growth: The Relationship with Business Advice and External Collaboration', *Small Business Economics*, vol. 15, pp. 193–208.

Rogers, M 1998, 'The Definition and Measurement of Productivity ', *Melbourne Institute Working Paper No. 9/98*, pp. 1-27.

Rondinelli, DA and Kasarda, JD 1992, 'Foreign Trade Potential, Small Enterprise Development and Job Creation in Developing Countries', *Small Business Economics*, vol. 4, no. 4, pp. 253-265.

Rosa, P and Scott, M 1999, 'The Prevalence of Multiple Owners and Directors in the SME Sector: Implications for our Understanding of Start-up and Growth', *Entrepreneurship and Regional Development*, vol. 11, no. 1, pp. 21-37.

Rose, RC, Kumar, N and Yen, LL 2006, 'Entrepreneurs Success Factors and Escalation of Small and Medium-sized Enterprises in Malaysia', *Journal of Social Sciences*, vol. 2, no. 3, pp. 74-80.

Ross, SA, Westerfield, RW and Jaffe, J 1999, *Corporate Finance*, 5th edition, Irwin: McGraw-Hill.

Sahakijpicharn, K 2007, 'Guanxi Network and Business Performance of Sino-Thai SMEs', PhD Thesis, School of Economics, Faculty of Commerce, University of Wollongong.

Saleh, AS and Ndubisi, NO 2008, *SME Development in Malaysia: Domestic and Global Challenges*, Small and Medium Sized Enterprises in East Asia, Charles Harvie and Boon-Chye Lee (eds), Edward Elgar, Cheltenham.

Syverson, C 2007, 'Prices, Spatial Competition and Heterogeneous Producers: An Empirical Test', *Journal of Industrial Economics*, vol. 55, no. 2, pp. 197-222.

Sally, R 2007, 'Thai Trade Policy: From Non-discriminatory Liberalisation to FTAs', *The World Economy*, vol. doi: 10.1111/j.1467-9701.2007.01014.x, pp. 1594-1620.

Sandee, H and Rietveld, P 2001, 'Upgrading Traditional Technologies in Small-Scale Industry Clusters: Collaboration and Innovation Adoption in Indonesia', *Journal of Development Studies*, vol. 37, no. 4, pp. 150-172.

Sarapaivanich, N 2003, *The Use of Financial Information in Financial Decisions of SMEs in Thailand*, The Small Enterprise Association of Australia and New Zealand 16th Annual Conference, Ballarat, Australia, 28 September - 1 October.

Sato, Y 1983, 'The Subcontracting Production (Shitauke) System in Japan', *Keio Business Review*, vol. 21, no. 1, pp. 1-25.

Schmitz, H and Nadvi, K 1999, 'Clustering and Industrialisation: Introduction', *World Development*, vol. 27, no. 9, pp. 1503-1514.

Schumpeter, JA 1942, *Capitalism, Socialism and Democracy*, Harper and Row, New York.

Seelanatha, SL 2007, 'Efficiency, Productivity Change and Market Structure of the Banking Industry in Sri Lanka'School of Accounting, Economics and Finance, Faculty of Business, University of Southern Queensland.

Serrasqueiro, Z 2008, 'SME's Growth: Empirical Evidence Using Dynamic Panel Estimators', *Actual Problems of Economics*, vol. 90, pp. 40-47.

Sevilla, RC and Soonthornthada, K 2000, *SME Policy in Thailand: Vision and Challenges*, Institute for Population and Social Research, Mahidol University, Salaya Campus, Nakhon Pathom.

Sharma, KR, Leung, P and Zaleski, HM 1997, 'Productive Efficiency of the Swine Industry in Hawaii: Stochastic Frontier vs. Data Envelopment Analysis', *Journal of Productivity Analysis*, vol. 8, pp. 447-459.

Simar, L and Wilson, P 2007, 'Estimation and Inference in Two-Stage, Semi-Parametric Models of Production Processes', *Journal of Econometrics*, vol. 136, no. 1, pp. 31-64.

Simpson, M and Taylor, N 2002, 'The role and relevance of marketing in SMEs: towards a new model', *Journal of Small Business and Enterprise Development*, vol. 9, no. 4, pp. 370-382.

Smallbone, D, Leig, R and North, D 1995, 'The Characteristics and Strategies of High Growth SMEs', *International Journal of Entrepreneurial Behavior & Research*, vol. 1, no. 3, pp. 44-62.

SME Development for Sustainability and Competitiveness 2004, accessed 26/05/2009, http ://www.smebank.co.th/index_en.php.

Smith, PC and Street, A 2005, 'Measuring the Efficiency of Public Services: The Limits of Analysis', *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, vol. 168, no. 2, pp. 401-417.

Snodgrass, DR and Biggs, T 1995, *Industrialization and the Small Firms: Patterns and Policies*, International Centre for Economic Growth and the Harvard Institute for International Development, San Francisco.

Stevenson, RE 1980, 'Likelihood Functions for Generalized Stochastic Frontier Estimation', *Journal of Econometrics*, vol. 13 no. 1, pp. 57-66.

Storey, D 1994, *Understanding the Small Business Sector*, Routledge, London.

Suprapto, B, Wahab, HA and Wibowo, AJ 2009, 'The Implementation of Balance Score Card for Performance Measurement in Small and Medium Enterprises: Evidence from Malaysian Health Care Services', *The Asian Journal of Technology Management*, vol. 2, no. 2, pp. 76-87.

Tambunan, T 2008, 'Development of SME in ASEAN with Reference to Indonesia and Thailand', *Chulalongkorn Journal of Economics*, vol. 20, no. 1, pp. 53-58.

Tambunan, T 2008a, 'SME Development, Economic Growth and Government Intervention in a Developing Country: The Indonesian Story', *Journal of International Entrepreneurship*, vol. 6, no. 4, pp. 147-167.

Tambunan, T 2008b, 'Development of Small and Medium Enterprises in a Developing Country: The Indonesian Case', *Journal of Rural Development/Nongchon-Gyeongje*, vol. 31, no. 2, pp. 1-23.

Tapaneeyangkul, P 2001, *Government Policies in Assisting SMEs for Sustainable Development*, The Office of Small and Medium Enterprise Promotion, Bangkok.

Thai Industrial Standards Institute 2009, accessed 26/05/2009, http: //www.tisi.go.th/eng/tisi.html.

Thailand Productivity Institute 2009, accessed 21/07/2009, http://www.ftpi.or.th/Home/tabid/36/Default.aspx.

Thanapornpun, R 2008, *Trade Policy Review of Thailand: The Thai Government Reports, 1995-2007*, Bangkok.

Thassanabanjong, K, Miller, P and Marchant, T 2009, 'Training in Thai SMEs', *Journal of Small Business and Enterprise Development*, vol. 16, no. 4, pp. 678-693.

The Association of Southeast Asian Nations (ASEAN) 2011, *The Economic Benefits to ASEAN of the ASEAN-China Free Trade Area (ACFTA)*, accessed 10/04/2011, http://www.aseansec.org/17310.htm.

The Small and Medium Enterprise Development Bank of Thailand 2009, accessed 26/05/2009, http: //www.smebank.co.th/eng/history.html.

the United Nations Statistics Division 2010, *Standard International Trade Classification, SITC: Revision 4*, accessed 13/05/2011, http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=28.

Theingi 2004, 'The Influence of Marketing Control and a Resource-Based View on Export Performance of SMEs in Thailand', PhD Thesis, University of Western Australia.

Thurik, AR 2008, *The 'Managed' and the 'Entrepreneurial' Economy* World Entrepreneurship Forum 2008 Edition.

Thurik, AR, Carree, MA, Stel, Av and Audretsch, DB 2008, 'Does Self-employment Reduce Unemployment', *Journal of Business Venturing*, vol. 23, pp. 673-686.

Thurik, R 2003, 'Entrepreneurship and Unemployment in the UK', *Scottish Journal of Political Economy*, vol. 50, no. 3, pp. 264-290.

Thurik, R 2009, *Entrepreneurship, Economic Growth and Policy in Emerging Economies*, Unied Nations University, World Institute for Development Economics Research, Research Paper No. 2009/12.

Thuvachote, S 2007, *Agricultural Cooperatives in Thailand: Innovations and Opportunities in the 21st Century*, Department of Cooperatives, Faculty of Economics, Kasetsart University, Bangkok.

Tinakorn, P and Sussangkarn, C 1994, 'Productivity Growth in Thailand', *Thailand Development Research Institute (TDRI) Quarterly Review*, vol. 9, no. 4, pp. 35-40.

Tippakoon, P 2009, *The Role of the Buyer in the Upgrading of Rural Enterprises in Thailand: Lessons from 13 Silk-Weaving Enterprises in PakThong Chai District, Nakhon Rachasima Province*, accessed 02/01/10, http://ir.nul.nagoya-u.ac.jp/dspace/handle/2237/11805.

Tran, TB, Grafton, RQ and Kompas, T 2008, 'Firm Efficiency in a Transitional Economy: Evidence from Vietnam', *Asian Economic Journal*, vol. 22, no. 1, pp. 47-66.

Tran, TB, Grafton, RQ and Kompas, T 2008, 'Firm Efficiency in a Transitional Economy: Evidence from Vietnam', *Asian Economic Journal* vol. 22, no. 1, pp. 47-66.

Tranh, VT, Narjoko, D and Oum, S 2009, *Integrating Small and Medium Enterprises into More Integrating East Asia, ERIA Research Project Report, No. 8*, Jakarta.

Tybout, JR 2000, 'Manufacturing Firms in Developing Countries: How Well Do They Do, and Why?', *Journal of Economic Literature*, vol. XXXVIII, pp. 11-44.

UNCTAD 2005, *Improving the Competitiveness of SMEs through Enhancing Productive Capacity*, United Nations, Geneve and New York.

UNCTAD 2006, *Promoting TNC–SME Linkages to Enhance the Productive Capacity of Developing Countries' Firms: A Policy Perspective, The UNCTAD Secretariat, Trade and Development Board*, UNCTAD, Geneva.

Varatorn, S 2005, *Literacy through Child Activities: Community Children's Libraries and the Story - Book Projects*, World Library and Information Congress:71th IFLA General Conference and Council "Libraries - A Voyage of Discovery", Oslo, Norway, 14 - 18 August.

Varian, HR 1999, *Intermediate Microeconomics: A Modern Approach*, W.W. Norton & Company, New York.

Vu, QN 2003, 'Technical Efficiency of Industrial State-Owned Enterprises in Vietnam', *Asian Economic Journal*, vol. 17, no. 1, pp. 87-101.

Wadud, MA 2003, 'Technical, Allocative, and Economic Efficiency of Farms in Bangladesh: A Stochastic Frontier and DEA Approach', *The Journal of Developing Areas*, vol. 37, no. 1, pp. 109-126.

Wang, C, Walker, EA and Redmond, J 2007, 'Explaining the Lack of Strategic Planning in SMEs: the Importance of Owner Motivation', *International Journal of Organisational Behaviour*, vol. 12, no. 1, pp. 1-16.

Ward, J and Dolan, C 1998, 'Defining and Describing Family Business Ownership Configurations', *Family Business Review*, vol. 11, no. 4, pp. 305-310.

Wiboonchutikula, P 2002, 'Small and Medium Enterprises in Thailand: Recent Trends ', *Small Business Economics*, vol. 18, pp. 213-226.

Wilson, K 2012, *Encouraging the Internationalisation of SMEs*, accessed 30/07/2012, http://www.gvpartners.com/web/pdf/Chapter_2_Wilson_FINAL.pdf.

Wilson, PW 2009, *FEAR 1.12 Command Reference*, This Manual Is for FEAR Version 1.12, A Library for Estimating Productive Efficiency, etc. using R, South Carolina.

Woods, N 2001, *International Political Economy in an Age of Globalization*, The Globalization of World Politics, John Baylis and Steve Smith (eds), Oxford University Press.

World Bank 1993, *The East Asian Miracle: Economic Growth and Public Policy*, Oxford University Press, New York.

World Bank 2001, *World Bank Group Review of Small Business Activities*, Washington DC.

World Bank Report 1997, *The State in a Changing World*, Oxford University Press, New York.

Yamawaki, H 2002, 'The Evolution and Structure of Industrial Clusters in Japan', *Small Business Economics*, vol. 18, no. 1-3, pp. 121-140.

Yang, C-H and Chen, K-H 2009, 'Are Small Firms Less Efficient?', *Small Business Economics*, vol. 32, pp. 375-395.

Yang, JC 2006, 'The Efficiency of SMEs in the Global Market: Measuring the Korean Performance', *Journal of Policy Modeling*, vol. 28, pp. 861-876.

You, J-I 1995, 'Small Firms in Economic Theory', *Cambridge Journal of Economics*, vol. 19, no. 3, pp. 441-462.

Yuwaboon, C 2004, *Strategic Partnership in Promoting Technology Incubation System for SMEs*, Thailand Science Park, National Science and Technology Development Agency (NSTDA).

Zahid, Z and Mokhtar, M 2007, *Estimating Technical Efficiency of Malaysian Manufacturing Small and Medium Enterprises: A Stochastic Frontier Modelling*, The 4th SMEs in a Global Economy Conference, University of Wollongong, 9-10 July.

Zheka, V 2005, 'Corporate Governance, Ownership Structure and Corporate Efficiency: The Case of Ukraine', *Managerial and Decision Economics*, vol. 26, pp. 451–460.

Zhu, J 2003, *Quantitative Models for Performance Evaluation and Benchmarking: Data Envelopment Analysis with Spreadsheets and DEA Excel Solver*, Springer, New York.