Competitiveness, Efficiency and Convergence in the ASEAN Banking Market

By

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DECLARATION

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ABSTRACT

The regional coordination toward financial integration of the ASEAN economies started in the aftermath of the 1997 Asian crisis. Along with banking structural reforms in individual countries, several regional financial integration initiatives were launched to promote regional financial stability and economic growth. This thesis investigates the impact of national banking structural reforms and ASEAN regional financial integration on bank efficiency and performance. It examines the similarity and convergence properties of the banking systems across the major ASEAN economies from two aspects, namely bank efficiency and bank competitiveness. This thesis contains three empirical essays; Chapter 3 examines the cost efficiencies of ASEAN banks by using Battese and Coelli (1995) Stochastic Frontier Approach (SFA). The cost efficiency scores are then used to test for efficiency convergence properties. The ASEAN banking markets have been found to be converging at the aggregate level, but lack convergence at the micro individual bank level. The importance of individual banks is further proved by a single country bank efficiency study on Indonesia in Chapter 4, using an alternative method known as non-parametric DEA with Simar and Wilson (2007) double bootstrap method. In Chapter 5, the banking market competitiveness is modelled by the new empirical industrial organization (NEIO) non-structural approach, Panzar-Roasse (PR) reduced-form revenue model. The degree of similarity in banking market competitiveness across major ASEAN countries is assessed by comparing the estimated *H*-statistics. The ASEAN banking markets have been found to differ a lot in terms of competitive structures and have experienced very different evolution processes of market structure with a weak convergence tendency. However, certain degree of contestability has been found by examining the relationship between market competitiveness and market concentration. The research of this thesis does not find strong evidence for improvement in bank performance and banking market convergence, although some positive aspects are discovered. The degree of banking market integration for ASEAN countries is still relatively low.

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Chapter 1 Introduction

The Association of Southeast Asian Nations, or ASEAN, was established on 8 August 1967 in Bangkok by the 5 initial members, Indonesia, Malaysia, the Philippines, Singapore and Thailand. Another 5 countries, Brunei Darussalam, Vietnam, Lao PDR and Myanmar, joined in the following years. After more than 4 decades of development, ASEAN now is an important area for the Asian and the world economy, and has achieved significant progress in regional cultural, political and economic co-operation and integration. ASEAN has experienced similar characteristics to that of the European Union before the adoption of the Euro as a single currency, such as the high degree of flexibility of production factors and shock symmetries between countries. However, the substantial macroeconomic differences in income and output levels between countries and weak macroeconomic convergence requires further policy direction for deeper regional coordination in both real and financial aspects. The regional coordination toward financial integration started in the aftermath of the 1997 Asian crisis. Together with the significant banking structural reforms in individual countries after the 1997 financial crisis, several regional financial integration initiatives have also been launched to promote regional financial stability and economic growth. Especially when the Euro was launched as a single currency since 1999, the notion of a similar currency union in ASEAN was emerged and became a long-term strategy for the ASEAN policy makers.

The regionalism and economic integration also exist to large extent in larger geographical areas, for example, the East Asia area, including all ASEAN countries

plus People's Republic of China, Japan, South Korea and Taiwan; or even the Asia as a whole. However, in the present thesis, ASEAN is chosen as the only objective for the reason that, among the alternative geographical areas, ASEAN has the most possibility for a regional currency arrangement, primarily because of the political wills. ASEAN is the only area in which the policy makers have expressed their strong interests in the possibility of moving toward a currency union (Bayoumi and Mauro, 2001). Also based on the current economic development levels of the Asian countries, a greater region would have greater economic and political asymmetries which are not in favour of successful financial and monetary integration.

Arguably, one of the benefits of financial integration is that it will promote competition in the financial markets by eliminating cross-border barriers, and therefore improve the economic welfare through greater efficiency in production and allocation of credit. This thesis examines the impact of national banking structural reforms and ASEAN regional financial integration on the performance in financial markets, particularly, in the banking market. The first question to be answered is, has the financial integration improved bank efficiency and competitiveness in ASEAN? Secondly, this thesis also contributes to the literature of financial integration indicators, by evaluating the degree of banking integration through the convergence properties from the institutional and operational perspective, i.e. convergence in bank efficiency. Regional convergence in bank operational efficiency levels signals that the inefficient banks are catching up with the efficient banks trough adaption of superior technology, which is one of the desired outcomes from financial integration. Declining dispersion in operational efficiency levels is also an indicator for financial integration.

Rather than presenting all the empirical analyses straight away, some background information about ASEAN is given in Chapter 2. Significant degree of strategic economic co-operation and integration are evidenced by dramatic increases in total trade volume and gradual increase in the intra-regional trade, as well as the political willingness for further regional integration. From a macro perspective, the ASEAN economies appear to exhibit some characteristics of the European Union at the time of the Maastricht Treaty. However, empirical evidences on real and financial convergence provides mixed results, and more investigation on various aspects, such as the research has been done in the present thesis on banking industry, are necessary.

Chapter 3 examines the differences in bank cost efficiencies across the 5 major economies in ASEAN, using the Battese and Coelli (1995) Stochastic Frontier Approach (SFA) model. A common best-practice frontier based on 1889 bank-year observations in 5 countries over 16 years (1994-2009) is estimated to facilitate the cross-country comparison on bank efficiency levels. Chapter 3 does not only compare the general efficiency level across countries, but also utilise the concepts of *β-convergence* and *σ-convergence* which are borrowed from the growth-convergence literature to examine their convergence properties, which are typically only done for nominal macroeconomic variables in the literature. The ASEAN banking market has been found to be converging at aggregate level, but the institutional level convergence is weak.

A well-integrated banking market requires banking system to converge not only at the aggregate level, but also at the institutional level, i.e. convergence tendency from individual banks. The important role played by individual banks has been

noticed in Chapter 3 and has been further investigated in Chapter 4, which is a single-country study on bank efficiency and its convergence properties for Indonesia only. The main contribution of this chapter is to check the robustness of the results found in the previous chapter using an alternative efficiency estimation method, and also to investigate bank efficiency and the policy implications for a single country in more details. A relatively new method of estimating banking efficiency, the non-parametric Data Envelopment Analysis (DEA) with two-stage semi-parametric bootstrap method of Simar and Wilson (2007), is used to check the consistency of the results from different methodologies, and similar convergence tests as in the previous chapter are carried out in a single country context too. The same estimations are conducted for three models with different specification of banking outputs, and the results show that both the level of bank efficiency and its convergence properties are sensitive to output choice. Main findings in this chapter indicate a major structural change in the aftermath of the 1997 Asian crisis in Indonesia banking industry, with small banks and foreign banks become more efficient in the post-crisis period.

The last empirical chapter, Chapter 5 examines the differences in banking market competitive structures of ASEAN-5. The degree of competition in one particular market is measured by the *H*-statistic, obtained by using a non-structural approach, known as the Panzar-Rosse (PR) reduced-form revenue model, which is based on the new empirical industrial organization (NEIO) theories of contestable markets. After a cross-country comparison on banking industry competitiveness, the *H*-statistics are then used to test the relationship between market competition and concentration. It was found that the ASEAN banking market as a whole could be described as a contestable market.

Chapter 6 concludes the thesis, highlights the main findings and discusses some policies implications. The degree of integration in the current ASEAN banking markets is still relatively low. Substantial differences exist in terms of bank efficiency levels and the degree of competitiveness of each country's banking market. The bank efficiency levels show some degree of convergence at aggregate level; however are lack of convergence at individual bank level. The national banking structural reforms and the regional financial integration projects have not effectively improved the convergence in banking market. Therefore policy encouragement from regional coordination is still needed for deeper banking integration and future monetary integration in ASEAN.

Chapter 2 ASEAN and Regional Integration

1. Introduction

Applied economics and empirical analysis on any particular country/countries would be meaningless without a thorough awareness of the context. In order to help understand the empirical analyses in the rest of the thesis, this chapter will serve as a preface and give the necessary background information about the Association of Southeast Asian Nations (ASEAN), particularly about the 5 core initial member countries, namely Indonesia, Malaysia, the Philippines, Singapore and Thailand, which are the 5 countries used as a sample for all following empirical analyses.

In this chapter, the general information about ASEAN from different perspectives is reviewed in section 2, including the history of formation and development of ASEAN, the member countries and major macroeconomic indicators. The relative position of ASEAN to the world and the relative positions of member countries within the region are also compared. Section 3 outlines the roadmap of ASEAN's economic and financial integration within the region and with the outside world. Section 4 discusses the achievements of the regional integration efforts, and comparison with its peer groups, such as the European Union. Section 5 outlines the central role the banking system plays in the process of financial integration and highlights the primary motivation of the research carried out in this thesis. Section 6 concludes the chapter.

2. ASEAN and ASEAN-5 in Perspective

2.1 ASEAN and the world

The Association of Southeast Asian Nations, or ASEAN, was established on 8 August 1967 in Bangkok, with the initial aim of promoting political co-operations, by the 5 original member countries which are also known as ASEAN-5, namely, Indonesia, Malaysia, the Philippines, Singapore, and Thailand. Another 5 member countries joined the association in the following year. Brunei Darussalam joined on 7 January 1984, Vietnam on 28 July 1995, Lao PDR and Myanmar on 23 July 1997, and the last member, Cambodia, joined on 30 April 1999. During more than 4 decades of development, ASEAN has achieved many dramatic accomplishments in regional co-operations on economics, social security, cultural development, education, regional peace and stability and other fields. The present study will mainly focus on the impressive economic achievements and potentials.

As of 2009, the ASEAN has 10 members in total, with a combined gross domestic product (GDP) of US$ 1,496.34 billion, a total population of about 591 million and a total area of 4.4 million square kilometres[1]. If ASEAN was treated as a single entity, it would rank as the ninth largest economy in the world. The main focus of ASEAN has been shifting gradually from political co-operations towards economic integration and co-operation. Figures 2-1-2-4 provide some general visual comparisons on ASEAN's economy with its near neighbours in Asia, namely, China, India and Japan, and other major economies in the rest of the world.

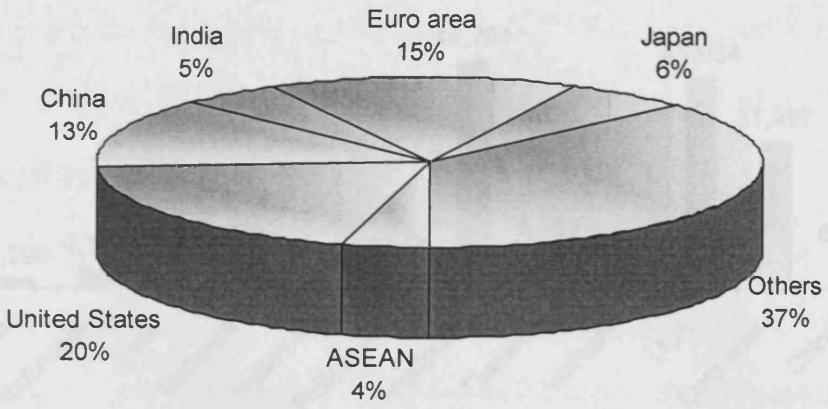
[1] "Selected basic ASEAN indicators", ASEAN Secretariat. http://www.aseansec.org/19226.htm. Retrieved 26 June 2011.

Compared with the rest of the world, ASEAN is a relatively small economy, the 10 member countries together only counts for 4% of the world total (PPP adjusted) GDP in 2009. Also the recent rise of their Asian neighbours, such as China and India, has made this region overlooked somehow. As shown in Figure 2-1, the GDP of a single country, India, is already greater than the sum of ten countries in ASEAN. However, by no means the ASEAN countries should be ignored, since they have much potentials and opportunities to offer to the rest of the world, and has been playing an increasingly important role in the world economy.

The ASEAN domestic market is of great potential. The total population of ASEAN-10 countries is around 591 million in 2009, which is nearly twice the size of Euro area or the USA. The purchasing power measured by per capital GDP in some of the ASEAN countries are quite high, such as in Brunei and Singapore, which are even higher than the US and average level of Euro area[2], although the relative economic sizes of Brunei and Singapore are much smaller. The income indicators of ASEAN countries are also comparable to their Asian developing neighbours, in fact, the average income levels of China and India could only be ranked as middle or low level comparing with most countries in ASEAN.

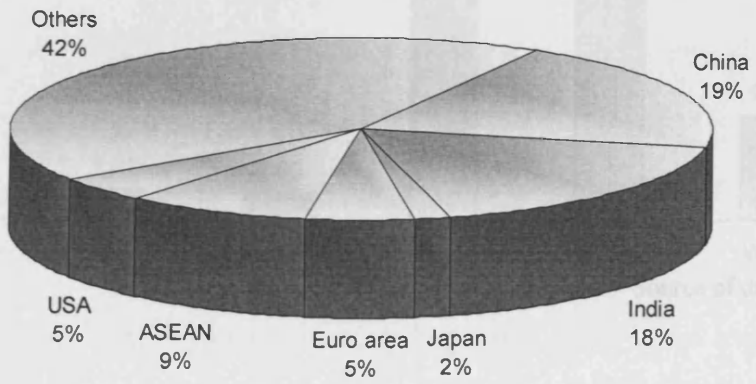
[2] Composed of 16 countries: Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovak Republic, Slovenia, and Spain.

Figure 2-1 GDP based on PPP as % of the world total (2009)



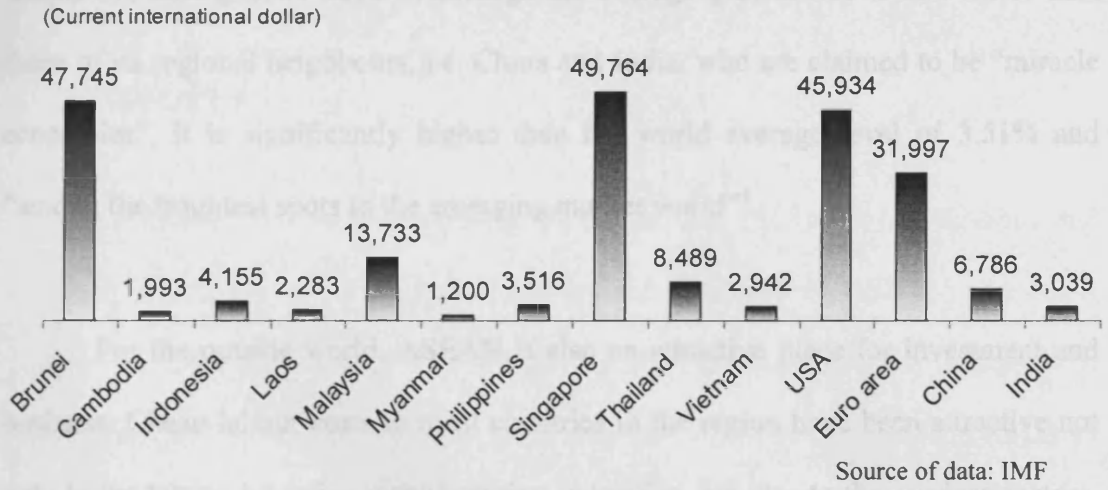
Source of data: IMF

Figure 2-2 Population as % of the world total (2009)



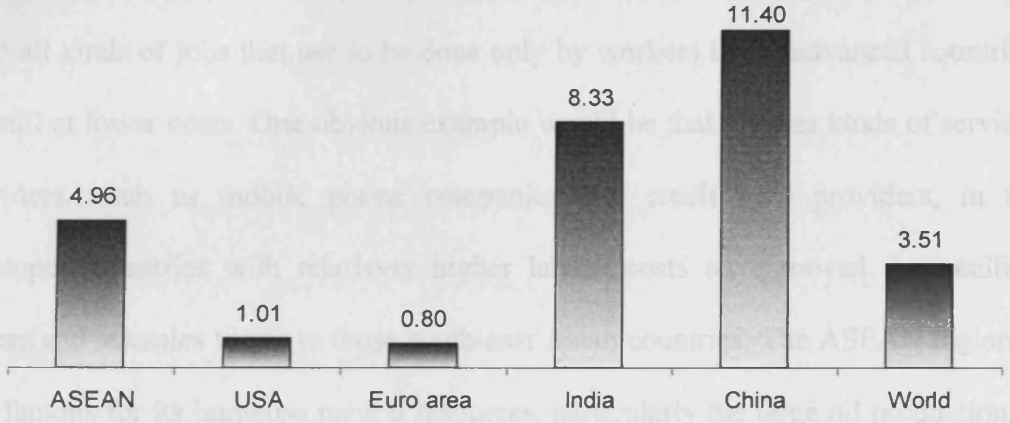
Source of data: IMF and UN Population Division

Figure 2-3 GDP per capita based on PPP in perspective (2009)



Source of data: IMF

Figure 2-4 Average real GDP growth rate for 2005-2009 (%)



Source of data: IMF

ASEAN is also one of the fastest growing emerging markets. The economies of ASEAN were badly hit during the 1997 Asian financial crisis, but recovered quickly and the economies have kept on growing at significant speeds. Even in the recent years of the world-wide economic recession, when the major advanced economies, such as the US and Euro area, have been experiencing zero or even negative

economic growth, the ASEAN countries still maintain an average GDP growth rate of almost 5% during 2005-2009[3]. Although the average growth rate is still lower than those of its regional neighbours, i.e. China and India, who are claimed to be "miracle economies", it is significantly higher than the world average level of 3.51% and "among the brightest spots in the emerging market world"[4].

For the outside world, ASEAN is also an attractive place for investment and business. Cheap labour costs in most countries in the region have been attractive not only to the labour-intensive manufacturing industries, but also to the services sectors. In fact, with the human capital has been acquired during years of education and training efforts in the ASEAN countries, as well as the dramatic developments in computer technologies and telecommunications, the ASEAN people now are capable to do all kinds of jobs that use to be done only by workers in the advanced countries, but still at lower costs. One obvious example would be that various kinds of services providers, such as mobile phone companies and credit card providers, in the developed countries with relatively higher labour costs have moved their calling centres and telesales teams to those south-east Asian countries. The ASEAN region is also famous for its immense natural resources, particularly the large oil production in Indonesia, Malaysia, Brunei and other countries, and Singapore is the largest oil rigs exporter in the world. In terms of finance, Singapore is a well-established financial centre in this region, due to its strong infrastructure of financial system and sound law and governance standards. The Singaporean financial institutions also have close

[3] The figure is calculated as a weighted average growth rate of ASEAN-10 countries weighted by each country's real GDP.
[4] Deutsche Bank Research, 2006.

connections with other international financial centres and could facilitate convenient and swift channelling of funds world-widely.

2.2 ASEAN-5

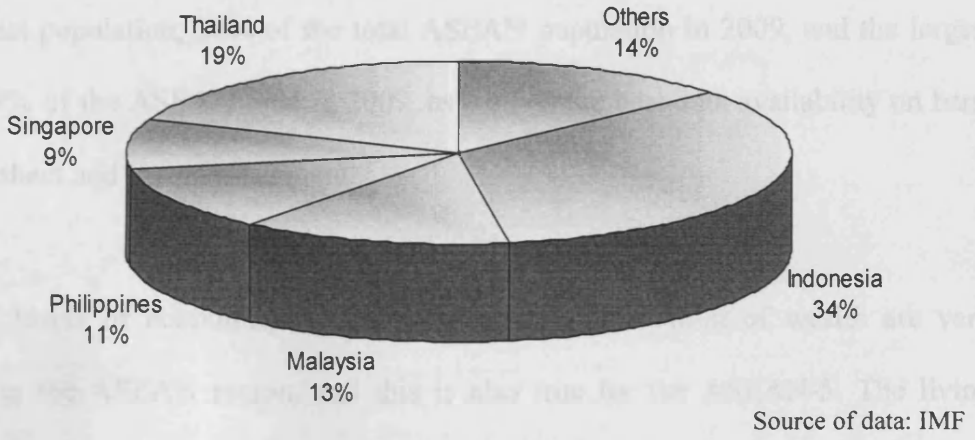
The ASEAN-5 refers to Indonesia, Malaysia, the Philippines, Singapore and Thailand, which are the 5 original members and initiators of ASEAN, and the 5 foreign ministers who signed the ASEAN Declaration[5] to form the organisation, Adam Malik of Indonesia, Narciso R. Ramos of the Philippines, Tun Abdul Razak of Malaysia, S. Rajaratnam of Singapore, and Thanat Khoman of Thailand are hailed as the "Founding Fathers" of ASEAN, which is "probably the most successful inter-governmental organization in the developing world today"[6]. These 5 countries are also the 5 largest economies in this sub-region, and together counts for 80-90% of the total GDP (PPP adjusted) of the ASEAN total. Figure 2-5 shows that, in 2009, the ASEAN-5 occupies 86% of the regional total GDP, and their economic sizes are many times larger than the rest of the ASEAN countries. The ASEAN-5 is also where most of the residents are located; the population of ASEAN-5 is more than 70% of the total population of ASEAN in 2009.

Given the dominating economic powers of ASEAN-5, their attitudes on regional co-operations and integrations, would be consequently crucial for the current and future developments of the entire ASEAN. The economic importance of them has made the 5 countries together a reasonable representative for the whole region in many aspects. Therefore, in this thesis, cross-country empirical analyses in Chapter 3

[5] Also known as Bangkok Declaration.
[6] "The Founding of ASEAN", ASEAN Secretariat. http://www.aseansec.org/20024.htm. Retrieved 26 June 2011.

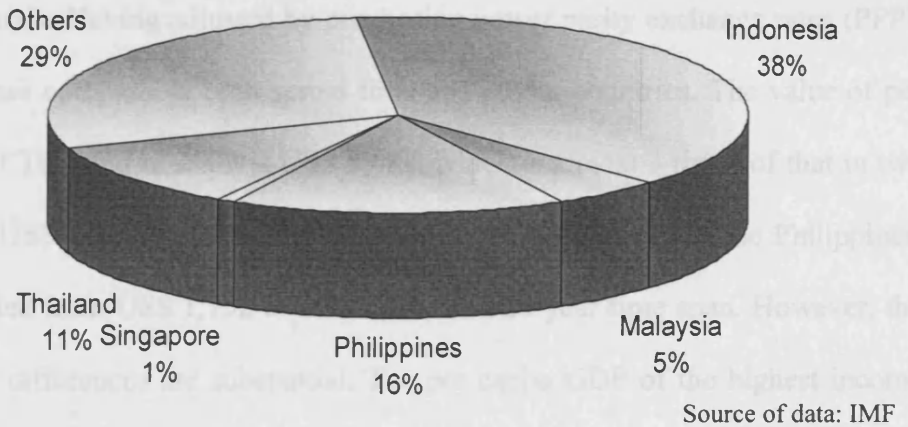
on bank efficiency comparisons and in Chapter 5 on banking competitiveness are based on

Figure 2-5 GDP based on PPP as % of ASEAN total (2009)



Source of data: IMF

Figure 2-6 Population as % of the ASEAN total (2009)



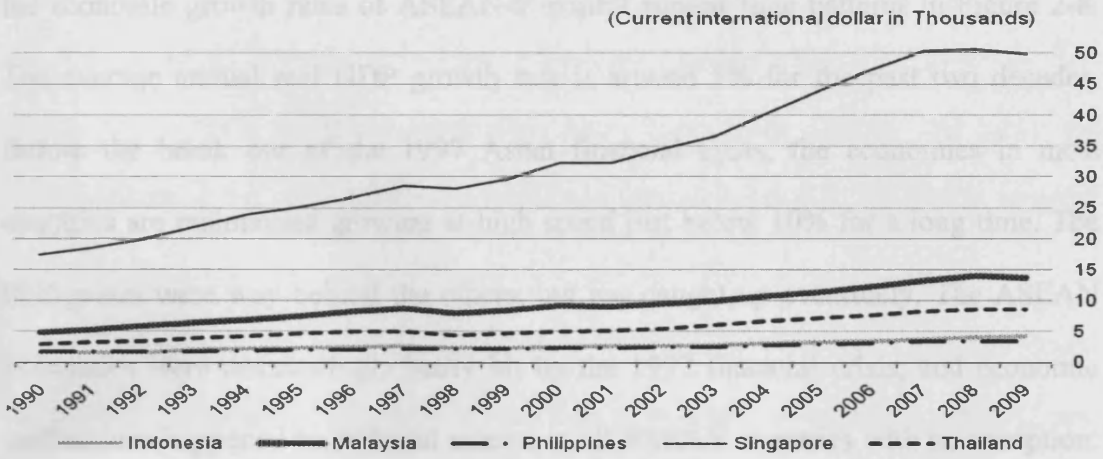
Source of data: IMF

samples of the ASEAN-5 countries. The results obtained and inferences drawn from them are served as general indicators for the situation in the whole region. In Chapter 4, Indonesia is chosen for a more detailed single country study on convergence properties of bank efficiency. The reason is that within the ASEAN-5, Indonesia has the largest population, 38% of the total ASEAN population in 2009, and the largest GDP, 34% of the ASEAN total in 2009, as well as the best data availability on bank balance sheet and income statement.

The levels of economic development and the distribution of wealth are very uneven in the ASEAN region, and this is also true for the ASEAN-5. The living standards, income levels and the extent of economic maturity differ significantly across countries, and these asymmetries in economic fundamentals may affect further economic integration in this region. Figure 2-7 plots the evolution of the per capita GDP of ASEAN-5 over the two decades. The continuous improving trends in average income levels are obvious, and apparently have not been distorted significantly by the 1997 Asian crisis. Having adjusted by purchasing power parity exchange rates (PPP), the numbers are comparable both across time and across countries. The value of per capita GDP of Thailand in 2009 is US$ 8,489, which is almost 3 times of that in two decades ago, US$ 2,909 in 1990. The least improvement happens in the Philippines, but still doubled from US$ 1,752 to US$ 3,516 in a 20 year time span. However, the cross-country differences are substantial. The per capita GDP of the highest income country, Singapore, is much higher than the income levels of other countries in this region, and is more than 10 times higher than those of the relatively low income countries, such as Indonesia and the Philippines. For example, in 2009 alone, the

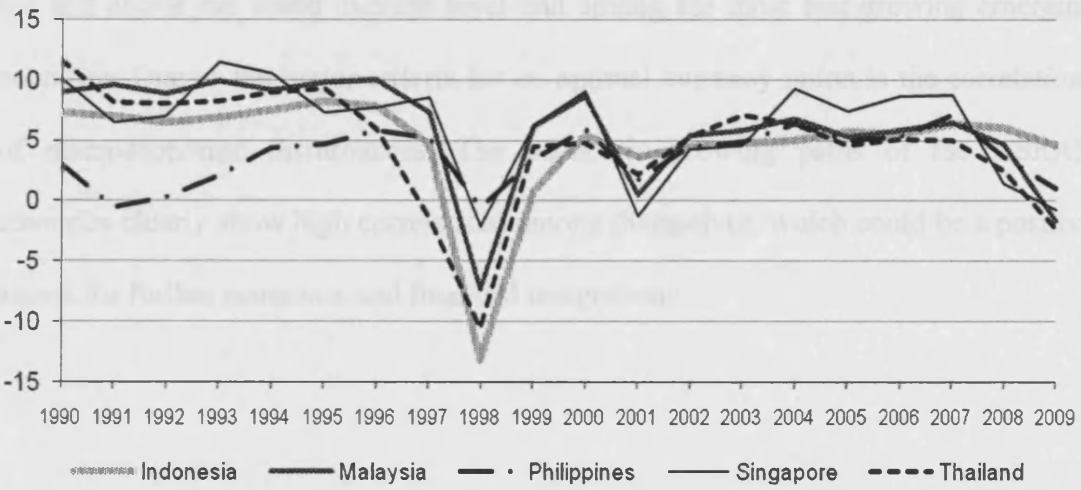
average income level of Singapore is US$ 49,764, and the average income levels of Indonesia and the Philippines are only US$ 4,155 and US$ 3,516 per year.

Figure 2-7 GDP per capita (PPP) of ASEAN-5 (1990-2009)



Source of data: IMF

Figure 2-8 Real GDP growth rate (%) of ASEAN-5 (1990-2009)



Source of data: IMF

The cross-country differences in average income and living standards are largely determined by the nature of national economic structures. However, the ASEAN countries are closely connected through political, economic, cultural and geographical links, therefore, their reactions to major economic shocks are somehow similar. Comparing with the substantial differences in per capita GDP shown in Figure 2-7, the economic growth rates of ASEAN-5 exhibit similar time patterns in Figure 2-8. The average annual real GDP growth rate is around 5% for the past two decades. Before the break out of the 1997 Asian financial crisis, the economies in most countries are maintained growing at high speed just below 10% for a long time. The Philippines were way behind the others, but has caught up eventually. The ASEAN economies were devastatingly badly hit by the 1997 financial crisis, and economic contractions happened to different extents in all ASEAN countries with no exception. The worst case was in Indonesia, as it was the only country that experienced both economic and political regime collapses, and a deep economic contraction of more than 30% in just one year from 1997 to 1998. In the aftermath of the financial crisis, the economic growth rates are generally lower than those in the pre-crisis period, but are still above the world average level and among the most fast growing emerging countries. One of the major criteria for an optimal currency union is the correlations of macroeconomic disturbances. The economic growing paths of the ASEAN countries clearly show high correlations among themselves, which could be a positive aspect for further economic and financial integrations.

3. Roadmap of ASEAN Economic and Financial Integration

The regional co-operations among ASEAN countries have been emphasised on three different aspects, including security, socio-cultural and economic integrations, and the economic integration is where this bloc has made the most progress. The efforts on regional economic integration have been made all the time since the establishment of the association, and have been intensified during the 1990s. In order to reduce intra-regional tariffs and promote the free flow of goods and services in ASEAN, the Common Effective Preferential Tariff (CEPT) scheme was introduced and actually acted as a framework for the later agreement of the ASEAN Free Trade Area (AFTA), which was signed on 28 January 1992 in Singapore. At the time when the AFTA agreement was signed, there were only 6 members in ASEAN, namely the ASEAN-5 plus Brunei Darussalam, also known as ASEAN-6. The remaining members who joined the association later are also official members of the AFTA, however are given longer time frames to fully implement their CEPT commitments. The leaders of ASEAN members have agreed to eliminate all import duties by 2015, and to create an ASEAN Community by 2015[7]. So far, the tariffs on more than 99% of the products in the CEPT Inclusion List (IL) of ASEAN-6 have been brought down to the 0-5 % range, and tariffs on 60% of the listed products are already in this range for the other 4 countries of ASEAN[8].

[7] "Overview", ASEAN Secretariat. http://www.aseansec.org/64.htm. Retrieved 26 June 2011.
[8] "TRADE", ASEAN Secretariat. http://www.aseansec.org/12021.htm. Retrieved 26 June 2011.

The most recent progress of the regional integration towards the ASEAN Community is the signing up of the "ASEAN Charter", which was signed on 20 November 2007 and entered into force on 15 December 2008. The charter has officially turned ASEAN into a legal entity which is a big step towards a similar EU-style community, and is a "very historic occasion for ASEAN"[9]. The Charter emphasises the centrality of ASEAN, and enhances members' commitments on new legal framework and new functional bodies to boost the process of community building.

Arguably, further economic integration and acceleration of intra-regional single market and trading activities require a stable financing framework for the region. The trend towards financial integration in the region started after the 1997 Asian financial crisis. The 1997 Asian financial crisis revealed the inherent weakness of the financial system in ASEAN countries, especially in the banking systems. The crisis was triggered by the decision of the Thai government to float its currency, baht, while the country has acquired large amount of foreign debts, and eventually led to the collapse of its currency. The crisis quickly spread to most Southeast and East Asian countries and led to significant real economic losses. The crisis was characterized by extremely high interest rates (+13% in Indonesia), huge drop in stock price indexes (-55% in Thailand; -52% in Malaysia), massive real exchange rate depreciation (-87% in Thailand), declines in net capital inflow and in gross domestic products (Sufian, 2009).

[9] "ASEAN Charter", ASEAN Secretariat. http://www.aseansec.org/21829.htm. Retrieved 26 June 2011.

The outbreak of 1997 Asian financial crisis has made the member countries realise the importance and necessity of further regional integration in both real and financial aspects to maintain the growth and stability. According to the European Central Bank, a well integrated financial system would improve the efficiency of the economy through lower cost of capital and better allocation of financial resources[10], and deeper financial integration could also improve the financial stability of the region. Several financial co-operation projects were launched since the 1997 crisis. The first major step, the Chiang Mai Initiative (CMI) is a multilateral economic/financial co-operation and currency swap arrangement framework between ASEAN and another 3 East Asian countries, China, Japan and South Korea (known as ASEAN+3). The CMI was initiated by a series of bilateral swap arrangements in 2000 and has been expanded to a multilateral structure in the past decade, and the Chiang Mai Initiative Multilateralisation (CMIM) Agreement was formally signed on 28 December 2009 and took effect on 24 March 2010. The main purpose of the CMI is to establish a co-operation framework of liquidity support among member countries during the economic/financial distress, and help avoid future recurrence of the 1997 Asian crisis. There are also other free trade agreements have been established with various countries in recent years, such as the ASEAN-Australia New Zealand, ASEAN- China, ASEAN-India, and ASEAN-Japan Free Trade Areas. The free trade agreement with the European Union is currently under negotiation[11].

Another notable financial co-operation project involving broader geographical region is the Asian Bond Funds (ABF), which are initiatives from the Executives' Meeting of East Asia and Pacific Central Banks (EMEAP). The EMEAP consists of

[10] European Central bank, 2005

[11] "AFTA & FTAs", ASEAN Secretariat. http://www.aseansec.org/4920.htm, Retrieved 26 June 2011.

11 countries[12], of which the ASEAN-5 are important members. Indirect financing, i.e. offshore and onshore borrowing through financial intermediaries, such as banks, was the main financing channel for most investments in this area. However, as the economies have been experiencing dramatic expansions and structural transitions, indirect financing becomes limited and ineffective while the bond markets are still underdeveloped in this area. This also has been claimed as one of the main reasons that caused the 1997 Asian financial crisis, as huge accumulation of foreign debts raised banks' leverage risk and interest rate risk. The mismatch of short-term borrowing from abroad and long-term lending to domestic projects also raised the maturity and liquidity risk for banks[13], and further risk such as exchange rate risk in the event of currency depreciation[14].

The primary aim of the ABF is to promote the development of bond market in this region and to improve the diversity and efficiency of financing channels. This initiative was launched in two stages: ABF1 was launched in June 2003 to set up actual bond funds in Asia, and raised funds from the 11 EMEAP central banks for a total value of US$ 1 billion that were invested in dollar bonds issued by 8 EMEAP sovereign and quasi-sovereign borrowers[15]. ABF2 was launched in 2005 with initial seed money of US$ 2 billion, with the aim to accelerate the bond market development and to reduce cross-border settlement risks[16].

[12] Australia, China, Hong Kong, Indonesia, Japan, South Korea, Malaysia, New Zealand, Philippines, Singapore and Thailand.
[13] Sufian, 2009
[14] Chang and Velasco, 1999
[15] Excluding Australia, Japan and New Zealand.
[16] Deutsche Bank Research, 2006

The 1997 Asian financial crisis had raised the question about appropriate exchange rate regime for countries in this region. Particularly, when the Euro was launched as a single currency in European countries since 1999, the notion of a similar currency union in ASEAN had emerged and been paid more and more attention to. Unlike other currency unions that were formed based on a solid foundation of strong political unions, member countries in the Euro zone are still independent states and maintain a high level of internal political independence, including fiscal policy. Therefore the EU experiences can be particularly valuable for ASEAN, as they provide a similar parallel (Bayoumi and Mauro, 2001).

The main attractiveness of a currency union is its usefulness in promoting trade and investment among the member countries, by reducing the cross-border transaction costs and the risk of exchange rate volatilities, which would eventually improve the welfare and economic efficiency in the whole region. As a final stage of economic integration, the realisation of a currency union in the EU has gone through a long process of economic and political integration of more than 4 decades. Compared with the EU currency union, ASEAN has still a long way to go; however, a currency union for ASEAN could be a possible long-term objective for the ultimate community.

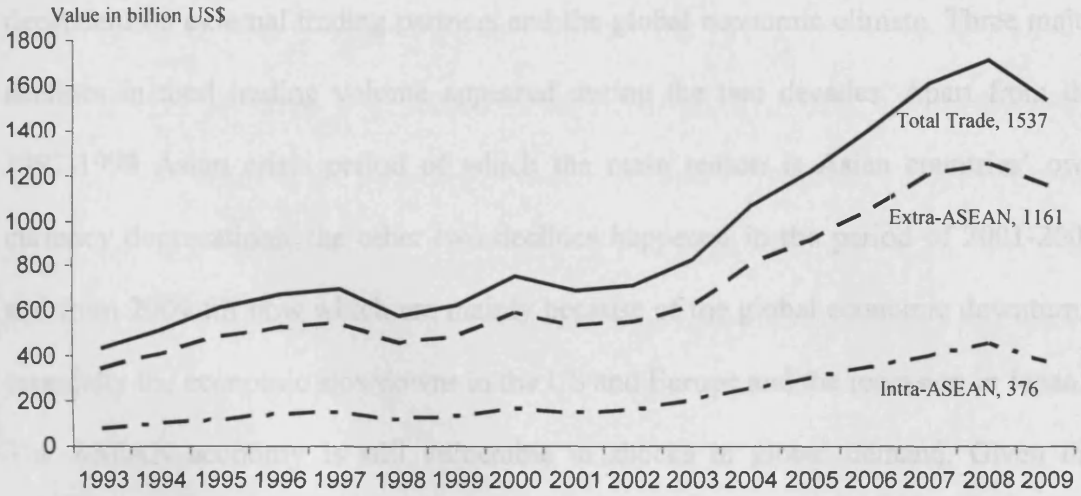
4. Regional Integration Achievements to Date

4.1 Trade volumes

As a result of the successful implementation of the CEPT-AFTA scheme and the co-operations with other countries on trade and financial integration, both the

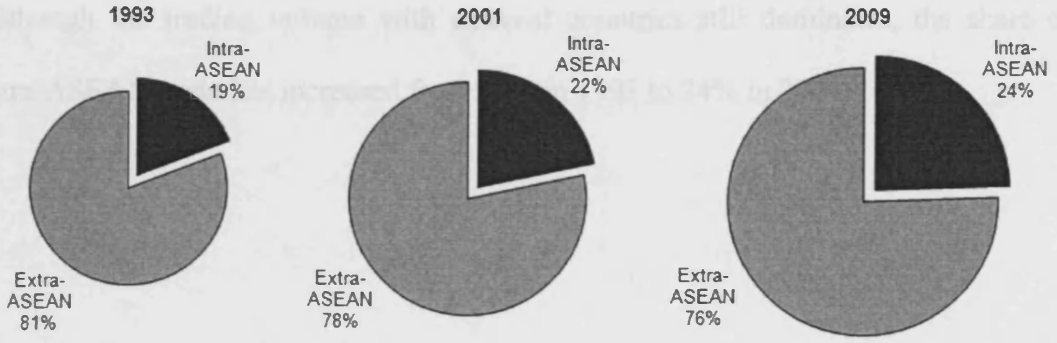
intra-regional and extra-regional trade of ASEAN countries have grown significantly during the past two decades. The total trade volume of all ASEAN countries has reached the peak of US$ 1,710 billion in 2008, which is almost 4 times of the value in 1993, US$ 430 billion, indicating an average annual growth of nearly 10%. The average annual growth rate of the total trade from 2001 onwards is as high as 14%, which is double the figure of previous years, thanks to the series of free trade area agreements launched in the last decade. The increasing trends are also significant when distinguish the directions of trade. All trade figures reached their peaks in 2008, with the intra-regional trade volume of US$ 458 billion, which has grown by 456% from 1993 with an average annual growth rate of 11%. The trade volume with the rest of the world has also increased by 260% from US$ 348 billion in 1993 to US$ 1,252 billion in 2008. The intra-regional trade growth rate has been kept at a high level of 16-17% per annual before the 1997 crisis and after the recovery, since the CEPT-AFTA scheme launched in 1992. The intra-ASEAN trade average growth rate during the whole period is 37.5% higher than the growth rate for extra-ASEAN trade. Figure 2-9 plots the trade volumes of total trade, intra-ASEAN and extra-ASEAN trade, which illustrates the significant improving patterns.

Figure 2-9 Trend of ASEAN trade



Source of data: ASEAN Statistical Year Book 2003 & 2008

Figure 2-10 Intra- and Extra-ASEAN trade



Source of data: ASEAN Statistical Year Book 2003 & 2008

In Figure 2-9, apart from the general increasing trend in trade activities of ASEAN, it also should be noticed that the ASEAN's economy remained heavily dependent on external trading partners and the global economic climate. Three major declines in total trading volume appeared during the two decades. Apart from the 1997-1998 Asian crisis period of which the main reason is Asian countries' own currency deprecations, the other two declines happened in the period of 2001-2003 and from 2009 till now which are mainly because of the global economic downturns, especially the economic slowdowns in the US and Europe and the recession in Japan[17]. The ASEAN economy is still vulnerable to shocks in global demand. Given the increasing global economic uncertainty, strengthen the regional domestic market and create a domestically sourced sustainable growth through further economic co-operations and integrations is an important goal for the region. In fact, the increasing importance of the intra-regional trading activities is a recognised evidence for the effort made towards greater intra-regional integrations. Figure 2-10 compares the share of intra-ASEAN trade in total trade volume in 1993, 2001 and 2009. Although the trading volume with external countries still dominates, the share of intra-ASEAN trade has increased from 19% in 1993 to 24% in 2009.

[17] "TRADE", ASEAN Secretariat. http://www.aseansec.org/12021.htm. Retrieved 26 June 2011.

4.2 Potentials for a monetary union and macroeconomic convergence

A number of studies have assessed whether ASEAN is an OCA[18]. These studies also highlight the progress and achievements of ASEAN regional integration, relative to the EU and other currency unions. Firstly, the extent of labour and capital mobility[19] has improved significantly in the ASEAN region, and is actually higher than those of the EU at the time of the Maastricht Treaty[20]. Madhur (2002) presented an example that, within the ASEAN-5, 10% of the employment in Singapore is from the remaining 4 countries, and the emigration rate is as much as 2% of the labour force of the migrating countries.

Secondly, the degree of openness[21], which is measured by its trading activities with other countries, of ASEAN economies has also improved markedly. The trading patterns shown earlier in Figure 2-9 and 2-10 have clearly shown the significant increases in both intra-ASEAN and extra-ASEAN trading volumes. It is also pointed out by Bayoumi and Mauro (2001), that although the intra-regional trade share in ASEAN's total trade (25%) is relatively lower than that of the EU (40%), it is significantly higher than the intra-regional trade shares in some of other currency unions. The intra-regional trade only counts for about 10% in the Eastern Caribbean Currency Union and the Western Africa Economic and Monetary Union, and the share for the Central African Economic and Monetary Community is only 3%.

[18] If a geographical region containing more than one country uses fixed exchange rates or a common single currency, and the welfare and economic efficiencies of the region are maximised through the adoption of this currency arrangement, this area is called an Optimal Currency Area (OCA). Horvath (2003)

[19] The importance of production factor mobility in the selection of appropriate exchange rate regime was raised by Mundell (1961).

[20] See Eichengreen and Bayoumi (1999) and Moon, Rhee, and Yoon (2000).

[21] The degree of openness of the OCA candidate economies is argued by McKinnon (1963).

Thirdly, ASEAN countries exhibit a high degree of shock symmetries, which are evidenced by both GDP growth rate figures in Figure 2-8 and the trading patterns shown in Figure 2-9. High similarities in responses to economic shocks among these countries are observed in many occasions, such as the region-wide economic contraction during the 1997 Asian crisis, the regional economic slowdown around 2001 due to the economic downturn in major advanced economies, and the similar reactions to the current global financial crisis. Similar conclusion has been drawn by other researchers as well, for example, Eichengreen and Bayoumi (1996) stated that the symmetry in shocks among the countries in the region is comparable to the EU, and the underlying macroeconomic disturbances have a similar pattern that was seen in Europe in the 1980s.

In fact, when European Monetary Union (EMU) selected its participating members, they used some quantitative criteria, which are called the "convergence criteria"[22], to ensure that the member countries have achieved a sustainable economic similarity and convergence. The first criterion is on inflation rate, which requires the country to have an inflation rate that is no more than 1.5% higher than the average of the best three countries in the EU. The second criterion is that the government budget deficit should be below 3% of its GDP and the government debt should be less than 60% of its GDP. The third criterion is a stable exchange rate and the country should have joined the exchange-rate mechanism (ERM II) for two consecutive years. The last criterion is that the long-term nominal interest rate must not be more than 2% higher than the average of the best-three countries.

[22] Also known as the Maastricht criteria

Obviously, the ASEAN countries are still far away from satisfying those convergence criteria of the EMU, but any convergence tendency towards a common level of those macroeconomic indicators would be considered as favourable to a future monetary alliance. Empirically, the convergence tendencies in economic variables are examined by the concepts of "*β-convergence*" and "*σ-convergence*" (Sala-i-Martin, 1996), which are originally initiated in the economic growth literature. The basic intuition of the existence of "*β-convergence*" is that the income level, measured by per capita GDP, in a low income country is growing faster than that of the high income country. In other words, the low income country is catching up with the high income country. "*β-convergence*" is a necessary but not sufficient condition[23] for "*σ-convergence*", which is saying the dispersion in income levels of different countries are diminishing over time. Both of them are considered as evidence of economic integration between countries.

A large number of economic convergence studies have been conducted for the EU countries, both before and after the adoption of the Euro. However, this kind of study for the ASEAN countries, or even the greater region of Asian countries is still limited. Only a few studies have been found in the literature. The classic unconditional and conditional "*β-convergence*" and "*σ-convergence*" tests were applied by Chowdhury (2005) to per capita income for 9 ASEAN countries, excluding Myanmar, during the period of 1960-2001. Unfortunately, no evidence was found for any type of the convergence concepts, and he imputed the non-convergence in per capita income to the low, although growing, volume of intra-regional trade and weak governance in some of the ASEAN countries.

[23] This issue is explained in details in Appendix A.

Other studies, notably, Ong and Habibullah (2007) examined the long-run macroeconomic relationship and the time-varying convergence in real GDP across ASEAN-5, but using econometric method of co-integration which is different from the typical convergence studies in terms of methodology. They found that all ASEAN-5 are compatible, and Malaysia, the Philippines and Thailand are relatively more co-ordinated. They also suggested more intra-ASEAN trade should be boosted to incorporate other ASEAN countries besides the 5 major economies.

4.3 Financial integration indicators

To assess the degree of financial integration in Europe, the European Central Bank (ECB) firstly published a set of financial integration indicators in September 2005, which are regularly updated in the annual reports on "Financial Integration in Europe" since then. Those reposts provide overall assessments on integration indicators of the main segments of the financial markets, namely the money, bond, equity and banking markets, and have been useful in monitoring the progress of financial integration in the euro area.

The "price-based" indicators are either computed or model-based measurements of (evolutions of) dispersions in assets returns based on their geographic origin, and a declining trend in dispersions are signals for financial integration as the assets returns should be more influenced by common factors rather than country-specific factors. For example, integration in money market is indicated by narrowing "dispersion of lending rates offered by different banks in each market segment". A smaller standard

deviation of the "yield differentials with respect to a benchmark bond" indicates degree of integration in bond markets. In the case of equity market, a larger "cross-sector" dispersion of equity returns comparing with "cross-country" dispersion indicates higher degree of integration, since the country-specific factors should be less influential in a well-integrated market. The banking market integration is indicated by a narrowing dispersion of "interest rates on consumer credit, lending for house purchase and deposits with agreed maturity. "Quantity-based" indicators are also used as a complement to "price-based" indicators, for example, increasing cross-border lending activities are also indicators of banking market integration, and increasing share of investors' holding of non-domestic assets in total holdings is an indicator of capital market integration[24]. At the time of 2005, it has been evidenced that high degree of integration exist in the EU money markets and bond markets, but lesser degree of integration in the equity markets, and the banking markets are generally much less integrated (ECB, 2005).

Similar indicators for financial integration have also been applied to Asian economies recently. The existing studies show mixed results, with the degree of integration in ASEAN financial markets improving since the 1997 Asian crisis, but not as strong as the real integrations. Intra-regional financial integration is outweighed by external integration with other major economies and sustainable long-term convergence is still weak. Boresztain and Loungani (2011) calculated the cross-country standard deviations of equity premia (1980-2008) and government interest rates (1984-2008) for 12 Asian countries[25]. In their study, a visual comparison

[24] Empirical studies on EU financial integration, using either price-based or quantity-based indictors, emerged long before 2005, e.g. Centeno and Mello, 1999; Fratzscher, 2002; Manna, 2004.
[25] Including all ASEAN-5 plus China, Hong Kong, India, Japan, Korea, Pakistan and Taiwan.

clearly shows that a significant declining trend in the cross-country dispersions starting around 1998, which is the wake of the 1997 Asian crisis. This visual impression was further validated by *σ-convergence* estimations. However, they also presented the indictors of financial integration between Asia and the major economies, and pointed out that the degree of financial integration for Asian countries with major countries outside the region was also significant and in some cases was larger than the intra-regional integration. Another very recent paper by Rizavi *et al.* (2011) investigated the degree of integration in the financial market by examining the convergence properties of the stock market returns. The study was conducted for 10 Asian countries[26], over the period of 1999-2009. They found some evidence to support the integration of the Asian stock markets, but the short-term convergence was not accompanied by overall long-term convergence.

5. Financial Integration and Bank Performance

In most ASEAN countries, capital markets remain underdeveloped and the banking system is still the principal vehicle of financial intermediation and the principal channel of monetary policy pass-through. Arguably, the ongoing process of financial integration and regional market liberalisation should lower the cross-border barriers to capital flows, and lead to a more open capital market. National protections in many industries will become less effective. The financial markets, particularly the banking markets, are opening up to the regional competitors from other member countries as well as competitors from outside the region. Foreign banks within the region could enter other countries' domestic market more easily through many ways,

[26] including all ASEAN-5 and China, Hong Kong, India, Pakistan and South Korea,

such as direct establishment of branches, acquisition of local bank to make it a subsidiary, or even direct investment in a local bank to form a joint venture bank. One of the main benefits of financial integration would be the reduction of cross-border transaction costs, therefore even without a direct local representative, cross-border lending may also be an attractive option for raising funds to finance investments. In theory, the regional integration would expand the market and promote competition by eliminating cross-border barriers, and improve the economic welfare through greater efficiency in production and resources allocation.

As argued by Karim (2001), the increased competitive pressures will "affect banks (differently) depends in part on their ability to adapt and operate efficiently in the new environment". Banks, from countries in which the financial intermediaries are operating in a more competitive market environment, and those in which the financial intermediation are conducted in a more efficient manner would be more productive and profitable given the available resources. Superiority in effective use of technologies would allow those banks to operate on lower interest spread than that of the weaker banks in other countries. The less competitive and less efficient banks would lose market shares through the competition and will be driven out of the market or be taken-over eventually.

Therefore, understanding the current operational efficiency and competitiveness structure in banking industries is important for policy-making in the process of integration. A well-integrated banking market should impose encouragement to promote bank efficiency and competitiveness through the pressure of intensified competition. One of the main research objectives of this thesis is to investigate

whether the regional integration processes has improved the operational efficiency level and competitiveness in member countries' banking markets, by evaluating the evolution of the bank efficiency and competitiveness measurements over time.

Improvement in bank performance and market competitiveness is one of the main desired outcomes from regional market integration; therefore the magnitude of the improvement itself can be used to assess the effectiveness or success of the integration efforts. As discussed in the previous section, the degree of integration in the financial markets is usually assessed through indicators derived from the price/return information, or from the volume of cross-border business.

To the best of my knowledge, no research has been done for ASEAN on the convergence properties of bank operational dispersions, e.g. dispersions in bank efficiency levels[27]. Regional convergence in bank operational efficiency levels is a clear sign for the adaption to superior technology by inefficient banks, and they are catching up with the efficient banks. This convergence at institutional level is also a valuable indictor for the degree of banking market integration, although has been typically ignored in the ASEAN financial integration literature. The present thesis aims to fill this gap by providing a detailed convergence analysis on ASEAN bank efficiency over a long period (1994-2009),

[27] There are few recent studies of this kind for EU countries, for example, Weill (2009), Casu and Girardone (2010).

6. Conclusion

The present chapter is a context chapter aiming to provide some background information of ASEAN region, particularly the ASEAN-5, which are the 5 largest economies in the region. The relative economic importance of ASEAN in the world and the relative economic positions of each individual country within the region are shown by presentations and comparisons of the macroeconomic indicators. Through decades of efforts towards a well-integrated regional community, the ASEAN countries have achieved dramatic accomplishments in regional co-operations on economics, social security and cultural development_The ASEAN economies have exhibited a common set of characteristics that were experienced by the European Union before the adoption of the Euro as a single currency. Specifically, these are the high degree of flexibility of production factors and shock symmetries between countries. However, the substantial macroeconomic differences in income and output levels between countries and weak macroeconomic convergence requires further policy reinforcement for deeper regional coordination in both real and financial aspects.

The interest in deeper financial and monetary integration of the ASEAN policy makers have been deepening since the 1997 Asian financial crisis and the launch of Euro in 1999. Several financial integration initiatives have been launched in the aftermath of the 1997 Asian crisis. Existing empirical studies on the degree of ASEAN financial integration has been sparse and provide mixed results. This thesis will contribute to the literature from the following aspects: 1), To evaluate the effectiveness of the national banking reforms and financial integration process

through the evolution of bank efficiency and competitiveness. To answer the question, have the national banking reforms and financial integration process improved bank efficiency and banking market competitiveness level? 2), To investigate the convergence properties of ASEAN bank efficiency, which is used as an indicator of banking market integration at the institutional level. 3), To identify the weakness and strengthens of the current ASEAN banking market, and draw policy implications for further regional integration toward the ultimate ASEAN community 2015.

Chapter 3 Bank Efficiency Convergence Properties of Selected ASEAN Countries

1. Introduction

In this chapter, the impact of the national banking structural reforms and the regional financial integration after the 1997 Asian financial crisis will be assessed from the perspective of bank cost efficiencies. Opening up the cross-border barriers would lead to intensified competition from banks of other member countries. Without effective national protective policies, domestic banks' market shares can be eroded by foreign banks which operate in a more efficient way in terms of production maximisation and cost minimisation. Therefore, incumbents need to adapt and operate efficiently in the new context to survive. In theory, intensified competition through regional market integration should help improve the industry's efficiency level as inefficient banks catch up with the efficient banks, and the dispersion in operational efficiency levels declines overtime.

Bank cost efficiencies are modelled by using Battese and Coelli (1995) Stochastic Frontier Approach (SFA) under a common frontier framework. A common best-practice frontier based on 1889 bank-year observations in 5 countries over 16 years (1994-2009) is estimated to facilitate the cross-country comparison on bank efficiency levels. Asymmetries in bank efficiency may imply insufficient degree of financial integration among member countries. However, whether banks are catching up with each other, and the dispersions in bank efficiency narrowing over time seemed also interesting questions that are worth emphasising. A converging tendency towards a common steady-state level of bank efficiency and a decreasing magnitude

of dispersion would also be indicators for banking market integration. Therefore, I apply the concepts of *β-convergence* and *σ-convergence*, which are borrowed from the growth literature, to bank efficiency analysis. In the hope that efficiency of banking system across countries are improving and converging over time, which can be seen as an indicator for banking market integration.

The rest of the chapter is organised as follows. Since the general background of ASEAN countries and the incentive for a currency union have been reviewed in Chapter 2 already, section 2 of this chapter starts directly with the review of literature in bank efficiency studies which are relevant to this study. Section 3 outlines the methodologies and modelling strategies used for both bank cost efficiency estimation and efficiency convergence properties investigation. Section 4 describes the data and variables used in estimation. The empirical results and discussions are reported in section 5, and finally, section 6 concludes this chapter.

2. Related Literature

2.1 An overview on bank efficiency studies

In the last two decades, the efficiency of the financial sector has received an increased attention by researchers and policy makers around the world. According to Farrell (1957), a firm is said to be technically inefficient if it produces less than maximum output using a given level of input, and it is allocatively inefficient if it uses the wrong mix of inputs given the input factor prices. Either of them could result in cost inefficiency, which indicates the firm does not produce at minimum (optimum)

cost level. The frontier efficiency methodologies measuring efficiencies relative to some benchmark have been developed dramatically these years. Frontier methodologies measure individual firm's efficiency relative to a "best-practice" frontier for the industry. Compared with the conventional financial ratios which are only partial productivity measures, such frontier efficiency measures are superior because they take all inputs and outputs into account and measure the "total factor productivity". These frontier efficiency methodologies could be classified into two broad categories[28], either in a non-parametric way, like Data Envelopment Analysis (DEA), or in a parametric way, like Stochastic Frontier Approach (SFA). The non-parametric methods generally employ mathematical (linear) programming or other non-parametric methods to estimate efficiency without specific assumptions about the functional form of the specific production, cost, revenue or profit functions; therefore suffer less from the problem of misspecification. By contrast, parametric methods are normally econometric techniques with certain assumptions made on the functional form of the objective functions and distribution of firm-specific effects (inefficiencies), but with the advantages of allowing random noise and the capability of statistical inference. Each of the two techniques has advantages over the other, and each of them has its own problematic aspects waiting to be resolved. According to Banker *et al.* (2010), "although much has been written about the relative merits of the two methodologies, both have gained a firm foothold in the efficiency estimation literature".

The majority of early papers are based on North American financial markets, largely due to the widely available data. An early survey by Berger and Humphrey

[28] More recently, new innovations like "semi-parametric" bootstrap method (Simar and Wilson, 2007) have been developed, which will be discussed in the next chapter.

(1997) reviewed 130 studies that have employed frontier analysis in 21 countries. Studies on US financial institutions were the most common, counting for 66 out of 116 single country studies, and only 8 were of developing and Asian countries (including 2 in Japan). More recently the single country studies have been expanded to Asian and other regions, such as Hong Kong (Drake *et al.,* 2006), Greece (Pasiouras, 2008), Singapore (Sufian, 2007), Ukraine (Kyj and Isik, 2008) and studies focusing on countries in transition, like India (Ataullah and Le, 2006; Bhattacharyya *et al.* 1997) and Malaysia (Sufian, 2009).

Early cross-country studies are mainly on developed counties too, using various methods. Berger *et al.* (1993) studied bank efficiency in Norway, Sweden, and Finland by using the DEA approach, and concluded that Swedish banks were in the best position to expand on a future common Nordic banking market. Fecher and Pestieu (1993) evaluated technical efficiency using SFA method for financial services of 11 OECD (Organization for Economic Co-operation and Development) countries, and found that the Japanese financial services sector was the most efficient among others. Allen and Rai (1996) used SFA to compare cost inefficiency across 15 developed countries grouped into either universal banking countries, in which the functional integration of commercial and investment banking is permitted; or separated banking countries, in which banks can only carry out one type of business. Pastor *et al.* (1997), compared bank efficiencies and productivities of banks from several European countries and the U.S, using DEA method. Both of Allen and Rai (1996) and Pastor *et al.* (1997) found that financial institutions in the United Kingdom were among the least efficient.

Cross-country comparisons on developed economies are still popular nowadays, for example, Lozano-Vivas *et al.* (2001) on a sample of banks from 10 EU countries with the non-parametric DEA approach; Vennet (2002) on cost and profit efficiency of banks from 17 European countries. A more recent cross-country study of Lozano-Vivas and Pasiouras (2010) investigated the impact of non-traditional activities on bank efficiency using SFA method, and compare bank efficiency of 752 publicly quoted commercial banks from 87 countries around the world. They found that non-traditional banking business increased cost efficiency but its impact on profit efficiency was mixed.

This stream of study has grown in complexity and has given greater insight into potential problems that banks and financial system can face. One of the important issues is the impact of a currency union on bank efficiencies. Most studies of this kind are based on the European Monetary Union (EMU). For example Ali and Gstach (2000) showed that joining the EMU improved Austrian banks' cost efficiency. However, other studies found negative effect of joining the EMU, such as in Greek banks due to Tsionas *et al.* (2003). Lozano-Vivas *et al.* (2001) used a so-called "complete DEA" model to investigate that how environmental conditions affect the cross-country banking activities within the integrated EU financial market, and they found that the adverse environmental conditions could be a fundamental deterrent for cross-country competition, and could be a good competitive factor for the home banking industry.

More closely related to the present study, some researchers apply the convergence concepts which are borrowed from the growth literature to bank

efficiency studies and investigate the convergence properties of bank efficiency cross countries. Few ex-post studies of bank efficiency convergence across European countries after the adoption of European currency union are found in the literature. Weill (2009) tested *β-convergence* and *σ-convergence* of cost efficiency of banks for 10 EU countries between 1994 and 2005, using SFA to estimate efficiency. Weill (2009)'s findings support the view of a convergence in the cost efficiency of banks across European countries, and that European integration had a positive impact on banking efficiency. Casu and Girardone (2010) applied the same concepts of convergence to non-parametric DEA cost efficiency of banks from 15 EU countries in the period 1997-2003, and the results provided supporting evidence for convergence of efficiency levels towards an EU average rather than the best-practice. The potential gains brought about by increased integration have been offset by a decrease in the overall efficiency level. Another convergence study on EU bank efficiency is Mamatzakis *et al.* (2008), who tested the convergence of cost and profit efficiency of banks from 10 new EU members over 1998-2003, and the results indicate some convergence in cost efficiency, yet no convergence appears to have been achieved in terms of profit efficiency.

2.2 Single country Bank efficiency studies on ASEAN countries

Recent works in this research field have extended the geographic coverage, and increasing attentions have been given to emerging markets, including China, Taiwan and Greece. Specific studies on ASEAN countries are still relatively limited but growing, and only start to appear from the beginning of this century. Single country

studies have been done for almost all member countries of ASEAN, some examples have been selected for the 5 countries used in this chapter.

For Indonesia, Margono *et al.* (2010) was one of the first to estimate bank efficiency by using SFA, over the period 1993-2000. They concluded the average cost efficiency of all banks is nearly 30% lower in the post-Asian crisis period comparing with the pre-Asian crisis period. Working papers by Hadad *et al.* (2008; 2011a, b) examined non-parametric, slacks-based DEA with Simar and Wilson's (2007) bootstrapping methodology to monthly/quarterly supervisory data within a relatively short period 2006-2007. They found that bank efficiencies are positively related to the JCI index of the Indonesian Stock Exchange, and state-owned banks are the most efficient. Another working paper by Besar and Milne (2009) studied the effects of ownership changes during the re-privatisation program after the Asian financial crisis by estimating SFA model over 2000-2007. They found that the re-privatisation program has contributed positively to Indonesian banks' efficiency and competition.

Matthews and Ismailb (2006) compared technical efficiencies and productivities of domestic and foreign commercial banks in Malaysia over 1994-2000, using the DEA method. They found that foreign banks were more efficient. Using the same method, Sufian (2009) found "high degree of inefficiency" in the Malaysian banking industry over a period around the Asian financial crisis 1997 (1995-1999). A second stage Tobit regression showed that technical efficiencies were positively and significantly related to foreign ownership, along with loans intensity, bank size, degree of diversification in business, but negatively associated with market share, management expenses and natural logarithm of GDP.

Montinola and Moreno (2001) is one of the earliest frontier efficiency studies for the Philippines, who found that there was no strong improvement in domestic bank efficiency after the liberalization. Dacanay (2007) found the commercial banking cost inefficiency increased in the aftermath of 1997 Asian crisis, which is more or less consistent with the findings in the present study. The most recent study for the Philippines has been found is Manlagñit (2011), which examined the cost efficiency of Philippine commercial banks over the period 1990-2006 using SFA method. The results show substantial bank inefficiencies with a significant pattern of persistence of inefficiency among banks, indicating that relatively inefficient (efficient) banks tend to remain relatively inefficient (efficient) over a period of time, and this result is consistent with the poor convergence tendency for Phillippine banks that has been found in this chapter.

Singapore is the only developed economy in this region. However, due to the poor data availability, both quantity and research scope of bank efficiency studies on Singaporean banks are limited. Chu and Lim (1998) estimated cost and profit efficiency for only 6 Singaporean listed banks over the period 1992-1996, and they found that cost efficiency was much higher than profits efficiency for these 6 banks and also bigger banks were tend to have higher efficiency levels. A more recent small sample study by Lim and Randhawa (2005) provided mixed results on relationship between bank efficiency and bank size when use different input-output combinations. The cost efficiencies for larger banks are higher under production approach, while under intermediation approach, the result is the opposite. To the best of my knowledge, Sufian (2007) is the only paper that estimated a long-term trend of

technical and scale efficiencies for Singaporean banks from 1993 to 2003 using a DEA window analysis method. What they concluded is that the Singaporean bank efficiency was declining in the early period due to the 1997 Asian crisis but fully recovered and increased dramatically thereafter. Another finding of theirs was that smaller banks have outperformed larger banks during the period with high technical and scale efficiencies.

One of the earliest papers that studies efficiency for Thailand financial services sector is Chansarn (2005), which concluded that the efficiency in the Thai financial sector was diminishing over the period of 1998-2004, and regarding the 12 commercial banks along with other financial institutions included in the study, there was no significant difference in efficiency between domestic and foreign banks. A later paper by the same author, Chansarn (2008), investigated specifically efficiencies of commercial banks during 2003-2006 with different input-output specifications, and found that efficiencies under operation approach were higher and more stable than those obtained under intermediation approach. Sufian and Habibullah (2010a) investigated bank technical and scale efficiency for Thailand banking sector in the post-Asia crisis period of 1999-2008 using DEA approach and a second stage regression to identify effects of internal and external environmental variables. They found that the recent global financial crisis exerted negative impact on bank efficiencies, and unlike results from other developing country studies, domestic banks in Thailand actually exhibited higher technical efficiency than foreign owned banks.

These single country bank efficiency studies on ASEAN countries have investigated various issues related to banking efficiency, although some inferences are

conflict with one another and same environmental factor may have completely different effects on bank efficiency in different countries, those results still provide basic understandings and useful insights for the overall bank efficiency conditions in this region.

2.3 Cross-country Bank efficiency studies on ASEAN countries

Cross-country studies of bank efficiency in developing counties are sparse in the literature, and even fewer for comparison of ASEAN countries. To the best of my knowledge, Karim and Zaini (2001) is the first attempt of systematically cross-country comparison on bank efficiencies for pure ASEAN countries, and is very closely related to the present study. They evaluated bank efficiencies for selected ASEAN countries (Indonesia, Malaysia, the Philippines, and Thailand), using the same method used in the present study, i.e. Battese and Coelli (1995) SFA model.

Although, there are something in common between the Karim and Zaini (2001) paper and the present study, the later is significantly different from the former in a number of aspects. First of all, the basic questions proposed in the two studies are different. The purpose of Karim and Zaini (2001) is merely to investigate country differences in terms of bank efficiency and the relationship between bank efficiency and few control variables. By contrast, the present study asks a deeper question about the impact of financial integration on bank efficiency and the answer provided is not only based on the cross-country differentials in bank efficiency but also their convergence properties. Secondly, Karim and Zaini (2001) only covered 4 ASEAN countries for the period of 1989-1996 before the 1997 Asian crisis, and they did not

include Singapore due to poor data availability. The present study evaluates bank efficiencies for a later and longer period from 1994 to 2009, covering periods both before and after the 1997 Asian crisis. Also Singapore is included in the present study, as it is an important member country of ASEAN and is too important to be excluded when consider regional financial integration. The third difference comes in the estimation details, Karim and Zaini (2001) used translog cost function whereas the Cobb-Douglas cost function is used in the present study, and different environmental variables are chosen in the inefficiency modelling. Although both of the two follow intermediation approach when choosing banks' input and output, they treat deposits as both input and output, whereas deposit is only used as input in the current study following the classical definition of intermediation approach[29] more strictly.

Despite the differences discussed above, some of their results are somehow consistent with the findings in this chapter. Although the ranking of countries in terms of average bank efficiency are slightly different, they found substantial difference across countries too and the Philippine banking market is among the least efficient ones. They also mentioned that "if the ASEAN banks are free to move within the wider ASEAN market, Philippine and Indonesian banks would be at a disadvantage...", which is implicitly consistent with the comments made in this chapter. In terms of bank efficiency determinants, they claimed that the ASEAN banks enjoy increasing returns to scale and the larger banks tend to have higher cost efficiency level, which is also consistent with the findings in the present study.

[29] Sealey and Lindley (1977).

There are also some cross-country studies are found on Asian countries, including other Asian countries, such as China, Taiwan, Hong Kong, Japan, which are not member countries of ASEAN. Studies of this kind include Ariff and Can (2008), which using nonparametric DEA method, estimated technical and scale efficiencies changes from pre- to post-IMF-restructuring periods for 138 commercial banks during 1991-2005 in 4 East Asian countries (Indonesia, Korea, the Philippines and Thailand). The effect of the interventions from IMF in the post-Asian crisis banking reforms in East Asian countries varies from country to country, and the restructured banks were not significantly more efficient. Increased foreign ownership in the later-stage reprivatisation improves bank efficiency but not significantly, which suggests it may take longer time for the potential benefits to be realised[30]. Shen *et al.* (2009) used the SFA method with conventional Random Effect panel estimation and Greene's 'true' stochastic frontier models[31], compared bank cost efficiency over 285 commercial banks among 10 Asian countries. They found that the cross-country heterogeneity was significant and may distort the efficiency estimates if not considered, and the average bank efficiency level of Southeast Asian countries, Indonesia, Malaysia, the Philippines and Singapore, are relatively low comparing with other Asian countries.

[30] This finding is also consistent with my results in Chapter 4 for Indonesian banks.
[31] Greene (2008)

3. Methodology and Model Strategies

3.1 Bank cost efficiency

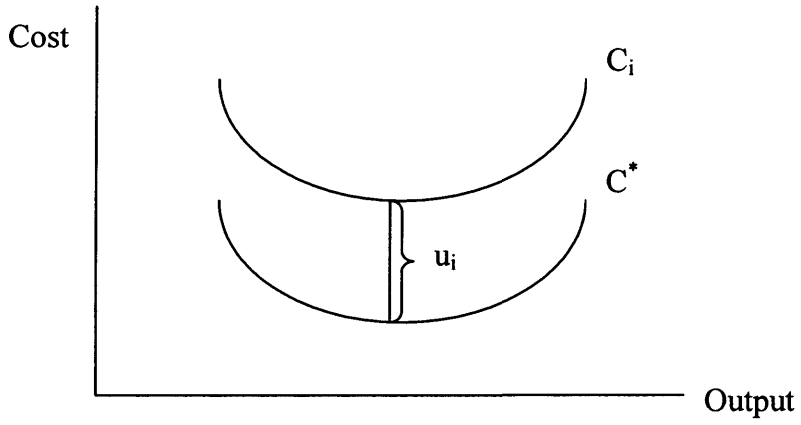
Cost efficiency is achieved when a bank is both allocatively and technically efficient, and it is normally measured by a ratio of the best-practice bank's cost to a bank's actual cost for producing the same level of output using the same production technology [32]. The parametric efficiency frontier methodology uses an arbitrarily-chosen production function to envelope data (outputs, inputs or input prices) observation points, with the assumption that firm-specific effects (inefficiencies) are one-side distributed. Early deterministic frontier models, such like Aigner and Chu (1968) for production function and Førsund and Jansen (1977) for cost function, assume that the deviation from the model predicted best-practice is solely attributed to the operational inefficiency and do not allow for random errors.

The stochastic production frontier models were firstly introduced separately by Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977), which added a symmetric random error to account for statistical noise that are not under the control of the firms. When input price data are available and under a set of regularity conditions[33], the production technology can be expressed as a cost function, which is a function for total cost in terms of outputs and input prices. In a multiple-output production environment, estimating a cost function is much more convenient than estimating multiple output production models.

[32] See section 3 of Chapter 4 for detailed explanations.
[33] See Shepahard (1953) or Nerlove (1963) for details.

The basic idea of SFA cost frontier method can be graphically illustrated in Figure 3-1. The model estimated minimum cost is shown by C^*, and the objective firm *i*'s actual cost is given by C_i. The vertical distance u_i between the two curves shows how inefficient the firm is, i.e cost inefficiency of firm *i*.

Figure 3-1 Cost function and Cost inefficiency



(Source: Coelli. 2005)

As a general rule, efficiency levels measured relative to one frontier cannot be directly compared with efficiency levels measured relative to another frontier. The analysis carried out in this chapter is in a multi-country and multi-period context. With cross-country comparison and cross time convergence analysis as purposes, the bank cost efficiencies are measured in a common-frontier framework[34], i.e. a common best-practice frontier cross countries and cross time. As argued in Berger and Humphrey (1997), "a frontier formed from the complete date set across nations would

[34] Estimating common-frontier is a popular practice in cross-country bank efficiency comparative studies, e.g. Karim and Zaini (2001); Lozano-Vivas et al. (2001). Criticisms on this practise include that the assumption of a single frontier technology is too restrictive, and do not allow for difference in technologies in different countries. For more details, see Bos and Schmiedel (2007), Ben Naceur et al. (2011).

allow for a better comparison across nations, since the banks in each country would be compared against the same standard" (pp.187-188).

In order to make a common frontier valid, one have to take cross-country heterogeneity into account, as well as the bank-specific characteristics as determinants of inefficiency. A popular practice of investigating the effects of determinants and other environmental variables on (in)efficiency is to conduct a second stage regression of predicted efficiencies, obtained from using either parametric or non-parametric frontier techniques, upon bank-specific and other environmental variables[35]. Those variables are normally exogenous that have been considered to be relevant to the banks' efficiency levels but are out of the bank managers' control. These factors might reflect differences in ownership, size, market share, business environment, degree of competition, and differences in country-specific macroeconomic conditions among the banks under analysis, which may help explain the efficiency differentiations. This two-stage estimation procedure has provided a useful analysing tool, but has been criticized for inconsistence in assumptions about efficiencies' distribution between the two stages[36], where in stage one efficiency terms are assumed to be independently half-normally/truncated-normally distributed, but in stage two they are assumed to be normally distributed and dependent on the bank specific variables[37]. Therefore, the two-stage procedure is likely to produce inefficient and biased estimates.

[35] E.g. Pitt and Lee (1981) and Sufian and Habibullan (2010a).
[36] Two-stage estimation based on non-parametric efficiency estimates also faces other criticisms. E.g. Simar and Wilson, 2007, which will be discussed in Chapter 4.
[37] See Kumbhakar, Ghosh and McGukin (1991), Reifschneider and Stevenson (1991) and Wang and Schmidt (2002) for more discussion.

This study uses Battese and Coelli (1995) specification of the stochastic frontier approach (SFA)[38] to estimate bank cost efficiency. One advantage of this model is that it estimates a stochastic cost frontier and the coefficients for environmental variables simultaneously in a single-stage estimation procedure, which avoids inconsistent distribution assumption problem and produce more efficient estimates. It also allows for unbalanced panel data which can significantly increase the sample size given the recognized difficulties in collecting long time series data for emerging countries. The general form of Battese and Coelli (1995) model is specified in a log-linear form as follows:

$$C_{it} = f(X_{it;}\beta) + (V_{it} + U_{it}) \qquad (3.1)$$

Where C_{it} is the natural logarithm of total variable cost of production of *i*-th bank in period *t*. The total variable cost is expressed as a function of a set of explanatory variables, X_{it}, which includes input prices and output measures of *i*-th bank in period *t*. β is a vector of parameters to be estimated. The error term contains two components. The first component is a symmetric random error, $V_{it} \sim iidN(0,\sigma_v^2)$, to account for statistical noise. Bank's inefficiency is captured by the second component of the error term U_{it}, which is defined as how far the firm operates above the cost frontier. Thus U_{it} is assumed to be non-negative and independently distributed following a (left) truncated-normal distribution with constant variance, $U_{it} \sim N^+(m_{it},\sigma_u^2)$, where $m_{it} = z_{it}\delta$ and

[38] Standard form of SFA were proposed by Lovell and Schmidt (1977) and Meeusen and ven den Broeck (1977) independently.

$$U_{it} = z_{it}\delta + \varepsilon_{it} \tag{3.2}$$

Equation (3.2) models the inefficiency in terms of its determinants, a set of bank-specific variables and other environmental variables z_{it}, with a vector of parameters δ, to be estimated. Since U_{it} is restricted to be non-negative, the error term in equation (3.2), ε_{it}, follows a truncated normal distribution $N(0,\sigma_{\varepsilon}^2)$ left-truncated at point $-z_{it}\delta$. The Battese and Coelli (1995) model allows simultaneous estimation of the stochastic cost frontier, equation (3.1), and the determinants of inefficiency, equation (3.2), with a one step maximum likelihood method.

If the inefficiency term is not statistical significant at all, then the model can be estimated as a cost function without having any bank-specific inefficiency consideration. Utilizing a simple parameterization of Battese and Corra (1977) who replaced σ_V^2 and σ_U^2 with $\sigma^2 = \sigma_V^2 + \sigma_U^2$ and $\gamma = \sigma_U^2/(\sigma_V^2 + \sigma_U^2)$, one can test whether the SFA specification is necessary by testing the significance of the γ parameter[39]. If γ is not significantly different from 0, it would indicate that σ_U^2 is 0, therefore U_{it} term should be removed from the model.

Regarding the functional form of the cost function, the Cobb-Douglas and translog models are the most popular in the extant literature. In this study, a simple

[39] As pointed out in Coelli (1996), "any likelihood ratio test statistic does not have a chi-square distribution because the restriction defines a point on the boundary of the parameter space. In this case the likelihood ratio statistic has been shown to have a mixed chi-square distribution". For more on this point see Lee (1993) and Coelli (1993).

Cobb-Douglas cost function has been chosen. The translog model has been argued to allow more flexibility by relaxing the assumption of unitary elasticity of substitution in the Cobb-Douglas function. But the cost of greater flexibility in the translog models is that the implied production function is not monotonic or globally convex as it is in the Cobb-Douglas models. The latter has universally smooth and convex isoquants and the implied cost function is likewise well behaved (Greene, 2008). Especially, researchers have showed that when used in efficiency estimation, the two functional forms produce little difference in efficiency ranking[40] (Guermat and Hadri, 1999).

Debates also rage about the appropriate choices of the input/output specification. There are two main approaches to the choice of input/output variables. One is the traditional "intermediation approach" (Sealey and Lindley, 1977), in which the input of funds and their interest cost is included in the analysis, since funds are the main "raw material" which is transformed in the intermediation process (e.g. Berger and Humphrey, 1991). The other is the "production" approach, in which only physical inputs such as labour and capital are included (e.g. Kuussaari and Vesala, 1995). Following the intermediation method of Sealey and Lindley (1977), I use three inputs and three outputs. Inputs are the number of employees (LAB), fixed assets (FA) and total deposits (TD). Outputs are total loans (LOANS), other earning assets (OEA), and other operating income (OOY) as an approximation for the non-traditional business activities of banks[41]. Total variable cost and input price terms are normalized by the third input price, p_{3it}, to impose the linear homogeneity (homogeneous of degree 1) restriction in the model. Thus, the complete model is as following:

40 Another reason for choosing the Cobb-Douglas cost function is that as pointed by (Greene, 2008) a simpler model setup with fewer parameters to be estimated may help cope with the problem of "wrong Skewness" of the residual term in the production/cost function. However, there is no theoretical basis for this in the literature.

41 More discussion on input/output specification see section 4.

$$\ln\frac{C_{it}}{p_{3it}} = \beta_0 + \beta_1 \ln y_{1it} + \beta_2 \ln y_{2it} + \beta_3 \ln y_{3it} + \chi_1 \ln\frac{p_{1it}}{p_{3it}} + \chi_2 \ln\frac{p_{2it}}{p_{3it}} + (v_{it} + \mu_{it}) \tag{3.3}$$

$$\mu_{it} \sim N^{+}(\overline{\mu_{it}}, \sigma_{\mu}^{2})$$

The environmental variables z_{it} included in equation (3.2) enable the control of differences in bank-specific characteristics and general country-specific environmental differences. For bank-specific characteristics, ownership dummy variable (*OWN*) with 1 denotes for dominant foreign ownership, and banks size (*SIZE*) which is measured by the natural logarithm of bank total assets are included. Instead of including country dummy variables, I use two variables that could be considered as indicators of general country-specific economic conditions to capture the cross-country heterogeneity, i.e. the GDP growth rate (*ΔGDP*) and real GDP per capita (*GDPP*) measured in PPP adjusted international dollar (US dollar). The former measures the economic improving speed and the latter represents the general wealth status and income level of each country. The degree of market concentration is also controlled by including the Herfindahl-Hirschman Index (*HHI*)[42] of each country in each period[43]. The inefficiency determinants model and the (in)efficiency scores (*EFF*) are specified as follows,

[42] A commonly accepted measure of market concentration, which is named after economists Orris C. Herfindahl and Albert O. Hirschman. For more discussion see section 7 in Chapter 5.
[43] For more discussion on environmental variables, see Section 4 of this chapter.

$$\mu_{it} = \delta_0 + \delta_1 * OWN_{it} + \delta_2 * SIZE_{it} + \delta_3 * \Delta GDP_{it} + \delta_4 * GDPP_{it} + \delta_5 * HHI_{it} + \varepsilon_{it} \tag{3.4}$$

$$EFF_{it} = \exp(\mu_{it}); \qquad EFF_{it} \geq 1$$

For interpretational convenience, the conventional Farrell (1957)'s definition of efficiency is used, which is merely the inverse of Shephard (1970)'s efficiency (inefficiency) measure, in cross-country efficiency comparison. Thus an efficiency measure is defined as ρ_{it}, that is, $\rho_{it} = 1/EFF_{it}$ and $0 \leq \rho_{it} \leq 1$.

3.2. Convergence models of bank efficiency

3.2.1 Convergence at country-level

In the growth convergence literature, *β-convergence* exists when the economy of low-income countries grows faster that of high-income countries, in other words, the low-income countries are catching up with the high-income countries. It also distinguishes between unconditional *β-convergence* and conditional *β-convergence*, where the former relates to convergence to a common point or common steady-state and the latter relates to different points or steady-states. An alternative concept is *σ-convergence*, which relates to the dispersion of interested measures across groups of economies and is achieved when the dispersion narrows over time. The two concepts of convergence are related but they are conceptually different: *σ-convergence* studies how the distribution of income evolves over time whereas *β-convergence* studies the

mobility of income within the same distribution. *"β-convergence* is a necessary, but not sufficient condition for *σ-convergence"* (Sala-i-Martin, 1996).

In this chapter, the convergence concepts are applied to bank efficiency and the convergence properties are investigated at two levels, namely, the country level and individual bank level. Firstly, *β-* and *σ-convergence* will be tested at the country level, using the (weighted) average cost efficiency level of each country's whole banking market. This is to investigate whether the aggregate banking market of each member country is converging towards a regional common steady-state level or towards each other. The two types of convergence at country level is a general indication of that the overall efficiency level of the banking industry in each country are improving and the differences between countries' aggregate bank efficiency level are diminishing over time.

Following Weill (2009) and Casu and Girardone (2010), the following equation is employed to test unconditional *β-convergence* at country level:

$$\ln \overline{\rho}_{j,t} - \ln \overline{\rho}_{j,t-1} = \phi^c + \theta^c \ln \overline{\rho}_{j,t-1} + \varepsilon^c_{j,t} \qquad (3.5)$$

$\overline{\rho}_{j,t}$ is (weighted) average of cost efficiency scores of all banks in country j at time t

$\overline{\rho}_{j,t-1}$ is the $\overline{\rho}_{j,t}$ in period *t-1*

ϕ^c and θ^c are parameters to be estimated, and

$\varepsilon^c_{j,t}$ is random error term, and $\varepsilon^c_{j,t} \sim iid\ N(0, \sigma^2_{\varepsilon^c})$

Similar with the exposition in Sala-i-Martin (1996), the dependent variable in the above equation is approximately the growth rate of bank efficiency level. If the partial correlation between growth rate in efficiency over time and its initial efficiency level is negative, then there is *β-convergence*, therefore a negative and significant value for the parameter θ^c implies unconditional *β-convergence* at country-level. The larger the absolute value of the coefficient, the greater the tendency of convergence. If *β-convergence* exists, intuitively, this implies that the bank efficiency level of countries with low initial bank cost efficiency were improving faster than those with high initial efficiency scores, while all countries are improving their efficiency towards the best practice level.

The other type of convergence, which is also of great economic interest, is *σ-convergence*. When the dispersion of efficiency scores across countries falls over time, there is *σ-convergence.* To test whether *σ-convergence* exists across ASEAN countries during the last two decades, a simple equation regressing the standard deviation across countries in each year on a time trend variable is employed.

$$\sigma_t^c = \alpha^c + \eta^c T + \xi_t^c \qquad (3.6)$$

σ_t^c is standard deviation of (weighted) average efficiency level across countries in time t,

T is a time trend variable with 1994=1.

α^c and η^c are parameters to be estimated.

ξ_t^c is random error, and $\xi_t^c \sim iid\, N(0, \sigma_{\xi^c}^2)$

A negative value for the parameter η^c implies *σ-convergence*, which indicates the dispersion in banking average cost efficiency across countries is narrowing over time. To be consistent with the reported efficiency scores, here variances/standard deviations around weighted average, which better presents the actual aggregated efficiency level, across countries are used[44].

3.2.2 Convergence at bank-level

Convergence properties at country level provide a general picture of banking development in this region, indicating if each country's banking market as a whole is converging towards one another. But using country-level data may neglect some of the important features regarding individual banks. Especially, when the weighted average of the efficiency level is used in convergence analysis, the relevance of small banks is mitigated. It is possible that the aggregate efficiency level of banking industry of one country is improving/regressing over time, while individual banks present different phases of evolution. Aggregate improvement in either the level of efficiency or the distribution of efficiency may well conceal problems associated with individual banks' situation. Ignoring these individual bank concerns is dangerous in policy making. Therefore, apart from convergence at country-level, the convergence properties at bank level may also be important.

By using individual bank as a unit instead of using each country's average bank efficiency in regression, the sample size can been significantly expanded and made

[44] Estimation using variances around arithmetic mean generates similar results.

sub-period estimations possible, therefore more interesting issues, such as the impact of financial integration movements since the 1997 Asian crisis and conditional *β-convergence*, can be investigated. In bank-level convergence estimation, the whole sample is also divided into two periods, with the 1997 Asian financial crisis as divide, namely 1994-2000 and 2001-2009, and investigate if the financial crisis, financial integration projects and banking reforms thereafter have significantly changed the speed of adjustment in bank efficiency.

The baseline model for bank-level *β-convergence* is similar with that used in country-level convergence tests, except that individual bank's efficiency scores are now used. Similarly, a negative and significant estimated value of θ^b indicates *β-convergence* across all individual banks in this region over time:

$$\ln \rho_{i,t} - \ln \rho_{i,t-1} = \phi^b + \theta^b \ln \rho_{i,t-1} + \varepsilon_{i,t}^b \qquad (3.7)$$

$\rho_{i,t}$ is cost efficiency score of bank i at time t

$\rho_{i,t-1}$ is cost efficiency score of bank i at time t-1

ϕ^b and θ^b are parameters to be estimated, and

$\varepsilon_{i,t}^b$ is random error, and $\varepsilon_{i,t}^b \sim iid\ N(0, \sigma_{\varepsilon^b}^2)$

Larger sample size also enables the inclusion of country dummies in the regression. Both intercept and slope dummy variables are included to capture the cross-country heterogeneity in the steady-state bank efficiency level and their convergence tendency. This can also be interpreted as the "conditional *β-convergence*", testing whether each country is converging to its own steady-state

level of efficiency. The testing equation is as follows, where there are i banks, i=1,...,1890, belonging to j countries, j =1,...,4:

$$\ln \rho_{i,t} - \ln \rho_{i,t-1} = \phi^{bc} + \theta^{bc} \ln \rho_{i,t-1} + \sum_{j=1}^{4} \varphi_j D_j + \sum_{j}^{4} \gamma_j D_j \ln \rho_{i,t-1} + \varepsilon_{i,t}^{bc} \quad (3.8)$$

$\rho_{i,t}$ and $\rho_{i,t-1}$ have the same meaning as defined earlier

D_j denotes four country dummy variables excluding Thailand

$\phi^{bc}, \theta^{bc}, \varphi_j and \gamma_j$ are parameters to be estimated, and

$\varepsilon_{i,t}^{bc}$ is random error, and $\varepsilon_{i,t}^{bc} \sim iid\ N(0, \sigma^2_{\varepsilon^{bc}})$

Bank-level *σ-convergence* tests the same property with country-level *σ-convergence*, but taking individual banks across different countries into account, which may encounter greater variation than at country aggregate level. This is simply tested by using standard deviations across individual banks' efficiencies, instead of using standard deviations across country (weighted) average efficiencies:

$$\sigma_t^b = \alpha^b + \eta^b T + \xi_t^b \quad (3.9)$$

σ_t^b is standard deviation around regional (weighted) average cost efficiency scores across all individual banks at time t.

T is time trend variable as defined before

α^b and η^b are parameters to be estimated, and

ξ_t^b is random error, and $\xi_t^b \sim iid\ N(0, \sigma^2_{\xi^b})$

Again, a negative and significant value for η^b indicates *σ-convergence* across individual banks, i.e. the dispersions in cost efficiency at bank level are narrowing over time.

3.2.3 Interpretation of convergence

If both types of convergence are confirmed, then the results could be interpreted as an indicator of general improvement in bank efficiency at country/bank level, as the banking industries in different countries are all catching up with the common best practice banks and the less efficient countries/banks are improving faster. As a result, the dispersion in banking efficiency across countries/banks is getting smaller over time.

However, as mentioned above, since *β-convergence* is a necessary but not a sufficient condition for *σ-convergence*, and not vice versa, there is a possibility that only one type of convergence exists while the other does not. Such like the case in Casu and Girardone (2010), only *σ-convergence* is significant. They interpret this as that the narrowing down dispersion in efficiency among countries is merely a result of moving toward the mean rather than moving towards the best practice. In other words, the inefficient banks, whose initial efficiency scores were below the average, are catching up with the average level; however, those efficient banks, whose initial efficiency scores were above the average, are actually regressing towards the average.

On the other hand, there is also a possibility that only *β-convergence* is significant, but *σ-convergence* does not exist. To the best of my knowledge, this

situation has not been detected in banking efficiency studies, but does exist in the growth literature studies. Young *et al.* (2008), for example, demonstrated why *β-convergence* is a necessary but not sufficient condition for σ-convergence from a theoretical point of view, and also provided empirical evidence from US country-level income growth from 1970 to 1998, where *σ-convergence* did not accompany *β-convergence*. They argued that cross sectional variance may increase or decrease, depending on the magnitude of initial variance, not only the adjustment speed towards steady-state. When the initial dispersion is relatively small to the variance of random shocks, the dispersion may converge towards steady-state level from below, i.e. increasing towards steady-state level. Thus *σ-convergence* may not be detected even if *β-convergence* exists. Intuitively, economies can be *β-converging*, while "random shocks are pushing them apart"[45]. Similar argument could also be applied to bank efficiency convergence analysis.

4. Variables and Data

4.1 Data sources

My data set covers the 5 initial member countries of ASEAN, namely Indonesia, Malaysia, the Philippines, Singapore and Thailand over the period 1994-2009, which contains two major financial crises in the history (1997-99 Asian financial crisis and the current global crisis starting from 2007). The data set is primarily drawn from the balance sheet and income statement of individual bank from the BankScope database of Bureau van Dijk, which reports published financial statements from financial

[45] Theoretical demonstration of this issue is presented in Appendix A

institutions worldwide. For those missing data that are not reported in Bankscope, other resources are used, including annual reports of individual bank, central bank reports and internet web resources. In the sample data set, only commercial banks are considered as they are carrying out relatively similar banking business, and comprise the largest segment of depository institutions. The unconsolidated financial reports are used, where available, to avoid double-counting. Consolidated reports are used wherever unconsolidated reports are not available. After adjusting the data for missing values, reported errors and outliers, I end up with an unbalanced panel data set of 1889 bank-year observations, in which a bank exists for at least 5 years with full information. Table 3-1 presents the observation numbers by year and country.

Table 3-1 Observation numbers by year and country

	Indonesia	Malaysia	Philippines	Singapore	Thailand	ALL
1994	36	16	20	4	14	90
1995	40	25	21	4	16	106
1996	39	27	22	4	17	109
1997	43	26	26	5	17	117
1998	49	26	27	6	18	126
1999	52	26	28	8	18	132
2000	45	24	27	8	18	122
2001	44	24	23	8	18	117
2002	41	27	26	8	18	120
2003	45	28	26	8	18	125
2004	47	27	25	8	17	124
2005	50	27	25	8	18	128
2006	48	26	24	8	18	124
2007	46	26	21	8	18	119
2008	43	26	22	8	18	117
2009	39	26	22	8	18	113
Total	707	407	385	111	279	1889

It is necessary to mention that in the data collecting process, it has been noticed that, surprisingly, only a limited number of bank reports with limited time periods are available on Bankscope database for Singapore. According to Monetary Authority of Singapore, although there are 120 commercial banks operating in Singapore by March

of 2011, but only 6 of them are local banks and only one-fifth (26 out of 114) of foreign banks offer full banking services. Financial reports of foreign subsidiaries or representative offices are not publicly available. However, given that the Singaporean banking industry is fairly competitive, surviving banks must represent the general level of efficiency of the whole industry, otherwise it can be argued that they would have been eroded quickly under the competitive pressure. The small sample of Singapore is treated as a representative of the Singaporean banking industry.

4.2 Variables in efficiency estimation and data treatment

Regarding the choices of the input/output variables, three-input three-output specification is chosen broadly following the traditional "intermediation approach" (Sealey and Lindley, 1977), in which the input of funds and their interest cost is included in the analysis, since funds are the main "raw material" which is transformed in the intermediation process (e.g. Berger and Humphrey, 1991). The three typical input variables under the intermediation approach are the *Number of Employees* (LAB), *Fixed Assets* (FA) and *Total Deposits* (TD=customer and interbank deposits + other deposits and short-term borrowings). The outputs are, *Loans* (total customer loans + total other lending), *Other Earning Assets* (OEA= interbank assets + securities), and *Other Operating Income* (OOY=net gain on trading and derivatives + net fees and commissions +other non-interest income). The first two variables are typical output variables used in many bank efficiency studies. The OOY variable is selected to proxy the non-traditional business activities of banks. Over recent years, non-traditional banking activities, such as securitization, derivative securities, standby letters of credit and many other off-balance sheet (OBS) fee-based services become

more and more popular. Therefore, the importance of fee-income and other non-interest income relative to the traditional interest income has increased dramatically[46]. As pointed out in Siems and Clark (1997) and Rogers (1998) among others, ignoring non-traditional activities in estimating efficiency produces misleading results, as the relevant outputs are not accommodated while the resources used to produce those activities were included. All the data were initially measured in its own country's currency and in nominal terms, in order to ensure the validity of cross-country and over-time comparison, the data is adjusted by Purchasing Power Parity exchange rate and is converted into a common currency (US dollar)[47] .

Calculating input prices are crucial for estimating bank cost efficiency. The price of labour (p_1) is calculated as the ratio of personnel expenses divided by the number of employees. Where data on either personnel expenses or employees are not reported, the calculation of the price of labour relies on some reasonable and acceptable working assumptions. I follow what is standard in the literature and assume that the growth rate of the number of employees is the same as the growth rate of total assets (in real terms) for a given bank, and the ratio of personnel expenses to operational expenses is the same as the closest available year[48]. The price for total deposits (p_2), is calculated by the ratio of interest expenses to total deposits. The price of fixed assets (p_3), is measured by the ratio of operating expenses less personnel expenses to fixed assets. Here the operating expense can be interpreted as capital maintenance[49]. Table 3-2 provides some general statistics of the data set at per

[46] Clark and Siems (2002)
[47] The PPP exchange rates are obtained from the World Economic Outlook Database, International Monetary Fund, October 2010
[48] See for example Altunbas, *et al.* (2001) and Vannet, 2002
[49] Same interpretation used in Shen *et al.* (2009).

country category. In order to be more informative, the values presented in Table 3-2 are in levels, although natural logarithms of these variables are used in efficiency estimation.

Table 3-2 Statistical data description for variables used in efficiency estimation (1994-2009)

		MEAN	MEDIAN	MIN	MAX	S.D
Total Variables Cost (C)	I	636.67	87.86	4.84	14293.79	1433.45
	M	924.06	394.67	6.71	24493.37	2600.80
	P	364.48	200.82	4.64	1886.70	388.78
	S	976.31	165.40	8.06	4992.71	1267.01
	T	1262.42	796.93	1.27	7868.64	1342.26
	ALL	755.49	233.95	1.27	24493.37	1641.93
Total Loan (y_1)	I	2652.92	600.50	2.45	33257.29	5036.46
	M	8403.14	3983.75	0.52	81415.90	12548.02
	P	2445.59	1213.17	3.76	21000.04	2969.90
	S	17044.07	4708.30	104.89	92100.57	22736.32
	T	16325.44	8226.37	210.84	67181.00	17012.04
	ALL	6714.63	1703.51	0.52	92100.57	12177.95
Other Earning Assets (y_2)	I	2545.04	325.74	6.45	69070.92	7007.28
	M	3161.16	1470.82	19.78	38325.76	4672.13
	P	2163.06	1134.21	6.71	13834.23	2635.17
	S	15863.76	1309.90	6.23	96596.86	24193.54
	T	5385.48	2137.37	11.99	34660.27	7448.73
	ALL	3802.09	974.40	6.23	96596.86	8768.82
Other Operational Income (y_3)	I	80.63	13.51	0.00	2324.30	197.29
	M	140.70	61.17	0.00	1689.68	214.84
	P	97.71	48.86	0.00	637.95	116.26
	S	290.25	45.31	1.20	1704.28	433.28
	T	214.37	84.72	0.00	1594.47	296.78
	ALL	129.12	34.68	0.00	2324.30	234.19
Price of fixed assets (p_1)	I	2.99	1.25	0.09	121.50	7.94
	M	1.95	1.14	0.24	15.97	2.25
	P	1.46	0.95	0.15	13.83	1.64
	S	3.90	0.97	0.27	36.00	6.15
	T	1.22	0.61	0.06	45.50	3.05
	ALL	2.25	1.00	0.06	121.50	5.43
Price of Deposits (p_2)	I	0.14	0.09	0.00	4.57	0.26
	M	0.17	0.03	0.00	9.39	0.98
	P	0.06	0.05	0.01	4.60	0.23
	S	0.03	0.03	0.00	0.07	0.01
	T	0.05	0.04	0.00	0.17	0.04
	ALL	0.11	0.05	0.00	9.39	0.50
Price of Labour (p_3)	I	0.03	0.02	0.01	0.37	0.03
	M	0.07	0.04	0.01	1.41	0.14
	P	0.02	0.02	0.01	0.14	0.01
	S	0.07	0.06	0.00	0.33	0.06
	T	0.03	0.03	0.00	0.09	0.01
	ALL	0.04	0.03	0.00	1.41	0.07

*Except for No. of employee, other variables are measured in million US$ adjusted by PPP exchange rate. 2005=100

4.3 Environmental variables

Following other studies on bank efficiency determinants, e.g. Sufian (2009), Lozano-Vivas and Pasiouras (2010), the control variable vector z_{it}, used in the sub-regression (3.2), contains three categories of environmental variables[50]. The first group are bank-specific characteristics including ownership dummy variable (OWN) and banks size (SIZE). Earlier researchers[51] found that controlling foreign ownership is likely to increase efficiency level of a bank, especially in developing countries where domestic economy and financial market are less sophisticated (Jeon and Miller, 2003). Explained by Sufian (2009), this is because of "better risk management and operational techniques which is usually made available through their parent banks abroad". Bank size could have either positive or negative effect on a bank's efficiency level, depending on whether the bank operates under increasing or decreasing return to scale segment of its cost curve.

The second group of environmental variables are general macroeconomic condition indicators, i.e. the GDP growth rate (ΔGDP) and real GDP per capita (GDPP). These two variables represent two relevant but different concepts. Demand for financial services tends to grow as economies expand, but the impact of economic expansion on bank cost efficiency is ambiguous. Immoderate lending in economic boom may create potential non-performing loan problems which in turn would result in high cost of loan default. On the other hand, economic growth rate of wealthier countries may be lower, but with a relative sophisticated financial system, banks are

[50] Other variables were included, such as measure of banks risk; measure of bank profitability, but were statistically insignificant.
[51] For example, by Isik and Hassan (2003) on Turkish banks, Hasan and Marton (2003) on Hungarian banks, and Sathye (2003) on Indian banks.

likely to operate more efficiently than those in fast-growing but unstable economic environment.

The last variable included in estimation is Herfindahl-Hirschman Index (HHI) base on the total deposits of sample banks, which captures the specific characteristics of banking industry of each country. This variable is frequently used in banks efficiency studies[52]. Again, its effect on bank efficiency can either be positive, if higher concentration is a result of more efficient production; or negative, if higher market power leads to less competition. Table 3-3 summaries these environmental variables by country category.

[52] For example, Dietsch and Lozano-Vivas (2000); Lozano-Vivas and Pasiouras (2010).

Table 3-3 Environmental variables by country category (1994-2009)

	COUNTRY	MEAN	MEDIAN	MIN	MAX	S.D
Ownership (1 denotes >50% foreign ownership; 0 otherwise)	Indonesia	0.62	1.00	0.00	1.00	0.49
	Malaysia	0.53	1.00	0.00	1.00	0.50
	Philippines	0.14	0.00	0.00	1.00	0.34
	Singapore	0.32	0.00	0.00	1.00	0.47
	Thailand	0.30	0.00	0.00	1.00	0.46
	ALL	0.44	0.00	0.00	1.00	0.50
Size (natural logarithm of bank total assets measured in million US$)	Indonesia	7.31	6.96	4.35	11.42	1.63
	Malaysia	8.73	8.77	5.67	11.81	1.38
	Philippines	7.90	7.88	3.77	10.45	1.28
	Singapore	8.85	8.65	5.16	12.23	2.20
	Thailand	9.37	9.51	5.95	11.55	1.32
	ALL	8.13	8.13	3.77	12.23	1.70
ΔGDP (annual % change)	Indonesia	3.95	4.92	-13.13	8.22	4.98
	Malaysia	5.11	5.85	-7.36	10.00	4.41
	Philippines	5.21	5.19	-0.58	12.41	2.67
	Singapore	5.43	7.65	-2.39	11.40	4.28
	Thailand	3.46	4.75	-10.51	9.24	4.73
	ALL	4.47	5.33	-13.13	12.41	4.44
GDP per capita (measured in Thousand US$, adjusted by PPP exchange rate)	Indonesia	2.87	2.67	2.08	4.15	0.63
	Malaysia	10.25	9.58	6.90	14.15	2.21
	Philippines	2.58	2.36	1.88	3.52	0.52
	Singapore	38.08	36.62	24.72	51.25	8.79
	Thailand	5.94	5.46	4.23	8.24	1.34
	ALL	6.92	3.52	1.88	51.25	8.70
HHI	Indonesia	0.12	0.12	0.09	0.15	0.02
	Malaysia	0.10	0.10	0.08	0.12	0.01
	Philippines	0.09	0.09	0.08	0.11	0.01
	Singapore	0.33	0.32	0.30	0.37	0.02
	Thailand	0.12	0.12	0.11	0.14	0.01
	ALL	0.12	0.11	0.08	0.37	0.05

5. Empirical Results

5.1 Stochastic Frontier Approach (SFA) and bank cost efficiency

5.1.1 Estimation results of SFA cost function

Equation (3.3) and (3.4), which define the Battese and Coelli (1995) SFA model, are estimated simultaneously by maximum likelihood using **Frontier** in **R**[53], which is an extension package of FRONTIER 4.1 (Coelli, 1996) for R. The estimation results of the cost function and inefficiency model are given in Table 3-4.

Table 3-4 SFA cost function and inefficiency model estimation results

Variables	Parameter	Estimate	Z-value
Cost function			
Intercept	β_0	0.9383	(12.60)***
$\ln y_1$	β_1	0.5361	(48.64)***
$\ln y_2$	β_2	0.4793	(42.80)***
$\ln y_3$	β_3	0.0131	(3.03)***
$\ln(p_1/p_3)$	χ_1	0.0145	(1.31)
$\ln(p_2/p_3)$	χ_2	0.8566	(84.04)***
Inefficiency model			
Intercept	δ_0	431.4906	(2.64)***
Own	δ_1	-69.7131	(-3.50)***
Size	δ_2	-45.8782	(-2.56)**
ΔGDP	δ_3	-2.0117	(-1.98)**
GDP per Capita	δ_4	15.9235	(2.71)***
HHI	δ_5	-30.2203	(-2.70)***
sigmaSq.	σ^2	27.1306	(2.75)***
Gamma	γ	0.9929	(380.54)***
Log likelihood value:		-1273.16	

***, ** and * denotes coefficient is significant at 1%, 5% and 10% significance level accordingly

[53] R is 'GNU S', a freely available language and environment for statistical computing and graphics.

Since the variables used in the cost function are expressed in log forms, the estimates of coefficients can be interpreted as output elasticities or input price elasticities of total cost. Estimation of the cost function clearly shows that all three outputs have positive and significant effects on a bank's total cost, indicating that total variable cost increases with expansion in production and emphasising on the importance of both traditional and non-traditional banking activities. The sum of the three output elasticities is 1.0285, which implies that if the production is expanded systematically by 1%, the total cost of production would increase by a little higher than 1%. The aggregate production of banking industry in the ASEAN countries could be characterised as constant return to scale to diseconomy of scale. Further expansion of the banking market would lead to more than proportionally increase in costs.

However, compared with loans (y_1) and other earning assets (y_2), bank cost is less sensitive to non-traditional business (y_3), evidenced by a much lower elasticity level, 1.3% for the third output comparing with roughly 50% for the other two outputs. This may explain partly why banks are increasingly engage in non-traditional banking activities, as diversification in business increases bank's revenue without increasing much of the cost at the same time. Increases in input prices will all increase bank's total cost, but to different extents. Given the restriction of homogeneity of degree one in input prices imposed in the cost function[54], the main contributor to total cost is interest expenses on deposits and other short-term funding (P_2), which has the highest

[54] Which indicates $\chi_1 + \chi_2 + \chi_3 = 1$, where χ_3 is elasticity for price of labour, which is not shown explicitly in the estimation results.

elasticity level of 85.66%. Fixed assets cost (P_1) and labour cost (P_3) together only contribute less than 15% to the total variation in total cost.

The estimated value of γ parameter, which measures the significance of bank specific inefficiency effect in the cost function, is nearly 1 and statistically significant at 1% significance level, therefore, the SFA model specification on bank-specific inefficiency is necessary. With regard to the characteristics of inefficiency, only those variables which are significant (at most 10% level) are kept in the final regression[55]. Banks with dominant foreign ownership tend to have lower inefficiency level than their domestically owned counterparts. Given that most of the countries in ASEAN are developing countries, this result is consistent with those have been typically found in banking efficiency studies on developing countries, e.g. Isik and Hassan (2003) on Turkish banks, Sathye (2003) on Indian banks and Sufian (2009) on Malaysian banks. Home field advantage of developing countries with relatively unsophisticated financial markets is easily overcome by foreign banks from developed counties, because of their advantages in risk management and operational techniques. Another bank-specific variable included in the regression is bank size, measured by the natural logarithm of total bank assets. The negative and significant coefficient of bank size indicates that, on average, larger banks are more efficient than smaller banks. This is mainly due to the economies of scale. Along with the negative coefficient on HHI market concentration ratio, this also could be related to market power argument, larger banks pay less for inputs but charge more for financial products, resulting in

[55] Other variables, such as cost to income ratio, net interest margin, ratio of non-interest income to total income measuring degree of business diversification and state-own bank dummy variables, were included, but were found not statistically significant.

higher cost efficiency, and thus banks operating in highly concentrated markets are tend to be more cost efficient on average.

As mentioned earlier in Section 4, the two macroeconomic condition variables, GDP growth rate and real GDP per capita, represent two relevant but different concepts and could influence bank efficiency level in either way. Based on the estimation results for ASEAN countries, the two variables are both significant but with opposite signs, implying that economic expansion (higher growth rate) with higher demand for credit and banking services increases the bank efficiency level, but banks in wealthier economies are less efficient. At a first glance this is in contradiction with the widely accepted fact that banks of developed countries are more efficient, but if one look into the sample data and relate these findings to the later efficiency results, it is interesting to notice that Singapore has both the highest average GDP growth rate and the highest average real GDP per capita, and it also has the highest average cost efficiency level over the other countries. On the other hand, one may also notice that Indonesia has the second lowest average growth rate and the second lowest real per capita GDP, but its average bank cost efficiency over the whole period is the second highest among selected countries. Therefore, it seems that it is the joint effect of these two factors that mattered to the efficiency level rather than individual effect of each factor. When the effect of one factor dominates that of the other, bank efficiency may move in line with the dominating factor. However, the dominating factor may be different in different countries.

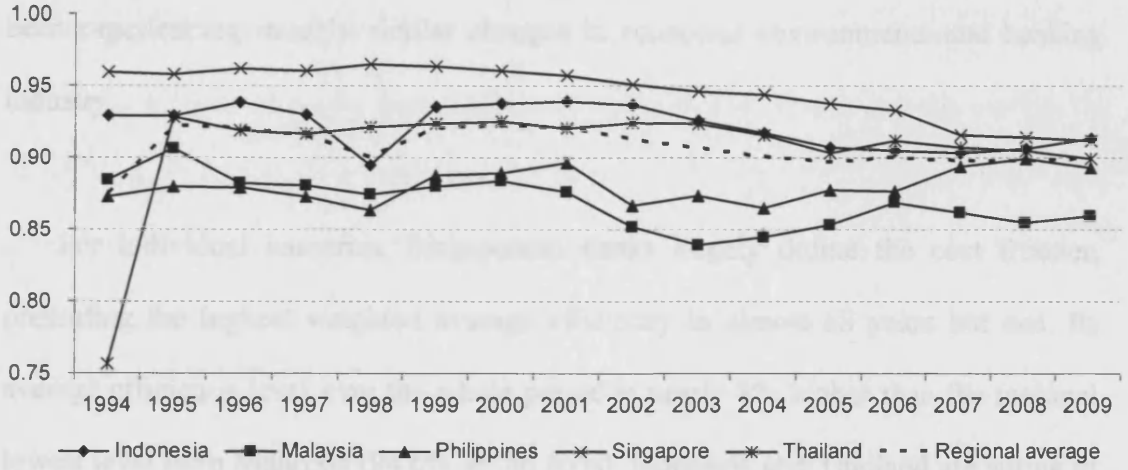
5.1.2 Bank cost efficiency estimates

The significance of bank size and market concentration ratio in bank efficiency determinants raises the necessary consideration of individual banks' size effect on market overall efficiency level. Arithmetic mean of bank cost efficiency may under-evaluate the importance of larger banks and over-estimate the contribution of smaller banks to the overall efficiency level, therefore, the weighted average of bank cost efficiency is used for comparison purpose rather than the arithmetic mean. The yearly average efficiency of each country is weighted by individual banks' total assets, and the cross countries average efficiency level is weighted by country GDP based on purchasing-power-parity (PPP) valuation. Table 3-5 provides these results of yearly weighted average of individual country and of the whole region, and a graphic presentation is given in Figure 3-2.

Table 3-5 Yearly (weighted) average efficiency of each country

Year	Indonesia	Malaysia	Philippines	Singapore	Thailand	Weighted Average
1994	0.9286	0.8845	0.8728	0.9591	0.7561	0.8749
1995	0.9288	0.9059	0.8799	0.9579	0.9282	0.9219
1996	0.9383	0.8817	0.8791	0.9621	0.9188	0.9201
1997	0.9297	0.8803	0.8725	0.9602	0.9163	0.9148
1998	0.8949	0.8743	0.8629	0.9647	0.9208	0.9001
1999	0.9350	0.8801	0.8874	0.9631	0.9232	0.9200
2000	0.9378	0.8839	0.8892	0.9598	0.9250	0.9219
2001	0.9389	0.8755	0.8962	0.9567	0.9205	0.9207
2002	0.9368	0.8514	0.8661	0.9506	0.9241	0.9123
2003	0.9259	0.8387	0.8738	0.9459	0.9233	0.9065
2004	0.9169	0.8447	0.8645	0.9435	0.9155	0.9008
2005	0.9070	0.8530	0.8770	0.9376	0.9034	0.8967
2006	0.9047	0.8691	0.8764	0.9324	0.9117	0.8998
2007	0.9030	0.8614	0.8935	0.9159	0.9074	0.8975
2008	0.9061	0.8544	0.8991	0.9141	0.9046	0.8974
2009	0.9132	0.8592	0.8933	0.9119	0.8989	0.8989
Average	0.9216	0.8686	0.8802	0.9460	0.9061	0.9065

Figure 3-2 Weighted average bank cost efficiency



Relative to the common-frontier across all countries for the sample period, average bank cost efficiency of the whole region is around 90%. A mild decease in efficiency happened around the 1997 Asian crisis and a relatively larger decline since 2003 when many of the ASEAN countries began a reprivatisation process which is part of the banking structural reforms, since many weak banks have been nationalised during the period of crisis. Many theoretical arguments and empirical evidence support that the incoming of new private ownership, especially foreign ownership, have positive impacts on bank's efficiency. However, it is probably that the change is gradual until the new culture and system are properly in place (Ariff and Can, 2008; Besar and Milne, 2009). The short period increase in cost might be explained by the increases of bank's investment in the newly acquired plants. Unfortunately, the most recent global financial crisis reached around 2006, before the benefits of banking structural reforms are actually realized. Similar patterns of efficiency evolution can be found in all individual country cases, which imply most of the ASEAN countries have been experiencing roughly similar changes in economic environments and banking industry.

For individual countries, Singaporean banks largely define the cost frontier, presenting the highest weighted average efficiency in almost all years but one. Its average efficiency level over the whole period is nearly 8% higher than the regional lowest level from Malaysia (94.6% vs. 86.86%). Indonesia and Thailand are sitting in the next tier, with efficiency scores just along or above the regional average level (the dotted line in Figure 3-2). Philippines and Malaysia are the two countries with relatively inefficient banking market comparing with other countries in this region, and their efficiency levels are roughly 2~4% lower than the regional average level.

Country differentials in terms of average bank cost efficiency level raises the worry about currency union's feasibility. Clearly, Singaporean banking industry has better management quality over other member countries by various degrees.

Individual banks' efficiency situation may add more information to the analysis. Take the average efficiency score of the most recent 5 years (2005-2009) for each individual bank, and rank them accordingly. Table 3-6 provides a summary of the results. The dispersion in bank cost efficiency are much greater at bank-level, the lowest efficiency score during the 5 years is only 34.33% from a Malaysian bank, whereas the highest level is 93.17% from a Singaporean bank. This is saying that the total cost of the best bank in the region is only one third of that of the worst bank for the same production level. If this comparison between the best and the worst bank is only an extreme case, then the substantial difference between the weighted average of top 30 banks and bottom 30 banks should be general enough to illustrate the point. The average efficiency of top 30 banks is 91.67%, which is nearly 15% higher than that of the bottom 30 banks during the most recent 5 year. Regarding the number of banks in each category, it is worth to mention that none of the 25 Malaysian banks are in the top 30 category and more than half of them are in the bottom 30. Clearly, these significant differences in average bank cost efficiency are not favourable for banking market integration.

Table 3-6 Bank level efficiency summary for 2005-2009

Average Efficiency		No. of Banks					
		Indonesia	Malaysia	Philippines	Singapore	Thailand	Total
TOP 30	0.9167	17	0	2	3	8	30
BOTTOM 30	0.7717	10	13	4	2	1	30
ALL	0.8957	46	25	22	8	18	119

5.2 Convergence of bank cost efficiency

Estimation results on bank cost efficiency level seem not supportive enough for a high degree of banking market integration, but as discussed earlier, the speed of adjustment of banks may also be of great interest. If low efficiency banks are catching up with high efficiency banks and the dispersions in bank efficiency are narrowing over time, the integration process is still effective. Convergence analysis in economic growth literature has been long recognised as a useful tool in assessing the economic integration. These convergence concepts are applied to bank efficiency analysis, seeking for evidence of catching up behaviours between banks and narrowing down dispersions over time. Convergence tests are carried out at two different levels, namely at country-level and at bank-level. The former consider each country's banking market as a whole and assessing the convergence properties of country weighted average efficiencies, while the later weights individual banks equally regardless of bank size and their origin country.

5.2.1 Country-level convergence properties

Firstly the country-level analysis is conducted to examine whether the banking industry of each country as a whole are converging towards one another. Equation (3.5) and (3.6) are estimated, using country weighted average bank cost efficiency scores reported in Table 3-5. Since the country weighted average efficiency is a reasonable indicator of overall efficiency level of one country at one point of time, convergence properties based on the country average will provide a general picture about whether countries are converging towards the common steady-state efficiency

level or towards each other as a whole, without taking individual bank performance into account. Equation (3.5), which models unconditional *β-convergence*, is estimated by fixed effect panel estimation[56], and equation (3.6) modelling *σ-convergence* is fitted by OLS. Table 3-7 reports the testing results at country-level.

Convergence testing at country-level delivers positive news, as both types of convergence are confirmed by negative and significant coefficient estimates on right-hand side variable in both equations. *β-convergence* indicates that efficiency level of low efficiency countries are improving faster than that of high efficiency countries. More specifically, within this region, countries with low banking industry average efficiency, like Malaysia and Philippines, are catching up with high banking efficiency country, like Singapore. They are improving their relative positions towards the best-practice frontier which are largely defined by Singaporean banks due to superior production technology or management quality. The intercept term in the regression can be used to calculate equilibrium regional average efficiency level when the growth rate of efficiency on the left-hand side of equation (3.5) is 0. The equilibrium regional average efficiency level is 90.58%[57] in this case. Evidence for *σ-convergence* proves that the distribution of efficiency also improves overtime, as the standard deviation[58] across country weighted average is declining over time, which implies the country differential in terms of bank efficiency are diminishing, and

[56] Model selection of all panel estimations in this thesis is based on results of F-test for fixed effect model against OLS, Hausman specification test for fixed effect model against random effect model, and Breusch and Pagan Lagrangian multiplier test for random effect against OLS. These three tests have been done sequentially for every panel estimation. The model selection test statistics are also reported along with the results of the test-accepted models.

[57] Calculated as exp(0.0795/-0.8042)=0.9058

[58] Here the standard deviation around weighted average of country weighted average efficiency across countries is used.

the general efficiency level of banking market of each country are getting closer towards one another.

Table 3-7 country level convergence results for 1994-2009

	Coefficient	*T-statistic*
Unconditional β-convergence (FE)		
Intercept	-0.0795	(-11.10)***
$\ln \bar{\rho}_{j,t-1}$	-0.8042	(-11.67)***
Steady-state efficiency	0.9058	
No. of obs.	75	
F-test	F(4,69)=20.79***	
Hausman test	chi2(1)=333.52***	
B-P test	333.52***	
overall R^2	0.2881	
σ-convergence (OLS)		
Intercept	0.0449	(8.61)***
T	-0.0015	(-2.78)**
No. of obs.	16	
Adj R^2	0.3098	

***, **, and * denotes coefficient is significant at 1%, 5% and 10% significance level accordingly
'F-test' -- the F-test for fixed effect model against OLS,
'Hausman test' -- the Hausman specification test for fixed effect model against random effect model.
'B-P test' -- the Breusch and Pagan Lagrangian multiplier test for random effect against OLS.

5.2.2 Bank-level convergence properties

The supportive evidence provided by country-level convergence properties should not be overvalued in assessing the actual degree of banking market integration, because all it proves is that each country's banking market as a whole are converging over time. The analysis itself and the inference drawn from it are both limited, as it only explains the general situation of each country without considering individual bank issues, and also limited number of observations does not enable in-depth analysis in changing behaviour of convergence over time and from different countries. As discussed earlier in section 3.2, ignoring problems associated with individual bank's situation is dangerous in policy making. The bank-level convergence analysis discussed below may fix this danger by providing more detailed information on converging behaviours of individual banks.

The larger sample size obtained by using individual bank as unit in estimation enable us to do sub-sample estimations and investigate whether the 1997 Asian financial crisis, the regional integration projects and banking structural reforms thereafter have changed the convergence properties in bank efficiency. The 16 years of sample are divided into two sub-periods: pre-crisis (including crisis) period 1994-2000 and post-crisis period 2001-2009. For both unconditional and conditional *β-convergence*, and bank-level *σ-convergence*, the test is firstly conducted for the whole sample period and obtains average convergence coefficients. Then test for two sub-periods, and conduct a Wald coefficient test to see if the convergence tendency significantly changed from the first period to the second period. If the change is significant, the question asked is whether the reforms after financial crisis have

improved or hampered the converging process? Table 3-8 summarized the bank-level unconditional *β-convergence* testing results, which are obtained by estimating equation (3.7). Table 3-9 and Table 3-10 report the testing results on bank-level conditional (country-specific) *β-convergence* results by estimating equation (3.8), and bank-level *σ-convergence* results are stored in Table 3-11.

5.2.2.1 Bank-level *β-convergence*

Using individual bank cost efficiency scores, strong evidence for unconditional *β-convergence* still can be found for the whole sample period and for the two sub-periods separately, as coefficients on the lagged efficiency are all negative and significant. Over the whole period, in general, low efficiency banks are catching up with high efficiency banks. But comparing with the results reported in Table 3-7, which are obtained by estimation using country weighted average cost efficiency, the convergence tendency is much smaller this time and also the steady-state efficiency level is lower. Given that larger banks are more efficient, this may emphases the anxiety about individual bank variations which was raised before, since when all banks are equally weighted regardless of bank sizes, either efficiency level or convergence tendency becomes more or less worse. Comparing the two sub-periods, the time evolution of average steady-state efficiency level is consistent with what has been found in analysis of efficiency estimates earlier in Section 5.1.2, Table 3-5 and Figure 3-2. This decline in average efficiency level could be explained by the short-term high investment cost in re-privatised banks and the current economic environment.

Table 3-8 Bank-level unconditional β-convergence testing results (Fixed effect)

	1994-2009		1994-2000		2001-2009	
	Coefficient	*t-stats*	*Coefficient*	*t-stats*	*Coefficient*	*t-stats*
Intercept	-0.0561	(-12.73)***	-0.1056	(-21.1)***	-0.0831	(-12.57)***
$\ln \rho_{i,t-1}$	-0.3230	(-14.48)***	-0.8554	(-22.16)***	-0.4092	(-13.99)***
Wald test				F(1,919)=232.91***		
Steady-state efficiency	0.8406		0.8839		0.8162	
No. of obs.	1718		660		1058	
F-test	F(149,1567)=3.12***		F(133,525)=3.54***		F(137,919)=3.27***	
Hausman test	chi2(1)=119.85***		chi2(1)=333.61***		chi2(1)=133.51***	
B-P test	chi2(1)=7.68***		chi2(1)=0.84		chi2(1)=7.64***	
overall R^2	0.0171		0.1632		0.0163	

***, ** and * denotes coefficient is significant at 1%, 5% and 10% significance level accordingly
'F-test' -- the F-test for fixed effect model against OLS,
'Hausman test' -- the Hausman specification test for fixed effect model against random effect model.
'B-P test' -- the Breusch and Pagan Lagrangian multiplier test for random effect against OLS.

Since the 1997 Asian crisis is a common major economic affair affecting all countries in ASEAN, government intervention and banking structural reforms were carried out in all countries to various degrees. If those reforms are effective and successful, banking industries should be strengthened since weak and insolvent banks were eliminated and healthy banks are enlarged in size through mergers and acquisitions. Therefore, despite the level of bank efficiency, which may be affected by other general economic issues, the converging tendency should be somehow improved as those banks that survived in the crisis should be reasonably considered to be more effective in adopting new technology and improving efficiencies. However, apparently this is not the case according to my findings, which clearly show that the convergence process has been slowed down after the 1997 Asia crisis. As shown in Table 3-8, the convergence tendency coefficient of post-crisis period is only less than half of that for pre-crisis period (-0.41 vs.-0.86), and the result of Wald coefficient test also confirms that this change in convergence tendency is significant at 1% significance level. Banking reforms after 1997 Asian crisis seems not effective from this point of view.

A larger sample size not only enables cross-time comparison on bank efficiency converging behaviour, but also enables the cross-country comparisons. The conditional *β-convergence* by introducing country dummy variables, modelled by equation (3.8), now could be tested to investigate the cross-country differences in convergence behaviour. The results are summarised in Table 3-9. In this test, both intercept dummy variables, to capture the difference in steady-state efficiency level, and slope dummy variables, to capture differences in convergence speed are included, therefore, it is essentially separate convergence estimations of each country towards

its own steady-state. The individual country-specific convergence tendency parameter could be obtained by taking the sum of coefficients on lagged cost efficiency and countries' slope dummy variable, and country-specific steady-state efficiency level could be calculated using the sum of intercept and coefficient on this country's intercept dummy variable. In order to make the analysis more intuitionistic, discussion will be based on Table 3-10, which reported all calculated country-specific convergence tendency and steady-state efficiency levels.

Country-specific steady-state cost efficiency levels in Table 3-10 exhibit similar patterns as what has been found before. In steady-state, the Singaporean banking market is still the most efficient one, and Malaysia still has the least efficient banking market in all periods. For most of the countries, efficiency level in post-crisis period is lower than that in the pre-crisis period due to the tightened regulatory forces and short-term high investment cost in reprivatisation, except for Philippines and Singapore. Country-specific convergence properties are slightly complicated this time. First of all, the average convergence tendencies are substantially different from country to country in all periods. More interestingly, it has been noticed that, there are two countries actually have a diverging banking market in the post-crisis period, i.e. Philippines and Singapore, who have positive and significant convergence coefficients. Balanced by a significant but relatively small convergence tendency in pre-crisis period, the average convergence tendency for Philippines is 0.0862, which is not significantly different from 0. Given that Philippines has been classified into low bank efficiency countries, this result indicates that within the Philippine banking market, low efficiency banks are not really catching up with high efficiency banks

through the whole period, and the banking reforms has made the situation even worse after the 1997 crisis.

Table 3-9 Bank-level conditional β-convergence testing results (OLS)

	1994-2009[59]		1994-2000		2001-2009	
	Coefficient	*t-stats*	*Coefficient*	*t-stats*	*Coefficient*	*t-stats*
Intercept	-0.0716	(-6.99)***	-0.0412	(-3.87)***	-0.0766	(-5.05)***
$\ln \rho_{i,t-1}$	-0.6597	(-9.72)***	-0.4003	(-3.86)***	-0.6746	(-7.78)***
I	0.0402	(3.00)***	0.0033	(0.29)	0.0430	(2.12)**
M	0.0449	(3.69)***	0.0246	(1.71)*	0.0424	(2.30)**
P	0.0847	(5.13)***	0.0004	(0.03)	0.1065	(4.36)***
S	0.0708	(4.44)***	0.0109	(0.46)	0.0681	(2.84)***
$I \times \ln \rho_{i,t-1}$	0.4015	(4.31)***	0.0032	(0.03)	0.4397	(3.48)***
$M \times \ln \rho_{i,t-1}$	0.5814	(8.42)***	0.3215	(2.63)***	0.5926	(6.72)***
$P \times \ln \rho_{i,t-1}$	0.7458	(7.99)***	0.1118	(1.02)	0.9140	(7.14)***
$S \times \ln \rho_{i,t-1}$	0.9282	(11.61)***	-0.2809	(-0.62)	0.9351	(9.16)***
No. of obs.	1718		660		1058	
B-P test	chi2(1) = 3.27*		chi2(1) = 0.24		chi2(1) = 2.60	
Adj. R^2	0.101		0.2331		0.1045	

***, **, and * denotes coefficient is significant at 1%, 5% and 10% significance level accordingly
'B-P test' -- the Breusch and Pagan Lagrangian multiplier test for random effect against OLS.

[59] Breusch and Pagan Lagrangian multiplier test for random effect against OLS only marginally reject OLS at 10% significance level, in order to be consistent with estimations for other periods, we report OLS estimates.

Table 3-10 Bank-level conditional β-convergence -- Country-specific results

			1994-2009		1994-2000		2001-2009	
		Country	*Coefficient*	*F-stats*	*Coefficient*	*F-stats*	*Coefficient*	*F-stats*
Convergence Tendency	I	$\ln\rho_{i,t-1}+I\times\ln\rho_{i,t-1}$	-0.2582	(16.41)***	-0.3971	(101.92)***	-0.2349	(6.56)**
		Wald test				F(1,1048)=3.13*		
	M	$\ln\rho_{i,t-1}+M\times\ln\rho_{i,t-1}$	-0.0783	(38.02)***	-0.0788	(1.50)	-0.0820	(25.71)***
		Wald test				F(1,1048)=0.04		
	P	$\ln\rho_{i,t-1}+P\times\ln\rho_{i,t-1}$	0.0862	(1.80)	-0.2885	(64.77)***	0.2394	(6.46)**
		Wald test				F(1,1048)=31.40***		
	S	$\ln\rho_{i,t-1}+S\times\ln\rho_{i,t-1}$	0.2685	(40.46)***	-0.6812	(2.35)	0.2605	(23.33)***
		Wald test				F(1,1048)=304.84***		
	T	$\ln\rho_{i,t-1}$	-0.6597	(-9.72)***	-0.4003	(-3.86)***	-0.6746	(-7.78)***
		Wald test				F(1,1048)=10.00***		
Steady-state Efficiency	I		0.8855		0.9090		0.8667	
	M		0.7111		0.8100		0.6590	
	P		0.8589		0.8681		0.8826	
	S		1.0000		0.9565		1.0000	
	T		0.8971		0.9022		0.8927	

***, ** and * denotes coefficient is significant at 1%, 5% and 10% significance level accordingly
I-Indonesia; M-Malaysia; P-the Philippines; S-Singapore; T-Thailand.

The situation in Singapore looks no better than in the Philippines. The only negative convergence coefficient appears in pre-crisis period, but not statistically significant. The positive and significant coefficient indicates divergence for post-crisis period and for the whole sample period. However, Singapore cannot be judged in the same way as that is for the Philippines. Most of the best-practice banks are Singaporean banks which largely define the efficiency frontier for the whole region. Since they are already on the frontier, the improvement potential for them relative to the frontier is very limited. The converging process maybe happened well before the sample period, and banking market in Singapore is already in a relative steady-state with a constant distribution of cost efficiency. The only warning massage that should be paid attention to is the diverging tendency in recent year, which may imply that, without hampering the average efficiency advantages that Singaporean banks have over banks in other countries, relatively low efficiency banks are not improving as fast as high efficiency banks in Singapore.

The situations in the other three countries are somehow similar in the sense that convergence coefficients are all negative and significant for all periods, indicating the convergence process is happening throughout. For Indonesia, the convergence process slowed down a little in the post-crisis period, but the change is only marginally significant at 10% significance level. Convergence tendency for Malaysia in the two sub-periods are roughly the same without significant changes. The only improvement in terms of bank efficiency convergence appears in Thailand with a stronger convergence tendency after the banking reforms, evidenced by a coefficient that is negative and significantly larger in absolute value in the post-crisis period. Country-specific bank-level *β-convergence* provides very mixed results, and the

convergence behaviours of different countries are very much different. Taking the individual banks' performance into account, one can clearly see that there is still a certain level of heterogeneity existing across countries, and the degree of banking market integration is still relatively low from this perspective.

5.2.2.2 Bank-level *σ-convergence*

In section 5.2.1, evidence for *σ-convergence* has been found at country level, which says that the dispersion between countries' average bank efficiency are narrowing over the sample period. However, distinguishing to the individual bank level produces completely different results. In bank-level *σ-convergence* test, the dispersion measure of individual banks' efficiencies is regressed on a time trend variable, and the dispersion is measured in three different ways. In the first scenario, I measure the dispersion around annual overall (weighted) average efficiency level of the whole region, for all banks regardless of their country origins as if they were operating in a common market. Unfortunately, without country separation, only 16 observations are obtained, the sub-period estimations are not permitted and only a simple OLS regression could be done. Results are reported in Table 3-11. Even from this simple regression, *σ-convergence* is completely rejected by a positive and significant coefficient on the time trend variable. This is already contradicting with the *σ-convergence* found at country level, and the enlarging dispersion in efficiencies of individual banks is further confirmed by the other two experiments using different measurements of dispersion.

Table 3-11 *σ-convergence* using regional standard deviation

	Coefficient	*t-stats*
Intercept	0.0291	(2.78)**
T	0.0087	(8.05)***
No. of obs.	16	
overall R^2	0.8097	

***, **, and * denotes coefficient is significant at 1%, 5% and 10% significance level accordingly

In order to conduct the test in greater details, two more measures of dispersion in bank efficiency are used. The standard deviations are also calculated in each year by country around (1) own country weighted average efficiency, and (2) regional weighted average efficiency. In each case, 5 observations are obtained each year over 16 years, and a balanced panel estimations using random effect have been conducted for the whole period and also for the two sub-periods defined earlier. Again, a Wald coefficient test is conducted to help identify changes in convergence behaviour between two sub-periods. Table 3-12 summarises the results using the two measures of dispersion.

By measuring dispersion around own country weighted average efficiency, it allows for some degree of intra-country heterogeneity in average bank efficiency level, and test whether banks are *σ-converging* within their own countries. Given what has been found earlier that the country weighted average efficiencies are *σ-converging*, *σ-convergence* within each country towards its own weighted average may also be indicative for cross-country *σ-convergence* in the region but to a lesser extent. The last experiment on bank-level *σ-convergence* is a more strict way of measuring dispersion. This time it does not allow for any intra-country heterogeneity, and assume that all banks are converging towards a common efficiency level, which they should do in a well-integrated banking market. The intuition of using this measurement is basically the same as using standard deviations across all banks regardless of their country of origin. The purpose of measuring standard deviations by country is merely to increase the sample size and conduct more detailed tests.

Table 3-12 *σ-convergence* using individual country standard deviation

	1994-2009		1994-2000		2001-2009	
	Coefficient	*z-values*	*Coefficient*	*z-values*	*Coefficient*	*z-values*
σ-convergence around own country weighted average						
Intercept	0.0063	(0.35)	0.0506	(3.87)***	-0.0483	(-1.04)
T	0.0094	(6.72)***	-0.0018	(-0.82)	0.0140	(4.57)***
Wald test				chi2(1)=26.67***		
No. of obs.	80		35		45	
F-test	F(4,74)=4.35***		F(4,29)=4.78***		F(4,39)=12.36***	
Hausman test	chi2(1)=0.00		chi2(1)=0.00		chi2(1)=0.00	
B-P test	chi2(1)=11.17***		chi2(1)=9.26***		chi2(1)=45.71***	
overall R^2	0.3304		0.0139		0.1911	
σ-convergence around regional weighted average						
Intercept	0.0179	(0.80)	0.0499	(3.98)***	-0.0279	(-0.57)
T	0.0089	(6.85)***	0.0009	(0.61)	0.0127	(4.11)***
Wald test				chi2(1)=14.51***		
No. of obs.	80		35		45	
F-test	F(4,74)=10.51***		F(4,29)=12.83***		F(4,39)=15.82***	
Hausman test	chi2(1)=0.00		chi2(1)=0.00		chi2(1)=0.00	
B-P test	chi2(1)=61.34***		chi2(1)=35.17***		chi2(1)=58.71***	
overall R^2	0.2877		0.0046		0.1417	

***, ** and * denotes coefficient is significant at 1%, 5% and 10% significance level accordingly
'F-test' -- the F-test for fixed effect model against OLS,
'Hausman test' -- the Hausman specification test for fixed effect model against random effect model.
'B-P test' -- the Breusch and Pagan Lagrangian multiplier test for random effect against OLS.

Unfortunately, no matter what measure is used for dispersion in efficiency at bank-level, no evidence can be found for *σ-convergence* in either the whole sample period case or in the sub-period cases. The estimated coefficients on time trend variables are either positive in most cases or negative but insignificant only in pre-crisis period of experiment (1). Both experiments show that the convergence behaviour is not clear in pre-crisis period since the coefficients are insignificant. However, in the post-crisis period, bank efficiencies are *σ-diverging*, with a widening dispersion, and the change in convergence behaviour is significant according to Wald coefficient tests. Once again, this test proves that countries are converging towards one another on average does not mean that all individual banks are converging too.

From the perspective of bank efficiency convergence properties, it seems that the degree of banking market integration is still weak. Good news is that bank efficiencies of each member country are both *β-* and *σ-converging* on average, and deeper banking integration could be achieved if strong convergence tendency also exist among individual banks. Unfortunately, the test results on bank-level convergence provide mixed results, and most of the results are actually negative due to strong asymmetries in terms of convergence behaviours from country to country.

6. Conclusions

In this chapter, the effectiveness of regional financial integration projects and national banking structural reforms in the aftermath of 1997 Asian financial crisis was assessed from a bank efficiency point of view, in the hope of finding evidence of convergence in banking market among the 5 core member countries of ASEAN. The bank cost efficiency was estimated by using Battese and Coelli (1995) SFA model under a common-frontier framework. The advantage of using this model is that the impacts of environmental variables on bank efficiency could be controlled by estimating cost function and bank inefficiency model simultaneously in one single-stage estimation, and this is particularly useful to capture cross-country heterogeneity when estimating a common-frontier for multiple countries. Bank efficiency scores are then used to test for their convergence properties at two different levels, namely country-level and bank-level. The concepts of *β-convergence* and *σ-convergence* that are borrowed from the growth-convergence literature were applied to bank efficiency analysis. Investigating cross-country and within country convergence properties of bank efficiency is interesting, because a banking market with catching up behaviour from laggers and improving distribution of efficiencies, i.e. narrowing down dispersion of efficiency, could be argued as an indicator of the degree of banking market integration.

Empirical estimations on country-level bank efficiencies and their convergence properties provide relatively supportive information. The 5 countries were classified into three tiers, with Singapore on the top having the highest average bank efficiency level, Indonesia and Thailand in the middle tier, and Philippines and Malaysia on the bottom, which are classified as low efficiency counties. Average cost efficiency of the

whole region is around 90% for the whole period, and the biggest cross-country difference in average efficiency of 8% appears between Singapore and Malaysia. The Cross-country differences in average efficiency may be less worrying, since strong evidence is found for both *β-* and *σ-convergence* among weighted average efficiencies at country-level. Therefore, ASEAN banking market looks like a converging market when only focusing on average bank efficiency of each country.

However, ignoring issues at micro-level can be dangerous in policy-making, but taking individual banks into consideration can erode the confidence, which has been built up based on country-level analysis results. Despite the substantial difference in efficiency levels among individual banks, merely the mixed results of bank-level convergence properties have made the situation more problematic. Conditional bank-level *β-convergence* show that the sample countries are in very different stages of convergence process. Some countries are converging faster than others, and both converging and diverging markets exist in the region. Particularly, not as expected, banking structural reforms and the regional financial integrations after the 1997 Asian financial crisis have not provided strong encouraging force for the regional banking convergence, and actual speed of banking market convergence becomes slower after the banking reforms in general. Tests of bank-level *σ-convergence* using various measurements of bank efficiency dispersion provide consistent results, which are also negative news. Dispersions of individual bank efficiencies are actually widening over time, indicating that the distribution of bank efficiency is rather getting worse. Neither *β-convergence* nor *σ-convergence* tests at bank-level support a high degree of banking market integration.

Chapter 4 Efficiency Convergence Properties of Indonesian Banks 1992-2007

1. Introduction

The cross-country efficiency convergence properties of ASEAN banks have been examined in the previous chapter, and it has been found that the degree of banking market integration for ASEAN countries is still relatively low, since the convergence tendency in terms of banking efficiency is not strong. In the previous chapter, I raised the question about the importance of individual banks' performance, and have examined bank efficiency convergence properties within each country by simply introducing country dummy variables into the convergence tests. Bank efficiency convergence within each individual country could be seen as a pre-condition for a meaningful cross-country convergence, otherwise integrated market would be dominated by only a few large banks. In this chapter, I will conduct a single country bank efficiency study on Indonesia in much greater details, and examine its convergence properties accordingly. This single country study is only based on Indonesia, which is one of the largest economies of ASEAN and has the best data availability, but the methodology developed for the examination of bank cost efficiency and its convergence properties in this chapter can be easily applied to any other country.

Studies of bank efficiency in the Far East emerging economies have become a growing industry in recent years. There are a number of reasons as to why this may be the case. First, since capital and debt markets remain undeveloped and immature, the principal process of financial intermediation remains the banking system. The role of

the banking system in propagating shocks to the rest of the economy is evident in the part it played in Indonesia during the 1997 Asian financial crisis, and it is claimed that a stronger banking system in 2008 cushioned the economy from the 2008 global crisis (see Basri and Rhardjaa, 2010).

Secondly, the banking sectors of developing economies face stronger competition due to globalisation of the financial system. Even with post crisis regulatory changes, liberalisation and bank reform will continue in the emerging economies through the dismantling of barriers to entry like equity ownership and to allow a greater number of the foreign-owned banks to operate and to compete directly with the domestic-owned banks. This creates the imperative to evaluate the position of the domestic banks in term of their performance and efficiency.

Thirdly, the pass-through of central bank policy will depend on the competitive structure and efficiency of the banking system. The efficiency and competitiveness of the banking system also affect the allocation of loanable funds to investment opportunities and ultimately the growth of the economy.

A number of studies of the efficiency of the Indonesian banking system have emerged in recent years, but hitherto none have posed the questions that are the purpose of this chapter. This chapter examines the evolution of efficiency in the banking system in Indonesia using non-parametric Data Envelopment Analysis (DEA) supplemented with a bootstrap technology to produce bias-corrected estimates that have inferential capability. Specifically it poses three questions. First, how sensitive are estimates of bank efficiency to semi-parametric methods of estimation and

input/output choices? This question is answered by estimating efficiency using the two-stage semi-parametric bootstrap method of Simar and Wilson (2007) with different combination of bank output variables. Second, has bank efficiency improved over the decade and a half to 2007? This question is answered by evaluating the convergence properties of bank efficiency. Third, have the 1997-1999 financial crises and the banking reform process hampered or promoted the speed at which banks have improved and caught up with the benchmark bank? This question is answered by sub-periods estimation and comparisons.

This chapter is organized along the following lines. The next section describes the development of Indonesian banking, highlighting the deregulatory trend of the 1990s and the impact of the financial crisis of 1997-98. Section 3 reviews the literature of bank efficiency estimation and details the methodology of two stage semi-parametric double bootstrap DEA estimation. Section 4 outlines the methodology of the growth convergence literature and its application to the convergence of banking efficiency. Section 5 describes the model strategies and data. Section 6 details the empirical results. Section 7 concludes.

2. Indonesian Banking System

Like many developing countries, the Indonesian financial sector is dominated by commercial banks rather than by bond and equity markets. There are quite a few banks (over 200 banks) in Indonesia. One of the reasons is the entry investment to open a bank is quite low, the lowest in South East Asia. Some of these banks are privately owned and are quite new. According to Indonesian banking law, Indonesian

banking institutions are typically classified into commercial and rural banks. Commercial banks differ with rural banks in the sense that the latter do not involve directly in payment system and have restricted operational area. In term of operational definition, bank in Indonesia are classified into non-Islamic and Islamic-based principles commercial banks.

The history of Indonesian banking industry started when several Dutch banks were nationalized after Indonesia proclaimed its independence in 1950s. During that period government also allowed entities to establish private commercial banks and limited number of foreign banks. From 1950s to 1970s, banks, especially state banks, were benefited from economic policies introduced by government to boost Indonesian economy. One aspect of these policies was that the state-owned enterprises were required to deposit all their funds in state banks. The government also subsidized state bank deposit rates (Margono and Sharma, 2004).

Indonesian banks were heavily regulated until June 1983. The state has played an influential role through direct ownership, the market was dominated by state banks, with Bank Indonesia alone accounting for 35 percent of the total assets of the entire financial system; other state banks holding another 40 percent (Halim, 2000). The central bank set interest rate ceilings on bank credits for individual banks, and instructed banks to support the national growth strategies and to finance certain types of investment. This "strategic" policy turned out to be one the root causes of the subsequent failure in credit assessment in the banking sector (Halim, 2000). The banking market was underdeveloped and played a very minor role in financial intermediation, because that the Indonesian economy at that time were characterised

by the presence of large, dominant corporate and family-owned corporations, which often own their own financial subsidiaries and conduct connected lending through the interrelationship between finance and ownership.

The early financial reforms were initiated in early 1980s with the economic transition from oil-reliant industry to manufacturing and financial services. The financial system was deregulated in two stages. The first stage, which began in 1983, was the removal of interest rate controls and credit ceilings for all banks, and resulted in significant increases in the deposit rate and lending activities. The second package in October 1988, also known as Pakto 88, was another cornerstone in the banking system. This reform included a major reduction in the reserve requirements of private commercial banks, liberalised the process of liquidity creation and opened the way for joint venture banks. State owned enterprises were allowed to put their funds in private banks. The deregulatory policies encouraged the opening of many new banks, the number of commercial banks jumped from 112 in 1989 to nearly 240 in 1994 (Margono and Sharma, 2004). As a result, Indonesian banking industry were completed by a mixture of state commercial banks, local government-owned banks, private national banks, joint venture banks, branches of foreign banks, and many small rural credit banks. The competition between banks was significantly intensified.

The banking deregulation packages lowered the barrier to new market entrants. Since then private banks had started to dominate the market. The deregulation policy had been double-edged. In common with many emerging economies, liberalization was followed by strong growth in the banking system and with it the growth in non-performing loans and fragility typically associated with banking crises (Goldstein

and Turner,1996; Halim, 2000). Financial deregulation always stimulates financial expansion. Higher interest rates and lower reserve requirements are always accompanied by rapid credit expansion; lifting restrictions on bank lending encourages borrowing in risky sectors such as property and construction.

Reregulation was undertaken between 1991 and 1995 aimed at increasing capital adequacy. In 1991 Bank Indonesia introduced a minimum Capital Adequacy Ratio (CAR) of at least 8 per cent, based on the Basle Accord. This minimum was scheduled to increase to 9 per cent by 30 September 1997, 10 per cent by September 1999, and 12 per cent by September 2001. The first banking law was passed in October 1992, which set up a formal regulatory framework for Indonesian banking industry. New regulations in 1995 raised the minimum equity requirement of banks from Rp 50bn to Rp 150bn by 2001. However, these time schedule was not achieved due to the economic crisis. By this stage, the government had realised the need to limit new entry in banking, and to regulate the "deregulated banks". The government had already perceived potential problems as a result of the previous speedy liberalisation, but policy enforcement was ineffective (Halim, 2000).

The financial crisis of 1997 revealed some of the inherent weaknesses in the banking system. A contagious process of a currency shock quickly became a banking crisis, and soon after, economic crisis. At the end of 1997, combined with high interest rates and a loss of currency value by more than 80%, banking sector was in deep trouble (Margono and Sharma, 2004). Under pressure from the IMF, the government launched a series of reforms in the banking sector, including the closure of ailing banks, take-over of troubled but viable banks, and the recapitalisation of

relatively healthy banks. In November 1997, the licenses of 16 insolvent banks were revoked and the banks were liquidated, and this triggered panic and significantly hampered the public confidence in banking sector.

In order to restructure banking sector in Indonesia, the government set up the Indonesian Bank Restructuring Agency (IBRA) in January 1998, which took over 7 troubled banks and put other 54 weak banks under its close supervision. By the end of 1999, 66 out of 239 banks were closed (Suta and Musa, 2003). Since then, the country's ailing banking sector has been suffering negative spreads and extremely high level of Non-Performing Loans (NPLs), which increased significantly within one year from 9 percent in 1997 to almost 60 percent in 1998 (Halim, 2000). The Indonesian government introduced the Central Bank Act (Act No.23) of 1999 and the 2004 amendment to the Central Bank Act of 1999, which gave independence to Bank Indonesia and reintroduced its status as 'lender of last resort'. Several institutions[60] have also been established to help the two monetary authorities, Ministry of Finance and the central bank (Bank Indonesia), manage the banking structural reforms. For Indonesia, the economic contraction was deeper and its recovery process was slower than other East Asian countries, like South Korea, Thailand, Malaysia and the Philippines, because of complication from political instability. As argued by (Hill and Shiraishi, 2007), the Indonesian economy was not fully recovered at least until 2004.

[60] These new institutions include IBRA (Indonesian Bank Restructuring Agency) and AMU (Assets Management Unit), which is a part of IBRA.

As shown in Table 4-1, at the end of June 2007 there were 130 banks[61] operating in Indonesia with a combined balance sheet of over IDR 1,770 trillion (US$ 190 billion). This total compares with a figure of 222 banks in existence at end-December 1997. The shrinkage was largely due to post-crisis liquidation, suspension and merger, engineered by the Indonesian Bank Restructuring Agency (IBRA) under agreement with the IMF (Hadad *et al.*, 2011a).

Table 4-1 The Structure of the Indonesian Banking Industry at end-June 2007.

Type of Bank	*Number of Banks*	*Total Assets (IDR tril.)*
State-owned banks	5	641.1
Foreign exchange private national banks	35	691.2
Non-foreign exchange private national banks	36	32.5
Regional government-owned banks	26	165
Joint venture banks	17	78
Foreign banks (branching)	11	163
Total	130	1770.8

* Data source: Bank Indonesia.

Since 1998, the banking sector has been effectively renationalized and returned to the pre-liberalization structure. To further strengthen the banking system, the government conducted a re-privatisation program of nationalised banks. Through this program, government shares were sold to both domestic and foreign investors. During 2000 to 2007, there were 15 banks were re-privatized to foreign investors (mostly Asian based institutions). The increased foreign presence changed the structure of banking system with the share of foreign subsidiary banks rising from 4.5% in 2000 to 32.8% in 2007 (Besar and Milne, 2009). Apart from the re-privatisation program,

[61] This comprised 5 state-owned banks, 35 foreign exchange private national banks, 36 non-foreign exchange private national banks, 26 regional government-owned banks, 17 joint venture banks and 11 foreign banks.

efforts also have been made towards a more stable banking environment by reducing the number of banks in the country, through a number of ways, such as requirement on minimum Tier I capitalisation, introduction of 'single presence policy' in June 2006 and the Financial Stability Net in 2007. The Structural Reform Programme has produced a stronger and better capitalized banking system in the post-crisis period. According to (McCawley, 2009), the present Indonesian banking system is sound, capital-adequacy and liquidity indicators have improved over the years, and the quality of loan portfolios has been strengthened.

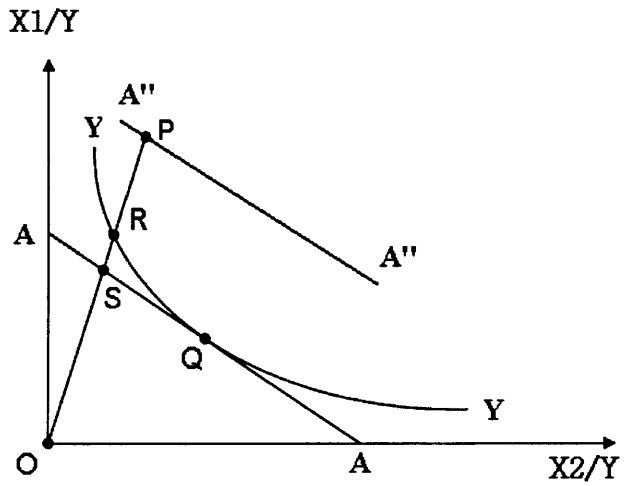
3. Measuring Efficiency Using Non-parametric DEA Approach

3.1 DEA efficiency literature

Compared with the conventional accounting ratios that are used to measure bank performance, the economic efficiency concepts defined using neoclassical production theory are more comprehensive measures which take account of all inputs and outputs and produce "total factor productivity measures" instead of "partial productivity measures"(Cooper *et al.,* 2007). According to Koopmans (1951), producers are treated as "optimizers", which are trying to maximise profit subject to input and output prices, minimise production costs subject to given factor inputs and input prices, and the efficiency concepts are defined as the ability of a firm to obtain those optimising objectives. First empirical implementation of these concepts was carried out by Farrell (1957), who further decomposed economic/cost efficiency into technical efficiency and allocative efficiency and implemented linear programming to

identify those (in)efficiency measures. Concepts of technical efficiency and cost efficiency can be illustrated by using an isoquant and isocost framework in Figure 4-1.

Figure 4-1Technical Efficiency and Cost Efficiency



(Source: Coelli. 2005)

Figure 4-1 shows a constant return to scale (CRS) isoquant YY for firms that produce a single output using two inputs X1 and X2, and AA is the isocost curve given the input prices. The isoquant represents the optimal production level given the current production technology and thus is treated as a technical frontier. All firms operating along the isoquant are technically efficient, but cost minimisation only happens on point Q, which is the tangential point of isoquant and the lowest isocost. Other points except point Q, e.g. point R, on the frontier YY are said to be technically efficient but cost inefficient, due to allocative inefficiency which means they do not use the optimal factor combination of inputs that minimises the cost. Points that are to the right of the isoquant, such as point P, are both technically and cost inefficient.

Take a firm that operates on point P for example, its technical efficiency (TE) is measured by the ratio of optimal input use to the actual input use, which is shown by OR/OP in the diagram, and technical inefficiency (TIE) is given by RP/OP. The TIE indicates the percentage by which all inputs need to be reduced, without a reduction in output, to achieve technically efficient production. The actual cost for firm P is shown by $A''A''$ given the input prices and the cost efficiency (CE) is defined by OS/OP, which is the ratio of optimal cost to its actual cost. It follows that the cost inefficiency (CIE) is given by SP/OP. Allocative efficiency (AE) is defined by OS/OR, by using point P's projection point on the technical frontier, point R, which is technical efficient but using the wrong factor mix. AE is essentially the residual between CE and TE, and can be calculated by CE/TE.

These theoretical efficiency concepts assume that the production technology is known, which is not the case in practice, and the efficiency frontier cannot be identified without *a priori* information on technology. Researchers then have developed various frontier efficiency methodologies to empirically estimate the efficient frontier based upon sample data. In the bank efficiency literature, bank efficiency is normally measured by either parametric or non-parametric method, however there is no consensus on the preferred method for determining the best-practice frontier against which relative efficiencies are measured. The parametric approach, such as the stochastic frontier approach (SFA), specifies a functional form and allows for random errors which follow a symmetric normal distribution while the inefficiencies are measured by a truncated distribution.

However, the parametric approach suffers from the problem of misspecification of the functional form, and possibly inefficiency and multi-collinearity. Usually a local approximation such as the Cobb-Douglas or trans-log form is specified, which has been argued to provide poor approximations for banking data (see McAllister and McManus, 1993; Mitchell and Onvural, 1996). In theory, parametric estimators offer faster convergence and produce consistent estimates, but this would be true only if there is no misspecification of the functional form. In contrast, the nonparametric model, such as the conventional Data Envelopment Analysis (DEA) which utilises linear programming method to construct an "envelope" of outputs against inputs usage, does not require the explicit specification of the form of the underlying production relationship, but at the cost of slower convergence rates and hence larger data requirements. The nonparametric approach also has been criticized for not considering errors due to chance, measurement errors, or environmental differences; hence all deviations are attributed to the measured inefficiency. The conflict between the nonparametric and parametric approaches is important because the two types of methods tend to have different degrees of dispersion and do not always produce a common ranking of the same financial institutions (Berger and Humphrey, 1997).

Early bank efficiency studies are mainly on developed economies in the US or Europe[62], but recently more and more attentions have been given to Asian and other regions, such as Hong Kong (Drake *et al.*, 2006) and Singapore (Sufian, 2007), and especially emerging markets, like India (Ataullah and Le, 2006; Bhattacharyya *et al.* 1997), and Malaysia (Sufian, 2009). Studies of Indonesian banks have been few but significant. Using the stochastic frontier approach (SFA), estimates of cost efficiency,

[62] See literature review in Chapter 3.

scale economies, technological progress and productivity growth of Indonesian banks over the period 1993-2000 have been produced by Margono *et al.* (2010). They found that the average cost efficiency of all banks was 70% during the whole period, with 80% and 53% for pre-Asian crisis and post-Asian crisis respectively. Other papers Hadad *et al.* (2008; 2011a, b) used non-parametric, slacks-based DEA with a Simar and Wilson's (2007) bootstrapping methodology to monthly/quarterly supervisory data within a relatively short period 2006-2007. They found that the average efficiency during the sample period was around 70%. Bank efficiencies are positively related to the JCI index of the Indonesian Stock Exchange, and state-owned banks are the most efficient. Using the Malmquist productivity index[63], technological progress was identified as the main driver of productivity growth. Besar and Milne (2009) examined the effects of ownership change during the reprivatisation program after the Asian financial crisis using a SFA model over 2000-2007. They found that the re-privatisation program had a positive impact on Indonesian bank's efficiency and competition, but the change happens gradually.

3.2 Bootstrap DEA and Simar and Wilson (2007) double bootstrap

In the previous chapter, parametric approach, SFA, is used to evaluate bank cost efficiencies for 5 ASEAN countries, including Indonesia. For comparison purpose, the cost efficiency of Indonesian banks will be evaluated by using the alternative method in this chapter, i.e. the non-parametric DEA method. The conventional DEA approach suffers from a common drawback of finite sample bias, inconsistency due to slow convergence rate, particularly in the case of multiple inputs and outputs, which

[63] The Malmquist index was first suggested by Malmquist (1953).

increased the dimensionality of the problem. As stated by Kneip, Park and Simar (1998), large bias, large variance and very wide confidence intervals may be produced when the number of inputs and outputs is large, unless a very large quantity of data are available. Also, the efficiency measure is very sensitive to outliers and is upward biased by construction. The bootstrap provides an attractive alternative to the conventional DEA.

The first use of the bootstrap in frontier models dates to Simar (1992). Its use for nonparametric envelopment estimators was developed by Simar and Wilson (1998, 2000a). The essence of the bootstrap idea of Efron (1979, 1982) and Efron and Tibshirani (1993) is to approximate the sampling distributions of interested variable by simulating, or mimicking, the data generating process (DGP). The bias of DEA estimator can then be estimated and confidence intervals can be constructed by using this approximated distribution.

Simar and Wilson (2007) propose a two-stage semi-parametric bootstrap model, which is capable of incorporating the effects of environmental variables in the non-parametric estimation of efficiencies. Simar and Wilson (2007) cite 47 published papers that employed a two-stage approach wherein nonparametric, DEA efficiency estimates are regressed on a set of environmental variables in a parametric, second-stage analysis. The typical two-stage approaches do not provided a coherent description of a DGP, and the method of inference is flawed since the DEA efficiency estimates are biased estimates and are serially correlated, in a complicated, and unknown way.

In order to deal with the problem described above, Simar and Wilson (2007) defined a DGP that provides a rational basis for regressing non-parametric, DEA efficiency estimates on some environmental variables in a second-stage analysis. In addition, they suggested bootstrap procedures to provide valid inference in the second-stage regression, as well as to increase the efficiency of estimation and correct the estimation bias. This chapter adopts Algorithm #2 of this two-stage semi-parametric double bootstrapping method set out by Simar and Wilson (2007) to estimate the cost efficiencies of Indonesian banks.

The concepts of cost efficiency related subjects were introduced by Farrell (1957) and Debreu (1951) and developed into implementable DEA form by Färe, Grosskopf and Lovell (1985) using linear programming technologies. The efficiency of a firm can be defined and measured as the radial distance of its actual performance from a frontier, as described earlier. The first stage is simply a conventional DEA efficiency estimation, and the Tone (2002) new cost efficiency DEA model, which allows for heterogeneity in unit prices of input among banks, is employed at this stage. As a general rule, efficiency levels measured relative to one frontier cannot be directly compared with efficiency levels measured relative to another frontier. In order to make the later cross-time convergence analysis more sensible, a common-frontier framework, wherein, efficiencies of all observations are measured relative to a common frontier, is used. The input oriented efficiency measure and constant return to scale (CRS) is assumed as an optimal scale in the long run.

The cost efficiency $\hat{\rho}$ for the j-th bank is defined as;

$$\hat{\rho}_j = e\bar{x}_j^* / e\bar{x}_j \tag{4.1}$$

where $e \in R^m$ is a row vector with all elements being equal to unity, and $\bar{x}_j^*$ is the optimal solution of the Linear Programming (LP) problem given below;

$$[\text{Cost}] \qquad e\bar{x}_j^* = \min_{\bar{x},\lambda} e\bar{x}_j$$

$$\begin{aligned} s.t. \quad & \bar{x}_j \geq \bar{X}\lambda \\ & y_j \leq Y\lambda \\ & \lambda \geq 0 \end{aligned} \tag{4.2}$$

where $\bar{X} = (\bar{x}_1, \ldots, \bar{x}_n)$, with $\bar{x}_j = (p_{1j}x_{1j}, \ldots, p_{mj}x_{mj})^T$, is the matrix of individual factor costs, and $Y = (y_1, \ldots, y_n) \in R^{s \times n}$ is a matrix of outputs.

The cost efficiency measure $\hat{\rho}_j \leq 1$ is the scalar efficiency score for the j-th bank. If $\hat{\rho}_j = 1$ the *i*-th bank is cost efficient as it lies on the frontier, whereas if $\hat{\rho}_j < 1$ the bank is inefficient and need a (1- $\hat{\rho}_j$) reduction in the total cost.

In the second stage, the efficiency estimates $\hat{\rho}_j$ are regressed on a set of environmental variables z_j by using a maximum likelihood method. In practice, Shephard's (1970) definition of efficiency is used to avoid two boundaries points. Shephard's efficiency measure is merely the reciprocal of the conventional Farrell efficiency score ($\hat{\gamma}_j = 1/\hat{\rho}_j$), and can be treated as a measure of inefficiency. If z_j is a vector of environmental variables for the jth bank and β is a vector of parameters

associated with each factor to be estimated, then equation (4.3) below describes the model to be estimated:

$$\hat{\gamma}_j = z_j\beta + \varepsilon_j \geq 1 \qquad (4.3)$$

Equation (4.3) is estimated under (left normal) truncated regression (use only $\hat{\gamma}_j > 1$ in this step) and ε_j is a truncated random error $N(0,\hat{\sigma}_\varepsilon^2)$, truncated at $(1 - z_j\hat{\beta})$. The rest of the second stage algorithm steps are:

Step 1: bootstrap, for each $j = 1,...,n$, randomly draw ε_j^* from the distribution $N(0,\hat{\sigma}_\varepsilon^2)$ with left-truncation at $(1 - z_j\hat{\beta})$ and compute $\gamma_j^* = z_j\hat{\beta} + \varepsilon_j^*$.

Step 2: construct a pseudo sample of inputs by setting $x_j^* = x_j\hat{\gamma}_j / \gamma_j^*$ for all banks and keep the output measure unchanged, $y_j^* = y_j$.

Step 3: re-estimate DEA cost efficiency $\hat{\gamma}_j^*$ using the method described in the first stage by replacing observed sample (x_j, y_j) by pseudo sample (x_j^*, y_j^*).

Step 4: loop over this procedure 100 times ($L_1 = 100$)[64], take the mean, $\bar{\hat{\gamma}}_j^*$, of 100 $\hat{\gamma}_j^*$ estimates, then compute the bias-corrected estimator $\hat{\bar{\gamma}}_j$ for each bank, such

[64] As stated in Simar and Wilson (2007), the purpose of this bootstrap is to get the mean of the bootstrapped distribution, and 100 iterations are sufficient for this purpose.

that $\hat{\hat{\gamma}}_j = 2\hat{\gamma}_j - \bar{\hat{\gamma}}_j^*$. The bias-corrected Farrell efficiency score can be easily obtained by taking the reciprocal of $\hat{\hat{\gamma}}_j$, that is $\hat{\hat{\rho}}_j = 1/\hat{\hat{\gamma}}_j$.

Step 5: re-estimate the marginal effects of environmental variables, z_j, using the bias-corrected efficiency estimate, $\hat{\hat{\gamma}}_j$, to obtained coefficients estimates $\hat{\hat{\beta}}$, by left-truncated regression with $L_2 = 1000$ bootstrap replications. Once the set of L_2 bootstrap parameter estimates for β and σ_ε^2 have been obtained, the percentile bootstrap confidence intervals can then be constructed.

This two-stage double bootstrap DEA model described in section 3 is estimated by using FEAR 1.12[65], which is a software package for frontier efficiency analysis with R. I program the estimations following strictly the procedures described above. The main commands used are "cost.min" to estimate the DEA cost efficiency, "trunc.reg" to carry out the truncated regression of DEA cost efficiencies on environmental variables, "runorm.trunc" to draw random samples from truncated regression residuals to facilitate bootstrap procedures, and the "boostrap.ci" to construct the bootstrapped confidence interval of interested parameters.

4. Convergence of Bank Efficiency

The concepts of *β-convergence,* conditional *β-convergence* and *σ-convergence* that are borrowed from the economic growth literature were introduced in Section 3.2 of Chapter 3. Applications of convergence concepts to cross-country comparison of

[65] Written by Paul W. Wilson (2009)

bank efficiency are also discussed in Chapter 3. To the best of my knowledge, Fung (2006) is the only paper that has examined convergence properties of bank efficiency for a single country, with an investigation on the convergence in pure technical efficiency and scale efficiency for the US bank holding companies (BHCs). The convergence speed is a measure of how quickly the less productive banks catch-up with the more productive ones. The findings did not support the hypothesis of "absolute (unconditional) convergence", but showed strong evidence in favour of "conditional convergence", which means the steady-state productivity to which a BHC is converging is conditional on the BHCs own level of technical efficiency. In this chapter, bank specific characteristics have already been incorporated into efficiency estimation as environmental variables in the second stage estimation and country effects are common for every bank in a single country testing; therefore, unconditional *β-convergence* and *σ-convergence* are sufficient for the purpose of this chapter.

Following what has been done in the previous chapter, to estimate unconditional *β-convergence*, the following equation is employed:

$$\ln \hat{\bar{\rho}}_{j,t} - \ln \hat{\bar{\rho}}_{j,t-1} = \phi + \theta \ln \hat{\bar{\rho}}_{j,t-1} + v_{j,t} \qquad (4.4)$$

Where

$\hat{\bar{\rho}}_{j,t}$ is the bias-corrected cost efficiency of bank j at time t

$\hat{\bar{\rho}}_{j,t-1}$ is the bias-corrected cost efficiency of bank j at time t-1

ϕ and θ are the parameters to be estimated

$v_{j,t}$ is the error term, and $v_{j,t} \sim iid\ N(0,\sigma_v^2)$

A negative value for the parameter θ implies unconditional *β-convergence*. The higher the coefficient in relative terms the greater the tendency for *β-convergence.*

The *σ-convergence* is tested by regressing a dispersion measure, i.e. the annual standard deviation (around weighted average efficiency) of individual bank's efficiency, on a time trend variable:

$$\sigma_t^b = \alpha + \eta T + \xi_t \qquad (4.5)$$

where

σ_t^b is standard deviation around (weighted) average cost efficiency scores across all individual banks at time t.

T is time trend variable as defined before

α and η are parameters to be estimated, and

ξ_t is random error, and $\xi_t \sim iid\ N(0,\sigma_\xi^2)$

Similarly, a negative value for the parameter η implies σ *-convergence*. As discussed in Chapter 3, the two types of convergence do not necessarily exist at the same time, and implications are different when only one of them exists or both of them exist.

5. Model Strategy and Data

5.1 DEA efficiency estimation model strategy and variables

The data set is drawn primarily from the balance sheet and income statements of banks from the Bureau van Dijk Bankscope database. Data for missing periods were obtained from the annual reports of individual bank and central bank statistics. The data only focus on commercial banks as it comprises the largest segment of depository institution in Indonesia (98.6% of banking industry assets[66]). Where possible, the unconsolidated financial reports are used, to avoid double-counting.

Due to the major structural change of the banking system following the financial crisis, many problematic banks were acquired by other banks or merged to form a new bank, and nationalised banks have been resold to private sectors. The final sample is a very much unbalanced panel. In order to keep as many as observations possible and to smooth out the distortion effect of the financial crisis, the years of the financial crisis (1997-1999) are taken out of the sample as a separate period, and the pre-crisis (1992-1996) and post crisis period (2000-2007) are left as two separate periods. All estimations except *σ-convergence* test[67] are therefore carried out within each sub-sample. The sample sizes of different time periods are summarized in Table 4-2.

In this chapter, three classic input variables are chosen under the intermediation approach, which are the *Number of Employees* (*LAB*), *Fixed Assets* (*FA*) and *Total Deposits* (*TD*=customer and interbank deposits + other deposits and short-term borrowings). On the output side, bank asset creation and income generation are not

[66] Figures are calculated from reported values in 2007 Banking Statistics, Bank of Indonesia.
[67] Due to insufficient number of observations.

always highly correlated because of the creation of non-performing loans. Unfortunately data for non-performing loans are not available for most of the years; therefore I use three different combinations of outputs to test for robustness. Model 1 concerns only asset creation, and uses *Loans* (total customer loans + total other lending) and *Other Earning Assets* (*OEA*= interbank assets + securities), as outputs. Model 2 takes the income flows of a bank as the output, including the income from traditional banking business, the *Total Interest Income* (*TIY*=interest income on loans + other interest income) and *Other Operating Income* (*OOY*=net gain on trading and derivatives + net fees and commissions +other non-interest income) to proxy the growing non-traditional business activities of Indonesian banks. Model 3 is a mixture of previous two models and uses both stock and flow variables as outputs: *Loans, OEA* and *OOY*, and this model is consistent with what has been used in previous chapter, capturing both traditional and non-traditional banking activities. Except for LAB, all variables are measured in real terms (2005 = 100). Table 4-3 summarises the modelling strategies with different output specifications.

Table 4-2 Sample sizes of Indonesian banks

	Number of Bank-year observations
1992-1996	171
1997-1999	98
2000-2007	312

Table 4-3 Modelling strategy

	Inputs	***Outputs***
Model 1	LAB, FA, TD	Loans, OEA
Model 2	LAB, FA, TD	TIY, OOY
Model 3	LAB, FA, TD	Loans, OEA, OOY

Input prices are crucial for estimating cost efficiency. The price of labour (p_1) is calculated as the ratio of personnel expenses divided by the number of employees. Where data on either personnel expenses or employees are not reported, the calculation of the price of labour is conducted according to what is standard in the literature and assume that the growth rate of the number of employees is the same as the growth rate of total assets for a given bank and the ratio of personnel expenses to operational expenses is the same as the closest available year (see for example Altunbas, *et al*, 2001 and Vannet, 2002). The price for total deposits (p_2), is calculated as the ratio of interest expenses to total deposits. The price of fixed assets (p_3), is measured by the ratio of operating expenses less personnel expenses to fixed assets. Table 4-4 provides a snapshot of the data.

What is noteworthy is the evolution of the loan-to-deposit ratio which can be taken as a measure of leverage. In the pre-crisis period the ratio was greater than unity but in the final period this has dropped to an average of 0.45. This adjustment to a lower level of leverage is also seen in the liquidity ratio taken as the ratio of other earning assets to loans, which has risen from 35% in the pre-crisis period to 143% in the post-crisis period. A further noteworthy observation is that despite the growth in average earning assets between the pre and post crisis periods, the real price of labour has remained remarkably stable.

Table 4-4 Statistical data description (sub-periods)

	1992-1996				1997-1999				2000-2007			
	Mean	S.D	Min.	Max.	Mean	S.D	Min.	Max.	Mean	S.D	Min.	Max.
Total Cost (C)	2071	3439	49	14861	4449	9531	62	62651	2755	5629	19	44534
Inputs												
Fixed Assets (x1)	362	553	1	2440	394	681	1	3000	510	992	0.72	6159
Deposit (x2)	13378	21804	320	102236	17392	33203	302	140960	23905	46362	134	275132
Labour (x3)	1386	2486	17	14059	2257	4162	11	21607	4370	7888	9	39915
Input Prices												
price fixed assets (p1)	1.18	1.75	0.14	11.67	2.40	3.77	0.09	26.38	1.89	2.08	0.15	15.68
price of deposit (p2)	0.12	0.03	0.03	0.23	0.22	0.11	0.06	0.74	0.08	0.05	0.02	0.76
price of labour (p3)	0.20	0.15	0.01	1.00	0.15	0.20	0.01	1.29	0.14	0.21	0.02	2.11
Output												
Total Loan	13474	22357	293	85335	10987	23407	62	126757	10742	18080	11	94904
Other Earning Assets	4755	8736	52	41249	6913	17696	44	130098	15381	36326	49	299111
Other Operating Income	207	386	0.39	2171	339	1367	-6689	9826	404	903	-38	8726
Total Interest income	2193	3561	53	16236	3286	5918	73	31388	3064	6223	18	44380

*Except for No. of employee, other variables are measured in bil.IDR. 2005=100

5.2 Environmental variables

The environmental variables, z_j used in the second stage truncated regression, contains the bank-specific characteristics which may be related to the efficiency level of bank *i*. Following the literature on the determinants of bank efficiency (e.g. Sufian, 2009), the following seven variables are included, which have been found to be typical determinants of bank efficiency, for the bank-specific characteristics vector z_j [68]. The description of the variables and their expected relationship with bank cost inefficiency are provided in Table 4-5.

Table 4-6 presents the statistical descriptions of the firm-specific environmental variables. According to these statistics, over the two periods before and after the financial crisis, the average size of Indonesian banks has slightly increased by 3.5%. More significant increases are seen in the measure of foreign ownership (26%), market concentration (18%), business diversification (32%) and cost to income ratio (11%). Average GDP growth rate was lower after the financial crisis and fewer state-owned banks exist in the post-crisis period following the banking structural reforms.

[68]. Other variables were included, such as measure of banks risk; measure of bank profitability, but were statistically insignificant.

Table 4-5 Environmental variables used in truncated regression

Variables	*Description*	*Hypothesized relationship with inefficiency*[69]	
Ownership Dummy (OWN)	1 denotes >50% foreign ownership, 0 otherwise	-	A negative relationship with cost inefficiency is expected
HHI	Sum of the squares of the market shares of all banks in each year	+/-	A proxy of market concentration. No priori expected sign.
Size	Natural logarithm of total assets	+/-	A proxy of bank size. No priori expected sign.
Diversification (DIV)	Non-interest income/total assets	-	A proxy of diversification in traditional banking business. A negative relationship with cost inefficiency is expected
Cost to Income ratio (CtoI)	Overheads / (net interest revenue + other operating income)	+	Accounting measurement of cost inefficiency. Positive relationship with economic (DEA) cost inefficiency measurement.
ΔGDP	Growth rate of GDP	+/-	Included as Macroeconomic condition. No priori expected sign.
SOB	1 denotes SOB's, 0 otherwise	+/-	No priori expected sign

[69] The dependent variable used in truncated regression is Shephard's (1970) definition of efficiency, which indicates higher inefficiency by higher value.

Table 4-6 Descriptive Statistics of Firm-specific Environmental Variables

		Mean	*S.D.*	*Min.*	*Max.*
1992-1996	Ownership Dummy	0.5088	0.5014	0.0000	1.0000
	HHI	0.1028	0.0093	0.0946	0.1170
	Size	8.6271	1.5775	5.9610	11.6821
	Diversification	0.8955	0.5287	0.0159	3.2629
	Cost to Income ratio	0.5881	0.2147	0.2128	2.1888
	Growth of GDP	7.4455	0.6334	6.4600	8.2200
	SOB	0.1404	0.3484	0.0000	1.0000
1997-1999	Ownership Dummy	0.5612	0.4988	0.0000	1.0000
	HHI	0.1249	0.0168	0.1014	0.1447
	Size	8.6673	1.5866	6.0620	12.0815
	Diversification	1.7966	2.0747	-5.0493	8.7001
	Cost to Income ratio	2.2194	22.4067	-36.3600	206.8813
	Growth of GDP	-3.1251	7.8182	-13.1270	4.7000
	SOB	0.0918	0.2903	0.0000	1.0000
2000-2007	Ownership Dummy	0.6410	0.4805	0.0000	1.0000
	HHI	0.1212	0.0146	0.1033	0.1430
	Size	8.9332	1.7029	5.7541	12.8809
	Diversification	1.1809	0.9375	-0.5078	8.3749
	Cost to Income ratio	0.6533	1.4156	-2.9322	24.4664
	Growth of GDP	5.0183	0.7616	3.6430	6.3450
	SOB	0.1026	0.3039	0.0000	1.0000

6. Empirical Results

6.1 Bank cost efficiency and environmental variables

6.1.1 Bank cost efficiency

The cost efficiency estimations are conducted for each sub-period, and each bank is assigned an efficiency score in each year. Given the limited space, rather than report all individual bank efficiency scores, researchers normally only report the annual average or weighted average efficiency scores as a representative of the industry efficiency level, In this chapter, both arithmetic mean and the weighted average annual bank cost efficiency are reported and compared.

Table 4-7 to Table 4-9 report the yearly arithmetic average cost efficiency scores for each model and each individual estimation periods, and Table 4-10 to Table 4-12 report the corresponding counterparts of average cost efficiency scores that are weighted by individual banks' total asset. The first column of each table gives the standard DEA cost efficiency score $\hat{\gamma}$. Bootstrap results are given in the following columns, which are the mean of efficiencies from 100 bootstrap iterations, $\bar{\hat{\gamma}}^*$, followed by the bias-corrected cost efficiency estimate $\hat{\hat{\gamma}}$, which are calculated by using $\hat{\hat{\gamma}} = 2\hat{\gamma} - \bar{\hat{\gamma}}^*$, and the bootstrapped 95% confidence intervals are also reported after $\hat{\hat{\gamma}}$. Shephard's efficiency measures are used in the whole estimation process, but for interpretation convenience, the corresponding Farrell's efficiency measures are reported too in the last two columns, given by the standard DEA score $\hat{\rho}$, and the

bias-corrected efficiency score $\hat{\hat{\rho}}$ [70], and most of the discussions below will be based on these Farrell's efficiency measures.

All non-bootstrap standard DEA cost efficiency estimates are outside the bootstrapped 95% confidence interval, which means the estimation biases of conventional DEA are significant at 95% confidence level. As shown in the tables, the bias-uncorrected Farrell's efficiency measures, $\hat{\rho}$, are upward biased comparing with $\hat{\hat{\rho}}$, the bootstrapped bias-corrected cost efficiency estimate. These estimates are however significantly lower than the estimates available in the extant literature. The reason is that as I used a constant return to scale common-frontier framework, and efficiencies of all observations in each sample period are estimated relative to a common frontier, This common-frontier is like an envelopment of individual years' frontiers, so some of the observations may be found further away from the common-frontier than it could be if using a single year frontier as a benchmark. Despite the absolute level of efficiency scores, the indicative information delivered by them should still hold.

[70] One may notice that $\hat{\rho}$ and $\hat{\hat{\rho}}$ are not straight reciprocals of $\hat{\gamma}$ and $\hat{\hat{\gamma}}$, this is because $\hat{\rho}$ and $\hat{\hat{\rho}}$ are the average of the reciprocals of each individual bank's Shephard's efficiency, not the reciprocals of the averages.

Table 4-7 Bootstrapped cost efficiency -- Arithmetic yearly average. Model 1

		$\hat{\gamma}$	Bootstrap cost efficiency				Farrell efficiency	
			$\bar{\hat{\gamma}}^*$	$\hat{\hat{\gamma}}$	95% confidence interval		$\hat{\rho}$	$\hat{\hat{\rho}}$
					low	high		
pre-crisis	1992	3.3546*	1.1381	5.5755	5.5043	5.6249	0.3524	0.2485
	1993	3.5078*	1.1479	5.9093	5.8532	5.9476	0.3600	0.2642
	1994	3.4974*	1.1380	5.8860	5.8300	5.9246	0.3562	0.2657
	1995	3.4956*	1.1262	5.8669	5.8067	5.9127	0.3384	0.2442
	1996	3.5809*	1.1215	6.0617	6.0044	6.0992	0.3257	0.2229
financial crisis	1997	2.9353*	1.1541	4.7618	4.6891	4.8069	0.4188	0.3171
	1998	3.5493*	1.1430	5.9798	5.9078	6.0285	0.3851	0.3006
	1999	2.9947*	1.1553	4.8459	4.7622	4.9090	0.4197	0.3305
post-crisis	2000	2.2136*	1.2717	3.1872	3.1131	3.2528	0.5097	0.4264
	2001	2.2210*	1.2561	3.2165	3.1425	3.2803	0.4984	0.3998
	2002	2.2648*	1.2437	3.3089	3.2454	3.3648	0.4820	0.3769
	2003	2.2603*	1.2466	3.3077	3.2408	3.3638	0.4950	0.3959
	2004	2.5399*	1.2262	3.8881	3.8310	3.9373	0.4524	0.3587
	2005	2.4591*	1.2352	3.7252	3.6697	3.7745	0.4671	0.3748
	2006	2.3540*	1.2433	3.5027	3.4477	3.5554	0.4829	0.3962
	2007	2.3839*	1.2443	3.5849	3.5348	3.6292	0.4859	0.3935

* denotes basic DEA efficiency is outside the bootstrapped 95% confidence interval, i.e. it is significantly different from the bias-corrected efficiency score.

Table 4-8 Bootstrapped cost efficiency -- Arithmetic yearly average. Model 2

		$\hat{\gamma}$	Bootstrap cost efficiency				Farrell efficiency	
			$\bar{\hat{\gamma}}^*$	$\hat{\hat{\gamma}}$	95% confidence interval		$\hat{\rho}$	$\hat{\hat{\rho}}$
					low	high		
pre-crisis	1992	1.9671*	1.3597	2.6073	2.4316	2.7106	0.5481	0.4681
	1993	2.1803*	1.3171	3.0925	2.9404	3.1764	0.5005	0.3937
	1994	2.4228*	1.2739	3.6044	3.4750	3.6778	0.4457	0.3302
	1995	2.1377*	1.3177	2.9920	2.8522	3.0771	0.5000	0.4039
	1996	2.1662*	1.3124	3.0502	2.9033	3.1321	0.4903	0.3898
financial crisis	1997	2.8985*	1.1885	4.6281	4.4023	4.7032	0.3802	0.2619
	1998	1.9692*	1.3337	2.6859	2.5021	2.7951	0.5798	0.5120
	1999	3.2943*	1.1789	5.4097	5.2717	5.4909	0.3492	0.2418
post-crisis	2000	2.4118*	1.2276	3.6458	3.5546	3.7073	0.4717	0.3559
	2001	2.0689*	1.2422	2.9173	2.8001	2.9968	0.5132	0.3995
	2002	2.1682*	1.2355	3.1083	2.9897	3.1915	0.5031	0.3974
	2003	2.5526*	1.2009	3.9187	3.8174	3.9830	0.4335	0.3144
	2004	3.3307*	1.1450	5.5163	5.4353	5.5648	0.3254	0.2102
	2005	2.9227*	1.1600	4.6854	4.6018	4.7394	0.3644	0.2416
	2006	2.3712*	1.2056	3.5368	3.4266	3.6083	0.4500	0.3316
	2007	2.8142*	1.1686	4.4598	4.3742	4.5159	0.3824	0.2616

* denotes basic DEA efficiency is outside the bootstrapped 95% confidence interval, i.e. it is significantly different from the bias-corrected efficiency score.

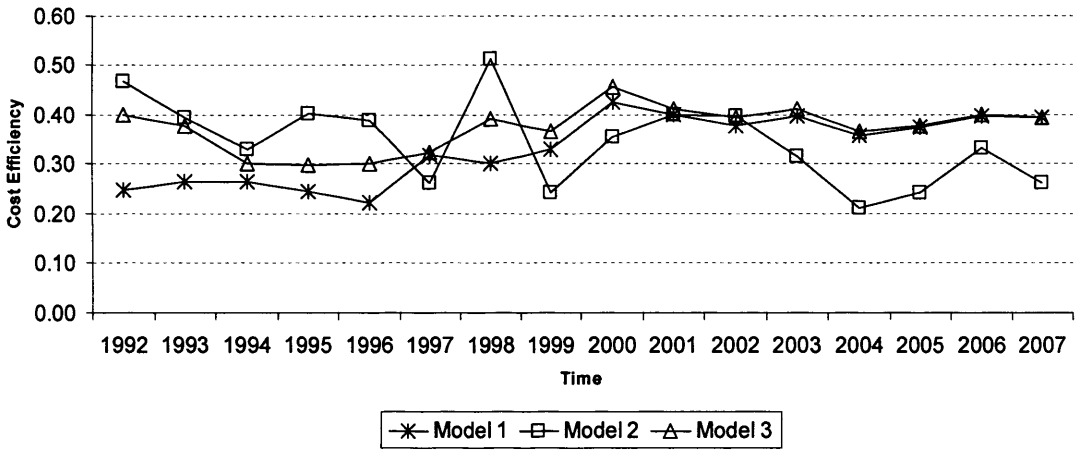
Table 4-9 Bootstrapped cost efficiency -- Arithmetic yearly average, Model 3

		$\hat{\gamma}$	Bootstrap cost efficiency				Farrell efficiency	
			$\bar{\hat{\gamma}}^*$	$\hat{\hat{\gamma}}$	95% confidence interval		$\hat{\rho}$	$\hat{\hat{\rho}}$
					low	high		
pre-crisis	1992	2.4230*	1.2321	3.6403	3.5356	3.7180	0.4884	0.3995
	1993	2.6110*	1.2312	4.0590	3.9698	4.1193	0.4757	0.3762
	1994	3.0870*	1.1807	5.0285	4.9566	5.0812	0.3988	0.3025
	1995	3.0418*	1.1741	4.9251	4.8556	4.9796	0.3931	0.2983
	1996	2.9498*	1.1805	4.7428	4.6611	4.8012	0.4057	0.3020
financial crisis	1997	2.8951*	1.1611	4.6759	4.6188	4.7164	0.4257	0.3252
	1998	2.9251*	1.2072	4.7282	4.6757	4.7654	0.4662	0.3907
	1999	2.7000*	1.1938	4.2245	4.1385	4.2937	0.4505	0.3651
post-crisis	2000	2.1529*	1.3101	3.0708	3.0030	3.1372	0.5315	0.4558
	2001	2.1643*	1.2816	3.0923	3.0193	3.1592	0.5089	0.4120
	2002	2.2205*	1.2664	3.1993	3.1347	3.2640	0.4913	0.3950
	2003	2.2139*	1.2729	3.1949	3.1329	3.2569	0.5024	0.4116
	2004	2.5141*	1.2451	3.8226	3.7680	3.8752	0.4555	0.3662
	2005	2.4539*	1.2482	3.7053	3.6523	3.7543	0.4679	0.3775
	2006	2.3437*	1.2613	3.4724	3.4170	3.5248	0.4856	0.4012
	2007	2.3811*	1.2566	3.5693	3.5204	3.6142	0.4861	0.3947

* denotes basic DEA efficiency is outside the bootstrapped 95% confidence interval, i.e. it is significantly different from the bias-corrected efficiency score.

For a better visual comparison on efficiencies across time and across models, Figure 4-2 plots the bootstrap bias-corrected Farrell efficiencies, $\hat{\hat{\rho}}$, of each model against the time horizon.

Figure 4-2 Bootstrapped cost efficiency -- Arithmetic yearly average



Interestingly, Model 1 and Model 2 exhibit different patterns in the results for the pre-crisis and post-crisis periods. Average efficiency rose in the post-crisis period measured by Model 1 but fell as measured by Model 2, highlighting the sensitiveness of the results to the choice of outputs. It also demonstrates that different output measures may need broader contextual background to understand the development of efficiency. The loan write-offs during the crisis period would have been unevenly distributed between the efficient and inefficient banks but the inefficient banks would have had to reduce costs faster than the efficient banks resulting in an overall increase in average efficiency. However, the inefficient banks may have carried more non-performing loans in the crisis period resulting in lower interest earnings and

lower average revenue efficiency measured by Model 2. Model 3 produces a smoother profile of efficiency estimates over the periods as an amalgam of both Model 1 and Model 2.

The efficiency scores also clearly reflect the impact of the re-regulation period 1993-1995, which leads to a short-period decline in bank efficiency after 1993 in all three cases. Average cost efficiency level is low during the 1997-1999 Asia crises but improves post crisis, reaching a peak in 2000-2001 and start declining due to two major events. One is the re-privatisation process which occurred around 2003 and the global financial crisis beginning in 2007. This is seen in the drop in average efficiency post 2003. While in general the consensus of the literature is that privatisation and increased foreign ownership has increased the efficiency of formerly state-owned enterprises, e.g. Megginson and Netter (2001); Megginson (2005), it is possible that in the case of Indonesian banks, the change is gradual until the new culture and system are properly in place (Besar and Milne, 2009). The short period increase in cost, thus lower cost efficiency, might be explained by the increased of bank's investment in the newly acquired subsidiaries. Unfortunately, there has come another global financial crisis around 2006, before the benefits of this re-privatisation reform are actually realised. This finding is consistent with the finding in Chapter 3 for most of the ASEAN countries, including Indonesia.

Arithmetic average efficiencies treat every individual bank equally weighted, but it is widely accepted that banks of different sizes are influential to the whole market differently. The contribution of a small bank with very little market share to the industry average efficiency level is also very small, even if it is the most efficient

bank. If large proportion of the market is dominated by a few large banks, then the industrial average efficiency level should be determined by the efficiency levels of these few large banks too. Therefore, in order to better present the actual average efficiency level of Indonesian banking industry, the annual weighted averages of bank efficiency scores are also calculated and reported in Table 4-10 to Table 4-12. In this case, the individual banks' cost efficiency scores are weighted by their market significance, i.e. banks' total assets. Followed by Figure 4-3 which plots the weighted average of bootstrap bias-corrected Farrell efficiencies, $\hat{\hat{\rho}}$, for three models with different output variables. Similar with the arithmetic average efficiency results, non-bootstrap DEA scores, $\hat{\rho}$, are still upward biased at 95% confidence level. Weighted averages efficiencies still reflect the major events during the sample period, including efficiency declining since 1993-1995 re-regulation, low efficiency level during the 1997-1999 Asia crises and a continuers decline in the post-crisis period lead by the re-privatisation reform after the crises and the beginning of the current global financial crisis.

Table 4-10 Bootstrapped cost efficiency -- Weighted yearly average. Model 1

		$\hat{\gamma}$	Bootstrap cost efficiency				Farrell efficiency	
			$\bar{\hat{\gamma}}^*$	$\hat{\hat{\gamma}}$	95% confidence interval		$\hat{\rho}$	$\hat{\hat{\rho}}$
					low	high		
pre-crisis	1992	2.8907*	1.1477	4.6340	4.5474	4.6923	0.3782	0.2516
	1993	3.1936*	1.1326	5.2603	5.1892	5.3101	0.3420	0.2207
	1994	3.2247*	1.1336	5.3206	5.2463	5.3709	0.3512	0.2336
	1995	3.3691*	1.1187	5.6196	5.5522	5.6660	0.3196	0.2041
	1996	3.4698*	1.1123	5.8303	5.7641	5.8724	0.3079	0.1922
financial crisis	1997	2.9955*	1.1235	4.8748	4.7977	4.9204	0.3643	0.2411
	1998	4.8280*	1.0890	8.5794	8.5339	8.6100	0.2550	0.1727
	1999	3.3763*	1.1285	5.6263	5.5264	5.6883	0.3470	0.2341
post-crisis	2000	1.9704*	1.3137	2.6382	2.5424	2.7310	0.5559	0.4942
	2001	2.1879*	1.2569	3.1241	3.0460	3.1948	0.4804	0.3611
	2002	2.3666*	1.2278	3.5077	3.4426	3.5677	0.4364	0.3073
	2003	2.5134*	1.1989	3.8313	3.7739	3.8839	0.4131	0.2831
	2004	2.8970*	1.1668	4.6329	4.5828	4.6755	0.3605	0.2383
	2005	2.9529*	1.1634	4.7502	4.7037	4.7893	0.3558	0.2355
	2006	2.7796*	1.1719	4.3913	4.3436	4.4344	0.3732	0.2485
	2007	2.8669*	1.1647	4.5764	4.5311	4.6163	0.3646	0.2415

* denotes basic DEA efficiency is outside the bootstrapped 95% confidence interval, i.e. it is significantly different from the bias-corrected efficiency score.

Table 4-11 Bootstrapped cost efficiency -- Weighted yearly average. Model 2

		$\hat{\gamma}$	Bootstrap cost efficiency				Farrell efficiency	
			$\bar{\hat{\gamma}}^*$	$\hat{\hat{\gamma}}$	95% confidence interval		$\hat{\rho}$	$\hat{\hat{\rho}}$
					low	high		
pre-crisis	1992	2.1827*	1.3774	3.0792	2.9690	3.1669	0.5594	0.5223
	1993	1.8494*	1.3627	2.3421	2.1291	2.4571	0.5578	0.4660
	1994	2.3894*	1.2691	3.5154	3.3705	3.5967	0.4450	0.3226
	1995	2.2495*	1.2855	3.2243	3.0898	3.3004	0.4650	0.3567
	1996	2.1379*	1.3064	2.9732	2.7969	3.0691	0.4879	0.3791
financial crisis	1997	3.4808*	1.1398	5.8229	5.4614	5.8830	0.2997	0.1848
	1998	2.6342*	1.2094	4.0718	3.9128	4.1577	0.4157	0.3024
	1999	3.7284*	1.1698	6.2871	6.1710	6.3605	0.3042	0.1955
post-crisis	2000	2.1847*	1.2332	3.1430	3.0194	3.2207	0.5025	0.3926
	2001	1.9240*	1.2523	2.5991	2.4684	2.6855	0.5390	0.4212
	2002	2.0094*	1.2454	2.7738	2.6494	2.8580	0.5272	0.4106
	2003	2.4811*	1.1891	3.7739	3.6784	3.8340	0.4214	0.2880
	2004	3.3147*	1.1369	5.4924	5.4184	5.5352	0.3157	0.1970
	2005	3.2180*	1.1363	5.2997	5.2268	5.3420	0.3199	0.1983
	2006	2.6121*	1.1742	4.0499	3.9576	4.1056	0.3964	0.2647
	2007	3.1759*	1.1381	5.2138	5.1408	5.2570	0.3255	0.2031

* denotes basic DEA efficiency is outside the bootstrapped 95% confidence interval, i.e. it is significantly different from the bias-corrected efficiency score.

Table 4-12 Bootstrapped cost efficiency -- Weighted yearly average. Model 3

		$\hat{\gamma}$	Bootstrap cost efficiency				Farrell efficiency	
			$\bar{\hat{\gamma}}^*$	$\hat{\hat{\gamma}}$	95% confidence interval		$\hat{\rho}$	$\hat{\hat{\rho}}$
					low	high		
pre-crisis	1992	2.0031*	1.2939	2.7755	2.6482	2.8678	0.5772	0.5054
	1993	2.0034*	1.2562	2.7587	2.6106	2.8562	0.5283	0.4098
	1994	2.8723*	1.1808	4.5695	4.4700	4.6376	0.3958	0.2766
	1995	2.6732*	1.1808	4.1670	4.0783	4.2349	0.4063	0.2945
	1996	2.6376*	1.1883	4.0901	3.9852	4.1602	0.4202	0.3024
financial crisis	1997	2.9791*	1.1267	4.8395	4.7842	4.8793	0.3674	0.2443
	1998	4.2705*	1.1146	7.4521	7.4132	7.4806	0.2920	0.2040
	1999	2.7743*	1.1805	4.3720	4.2696	4.4433	0.4204	0.3070
post-crisis	2000	1.8977*	1.3508	2.4634	2.3825	2.5783	0.5851	0.5671
	2001	2.0780*	1.2786	2.8868	2.8027	2.9757	0.5050	0.3912
	2002	2.2557*	1.2478	3.2661	3.1940	3.3428	0.4613	0.3371
	2003	2.4208*	1.2201	3.6259	3.5655	3.6902	0.4295	0.3017
	2004	2.8487*	1.1847	4.5194	4.4695	4.5673	0.3661	0.2446
	2005	2.9464*	1.1749	4.7264	4.6834	4.7670	0.3565	0.2367
	2006	2.7728*	1.1849	4.3655	4.3186	4.4103	0.3741	0.2501
	2007	2.8664*	1.1766	4.5640	4.5192	4.6056	0.3646	0.2421

* denotes basic DEA efficiency is outside the bootstrapped 95% confidence interval, i.e. it is significantly different from the bias-corrected efficiency score.

Figure 4-3 Bootstrapped cost efficiency -- weighted yearly average

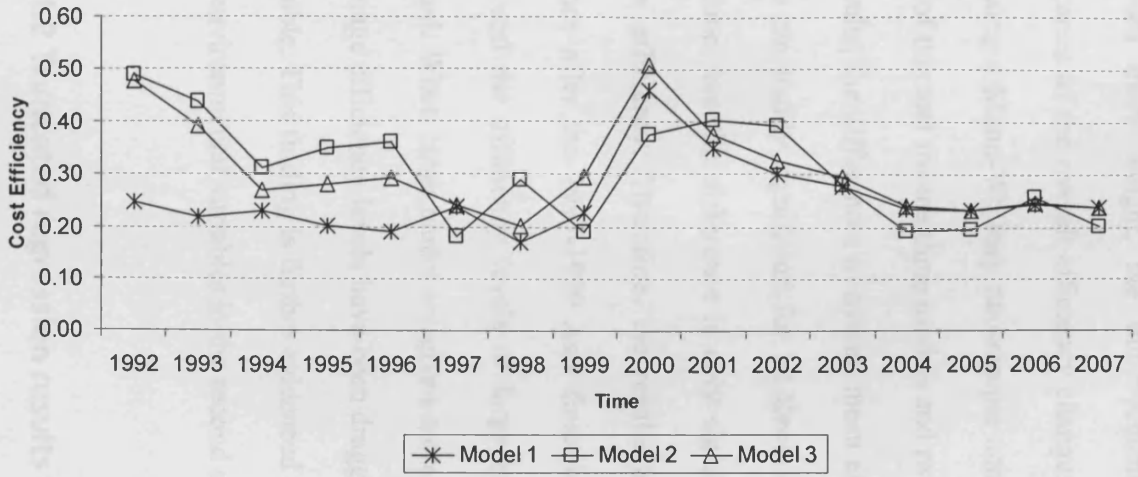


Table 4-13 Mann-Whitney test for two-period efficiency differences

	Arithmetic average			Weighted average		
Mean efficiency	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Pre-Crisis period	0.2491	0.3971	0.3357	0.2205	0.4094	0.3577
Post-Crisis period	0.3903	0.3140	0.4018	0.3012	0.2969	0.3213
Z value	-2.93***	1.76*	-2.20**	-2.34**	1.61	1.03

***, ** and * denotes coefficient is significant at 1%, 5% and 10% significance level accordingly.

Compare with the arithmetic yearly average efficiencies, the weighted averages provide more information about the distribution of cost efficiency level regarding bank sizes. When use arithmetic mean, efficiencies are improved in the post-crisis period in model 1 and model 3, but under weighted averages, i.e. when large banks are given more weight, the improvements become less clear. The statistical significance of the overall efficiency changes between the two periods are tested by conducting a Mann-Whitney two-sample non-parametric test. Table 4-13 reports the results of this test for the three models and two average calculations. As shown by the test results, the differences in overall mean efficiency of the pre-crisis and post-crisis periods are highly significant for all three models under arithmetic yearly average calculation, but the difference is only significant for model 1 when use weighted average efficiency. Therefore, the results indicate that the improvements in cost efficiency after the 1997-1999 Asia financial crises mainly comes from the small banks, and the efficiency levels of large banks have not been improved or even worsened. When large banks are given more weights, i.e. use the weighted average, the average efficiency levels have been dragged down and the improvements become less visible. This finding is further evidenced by looking into the coefficient estimates on the environmental variables in the second stage truncated regressions.

6.1.2 Truncated regression results for environmental variables

Table 4-14 reports the truncated regression results using the conventional DEA cost efficiency estimates ($\hat{\beta}$) and the bias-corrected DEA cost efficiency estimates ($\hat{\hat{\beta}}$) as the dependent variable. The differences are notable and confirm the

expectation that using biased DEA estimates in the second stage parametric regression on environmental variables produces inaccurate estimates. Most of the estimates on the environmental variables exhibit the expected sign and are consistent in all periods when significant at the 5% significance level, however, inconsistency does exist for few cases.

The dependent variable in Table 4-14 is Shephard's (1970) definition of efficiency, which indicates higher inefficiency by higher value. Thus positive/negative marginal effects in the truncated regression indicate negative/positive marginal effects on cost efficiency. Unsurprisingly, foreign ownership always has a positive impact on bank cost efficiency, like the case in most developing countries. Cost efficiency is negatively correlated with bank size, indicating small banks are more efficient. But these two effects are only significant in the post-crisis period for most cases. Clearly, the post-crisis newly re-privatised banks, especially foreign acquired ones have dramatically high level of cost efficiency, and they are obviously smaller in size comparing with big national banks. On the other hand, many small problematic banks have been merged into big state-owned banks or have been merged to form a new bigger bank with better capital adequacy during the structural reform process. The problems of high level non-performing loans and book value insolvency may have been carried over and lead to a low level of efficiency for large banks. This could explain what has been found earlier that the yearly weighted average efficiencies are lower than the arithmetic means, since the most influential banks to the industry are not the most efficient ones.

Table 4-14 Truncated regression results

		1992-1996		*1997-1999*		*2000-2007*	
		$\hat{\beta}$	$\hat{\hat{\beta}}$	$\hat{\beta}$	$\hat{\hat{\beta}}$	$\hat{\beta}$	$\hat{\hat{\beta}}$
Model 1	Const.	4.2725	7.1945	2.2213	2.5056	2.6309	3.4399
	OWN	-0.1824	-0.0331	-1.4342	-2.5669*	-0.6384	-1.0887*
	HHI	-19.4372	-32.0615	-11.4329	-14.536	-8.074	-15.187
	Size	0.0384	0.0021	0.3019	0.5992*	0.1508	0.2822*
	DIV	0.4237	0.6696*	0.0658	0.018	-0.0429	-0.0716
	CtoI	0.0257	0.0449*	0.0194	0.0379*	0.0259	0.0238
	ΔGDP	-0.0872	-0.0823	-0.057	-0.1294*	-0.038	0.0743
	SOB	-1.6964	-3.08948	-0.208	-0.3845	-0.6144	-1.2567*
	Sigma	0.8766	1.6399	1.4202	2.8115	0.6802	1.2809
Model 2	Const.	6.2136	12.0604*	-2.5046	-6.5457*	1.982	2.3741
	OWN	-0.0868	-0.1087	-0.576	-1.2949*	-0.1126	-0.2994
	HHI	-26.3348	-58.7551*	22.9392	46.9658*	-9.7569	-19.2493
	Size	0.1499	0.2773*	0.3347	0.6953*	0.0909	0.1763*
	DIV	-0.4779	-0.9039*	-0.0436	-0.0855	-0.0613	-0.0063
	CtoI	0.0098	0.0163*	-0.0016	-0.0026	0.0232	0.0469
	ΔGDP	-0.3493	-0.6863*	0.0979	0.2026*	0.2116	0.4741
	SOB	-0.8814	-1.7521*	-0.0961	-0.2466	-0.618	-1.4030*
	Sigma	0.459	0.9267	0.8858	1.896	0.8858	1.8961
Model 3	Const.	6.3595	10.5728	4.1113	6.6790*	2.7641	3.3137
	OWN	-0.1579	-0.0162	-1.2295	-1.7238*	-0.6289	-1.1239*
	HHI	-29.9489	-49.5821	-15.9499	-19.8219	-8.6528	-13.7195
	Size	-0.0035	-0.1073	0.1797	0.2544	0.1358	0.2316*
	DIV	-1.2422	-2.6463*	-0.2162	-0.4724*	-0.1077	-0.0509
	CtoI	0.0249	0.0417*	0.015	0.0288*	0.0235	0.0195
	ΔGDP	-0.075	0.0407	-0.0438	-0.1010*	-0.0169	0.1445
	SOB	-1.5114	-2.7600*	-0.1633	-0.1174	-0.5587	-1.1659*
	Sigma	0.8805	1.6347	1.0857	1.8211	0.6597	1.2254

*denotes coefficient is significant at 5% significance level.

Given the foreign banks are relatively more efficient, state owned banks also consistently exhibit higher efficiency. Cost efficiency is also negatively related to the cost to income ratio, when significant. Diversification in business is not very influential as expected, only helps to improve cost efficiency in the early period according to Model 2 and Model 3, but has an opposite effect in Model 1. This indicates that loan is still the main revenue generating business for commercial banks. Coefficient on market concentration measured by HHI is positive and significant in Model 2 in the pre-crisis period, but negatively related to cost efficiency in the crisis period. This suggests that market power may have been prevalent in loan pricing in the pre-crisis period driving up revenues relative to costs but is reversed in the crisis period. The macroeconomic environment measured by GDP growth, which has a common effect on all banks in the country, therefore shows no clear pattern of influence on cost efficiency over the individual models or over separate periods.

6.2 Convergence properties of cost efficiencies

Using the bootstrap bias-corrected Farrell cost efficiencies, $\hat{\hat{\rho}}$'s, for every individual bank, the unconditional β-convergence is tested by using unbalanced panel estimation and σ-convergence in banking cost efficiency is tested by an OLS estimation. STATA 10, which is a data analysis and statistical software, is used for this estimation. To select the appropriate panel data estimation model, the following model specification test procedures are adopted. Firstly, an F-test is used to test fixed effect model against Pooled OLS regression. If the Pooled OLS regression model is rejected, then a Hausman specification test is conducted to test for the appropriate common effect model, fixed effect or random effect model? Finally, a Breusch-Pagan

Lagrange multiplier test is carried out to test the significance of random effect, if Random effect model is not rejected in the second step[71]. The model selection tests show that fixed effect model is the most appropriate model to use in all models and for all periods. All the model selection test statistics along with the unconditional β-convergence test results are reported in Table 4-15.

For all models and in all periods, the estimates of coefficient on the lagged efficiency are all negative and significant at 1% significance level. This is very strong evidence for unconditional β-convergence, indicating that for both pre-crisis and post-crisis period, even in the transition period of financial crises, inefficient banks are catching up with efficient ones through a faster growth rate in cost efficiency. This also could be seen as a signal of the dynamic improvement in cost efficiency of Indonesian banks.

[71] Theoretically, this test is not necessary if random effect model is rejected in Hausman specification test; however, the test is still conducted for a robustness check even if random effect model is rejected.

Table 4-15 Unconditional β-convergence test results (Fixed effect estimation)

		1992-1996		1997-1999		2000-2007	
		Coefficient	*z-values*	*Coefficient*	*z-values*	*Coefficient*	*z-values*
	Intercept	-1.5541	(-9.94)***	-1.5042	(-7.15)***	-0.7922	(-11.56)***
	$\ln \hat{\hat{\rho}}_{j,t-1}$	-0.9422	(-9.97)***	-0.9969	(-7.35)***	-0.6910	(-11.55)***
	Wald test			F(1,52)=0.16		F(1,218)=17.64***	
MODEL 1	No. of obs.	130		89		262	
	F-test	F(38,90)=3.43***		F(35,52)=2.03**		F(42,218)=3.36***	
	Hausman test	chi2(1)=90.56***		chi2(1)=40.80***		chi2(1)=122.89***	
	B-P test	Chi2(1)=2.75*		chi2(1)=0.81		chi2(1)=0.71	
	overall R^2	0.0583		0.1336		0.0568	
	Intercept	-1.0830	(-12.67)***	-2.1927	(-16.05)***	-0.9802	(-11.97)***
	$\ln \hat{\hat{\rho}}_{j,t-1}$	-1.0074	(-13.01)***	-1.7887	(-15.20)***	-0.7544	(-11.96)***
	Wald test			F(1,52)=44.10***		F(1,218)=16.10***	
MODEL 2	No. of obs.	130		89		262	
	F-test	F(38,90)=3.10***		F(35,52)=3.87***		F(42,218)=1.84***	
	Hausman test	chi2(1)=378.23***		chi2(1)=648.63***		chi2(1)=70.02***	
	B-P test	chi2(1)=1.52		chi2(1)=0.03		chi2(1)=0.60	
	overall R^2	0.2877		0.4138		0.2199	
	Intercept	-1.2444	(-10.91)***	-1.4291	(-7.25)***	-0.7860	(-11.97)***
	$\ln \hat{\hat{\rho}}_{j,t-1}$	-0.9058	(-10.83)***	-1.0520	(-7.34)***	-0.6978	(-11.91)***
	Wald test			F(1,52)=1.04		F(1,218)=12.62***	
MODEL 3	No. of obs.	130		89		262	
	F-test	F(38,90)=3.15***		F(35,52)=1.87**		F(42,218)=3.61***	
	Hausman test	chi2(1)=103.59***		chi2(1)=42.05***		chi2(1)=123.92***	
	B-P test	chi2(1)=0.56		chi2(1)=2.61		chi2(1)=0.25	
	overall R^2	0.1310		0.1236		0.0675	

***, **, and * denotes coefficient is significant at 1%, 5% and 10% significance level accordingly.

However, the tendency of convergence alters over each sub-period. Wald tests are used to test whether the degree of convergence tendency in the post-crisis period has significantly changed from the pre-crisis level. During the financial crisis, the convergence tendency is higher than pre-crisis level, but the change is only significant in model 2. Given the economic environment during that time, the reason for this positive change is rather that the income generating ability of initially efficient banks were declining faster, and make the growth rate in efficiency of inefficient banks relatively higher. After the structural reforms, the post-crisis period shows significantly weakened tendency of convergence for all three models, indicating a more conservative strategy to risk-taking and asset growth as a means by which inefficient banks catch-up with efficient banks. Related back to the yearly average efficiency scores and the marginal effects of environmental variables discussed earlier, small banks and foreign owned banks become more efficient in the post-crisis period, while large banks become less efficient due to defensive mergers of insolvent banks during the financial crisis period and the banking reforms afterwards. It is possible that in both periods, relatively inefficient banks are catching up with efficient banks, but the leaders and laggers are reversed after the banking structural reform.

While *β-convergence* tests the movement within one distribution, *σ-convergence* tests the change of the distribution, which is done by regressing the annual standard deviation of cost efficiency scores across all banks, which measures the dispersion among individual banks' efficiency levels, on a time trend variable. Table 4-16 reports the testing results for *σ-convergence*. As the difference between arithmetic and weighted yearly average efficiency is quite substantial, the *σ-convergence* is tested using two different standard deviation calculations. One is the standard deviation

around the arithmetic average, which is the conventional way of calculating standard deviation. The other is the standard deviation around the weighted average efficiency.

Using two measurements of standard deviation produces very similar *σ-convergence* test results. The *σ-convergence* is only found in Model 2, but not in the other two models, especially not in model 1, where the coefficient on time trend variable is positive and significant. In terms of the convergence concepts themselves, there are two circumstances under which *β-convergence* does not accompany *σ-convergence*. One, the laggers overtake the leaders. In other words, the initially inefficient banks becomes more efficient than those initially efficient ones, and keep on growing at a faster rate which drives wider the dispersion. This point has been proved by the analysis above, in the post-crisis period, small and foreign banks become more efficient while big banks were more efficient in the pre-crisis period. Two, the initial dispersion of efficiency levels is very small, smaller than the steady-state dispersion level, and the random shock is relatively large. In this case, the dispersion will grow and converge towards steady-state level from below[72]. Given that the Indonesian banking market were heavily regulated by quantitative controls and political relationship banking at the beginning, which maybe even earlier than the sample period, the initial efficiency dispersion is very likely to be small. Indonesian banks are still catching up with one another, i.e. is *β*-converging, but random shocks are pushing them apart.

[72] See Appendix A for a theoretical illustration of this point.

Table 4-16 σ-convergence test results (OLS estimation)

		Arithmetic average		Weighted average	
		Coefficient	*t-values*	*Coefficient*	*t-values*
MODEL 1	Intercept	0.2314	(16.42)***	0.2232	(13.69)***
	T	0.0031	(2.12)*	0.0054	(3.22)***
	No. of obs.	16		16	
	Adj R^2	0.1896		0.3841	
MODEL 2	Intercept	0.2387	(11.97)***	0.2467	(9.51)***
	T	-0.0062	(-2.99)**	-0.0062	(-2.33)**
	No. of obs.	16		16	
	Adj R^2	0.3461		0.2277	
MODEL 3	Intercept	0.2691	(18.02)***	0.2657	(12.84)***
	T	0.0008	(0.50)	0.0027	(1.27)
	No. of obs.	16		16	
	Adj R^2	0.0523		0.0394	

***, ** and * denotes coefficient is significant at 1%, 5% and 10% significance level accordingly

Comparing the three models, Model 1 and Model 2 produce completely opposite results, in which *σ-divergence* is found in Model 1 while *σ-convergence* in Model 2. Again, Model 3 looks like an amalgam of the other two models. Model 1 shows that the dispersion of the cost efficiency across banks in terms of asset creating is widening, which could be explained by the increasing differences in bank management and operational techniques that are brought by the banking reform and new ownership structures. The new management team might be more efficient in credit creating process and in other financial investment. New financial products and other financial innovations may lead to a change in structure of banks' balance sheet, and allow banks to operate on a higher leverage ratio.

On the other hand, Model 2 suggests that the capabilities of generating income of banks are becoming more and more similar between banks over time. The message could be either positive or negative. For the whole industry, banks become more and more equally profitable is an overall improvement, but for those banks that have introduced new techniques and new ownership structures, creating more assets or more diversification in business did not effectively make them outstanding in terms of profitability. The reason could be many, one of which could be the cultural difference between the foreign operational mechanisms and the home country local environment. The comparative advantages in productivity have not been fully utilised to generate profit.

7. Conclusion

In this chapter, the bank cost efficiencies are estimated for a sample of Indonesian banks over the period 1992-2007 by using the Simar and Wilson's (2007) two stage semi-parametric double bootstrap DEA procedure, with the aim of analysing its convergence properties. The estimates of cost efficiency produced by this method are starkly in variance with the findings of the extant literature. This is explained by the assumption of constant returns to scale along with the common-frontier approach adopted in the estimation methodology. However, the absolute measures of efficiency are unlikely to influence its dynamic pattern.

One beauty of the Simar and Wilson's (2007) two-stage double bootstrap method is that one can incorporate the effects of bank-specific environmental variables into the efficiency estimation without sacrificing the non-parametric nature of DEA. Estimates of marginal effects of the environmental variables, together with the noticeable difference between arithmetic and weighted yearly average efficiency, proves that there is a structural change in Indonesian banking industry after the 1997-1999 Asia financial crises. Although, the cost efficiency estimates are sensitive to choice of outputs, in general, small banks, especially foreign owned banks become more efficient in the post-crisis period, thanks to the new managerial skills brought by the new ownership structure. Diseconomies of scale exist for large banks in the market.

The efficiency results then are used to test the convergence properties of Indonesian banks' performance. Strong evidences of *β-convergence* are found for all

models and in all periods, which indicate that inefficient banks are improving faster and catching up with the efficient banks in all sub-periods. However, the tendency of convergence was weakened in the post-crisis period suggesting that the reforms created an environment of caution that resulted in a slower catch-up by the inefficient banks to the efficient frontier. Given the sudden rise in the force of small and foreign owned banks, it is possible that the initially efficient large and national banks now become the relatively inefficient banks.

The efficiency estimates are sensitive to choice of outputs, so are the convergence properties. The results of *σ-convergence* are double-edged. Narrowing dispersion of bank efficiencies in terms of revenue generating indicates that there is an overall improvement in profitability for the whole industry. However, the *σ-divergence* found in Model 1, which mainly concerns assets creating behaviours, also shows that the introduction of new ownership structure and better operational skills are effective in credit creating and business diversification, but the changes are not effective enough to produce significant comparative advantages in terms of profitability for those newly acquired banks.

Chapter 5 Market Competitiveness of ASEAN Banking Markets

1. Introduction

Chapter 3 investigated the banks' capabilities in product maximisation and cost minimisation, which are represented by relative efficiencies. The analysis of ASEAN banks' cost efficiencies and their convergence properties produced mixed results on ASEAN banking market integration, due to the substantial cross-country bank efficiency asymmetries and the lack of convergence at individual bank level. The present chapter will examine the banking markets at the aggregate level, and asses the differences in terms of market competitiveness across countries.

With the improved trend in financial integration that emerged after the 1997 Asian financial crisis, one would expect to see lower entry barriers in ASEAN national financial markets, and hence intensified competition level. Banks operating in markets with different degrees of competitiveness may behave substantially different in pricing behaviours, and opening up the cross-country barrier, letting foreign banks to compete freely in domestic market will increase the competitive pressure in less competitive markets. Cross-country dispersion in banking markets' competitive structures is a crucial factor to evaluate the financial integration process, and the similarity in individual country's banking market competitiveness is also an indicator for integration. Differences in member country's banking market competition level may also affect the implementation of monetary policies in each member country. Similarity in the banking market competitive structure may also help reap the maximum benefits from future monetary integration.

The degrees of banking market competition is measured by a non-structural approach, Panzar-Rosse (PR) reduced-form revenue model, which is based on the new empirical industrial organization (NEIO) theories of contestable markets. The PR *H*-statistic is estimated for the whole sample period as well as rolling window periods to assess the time evolution of market competitiveness. The time series of *H*-statistics then are used to test the relationship between market competition and concentration. It has been found that the ASEAN banking market could be described as a contestable market; however the main finding of this chapter is again to show a low degree of integration.

The rest of this chapter is organised as follows. Section 2 briefly reviews the text book models of market structures, their relationships with economic efficiency and the implications for banking markets. Section 3 reviews how banking market competitiveness has been empirically examined in the literature and the main techniques have been developed. Section 4 outlines the methodology used in this chapter, i.e. the Panzar-Rosse model, along with some recent improvements. The empirical estimations in this chapter use the same sample as in Chapter 3; a detailed data description was presented in Chapter 3. Section 5 of the current chapter provides only brief data information on the main variables used in this chapter. Section 6 reports the PR model estimation results and implications for introducing currency union. Section 7 investigates the relationship between market competition and concentration in ASEAN banking markets under a counterfactual assumption of a existing currency union. The final section, section 8 concludes this chapter.

2. Market types and economic efficiency

In economics, market structure (also known as market form) describes the state of a market with respect to the degree of competition that exists between the firms in an industry. Market structure is categorized on the basis of market structural variables which are believed to determine the extent and characteristics of competition. Traditionally, those variables that have been used as the main criteria to distinguish different market structures are: the number and size of producers and consumers, the extent of product substitutability, the cost structure, ease of entry and exit, and the extent of mutual interdependence of producers and consumers.

Markets are normally classified into four major types of market structure, with descending order of degree of competition, perfect competition, monopolistic competition, oligopoly, and pure monopoly. These four market structures each represents generic characterization of a type of real market. Firms' behaviours are implicitly or explicitly different under different types of market structure, and therefore the contributions to economic efficiency are also different. The basic textbook models, firms' behaviors and to what extent that economic efficiency is achieved under each market type are reviewed briefly below.

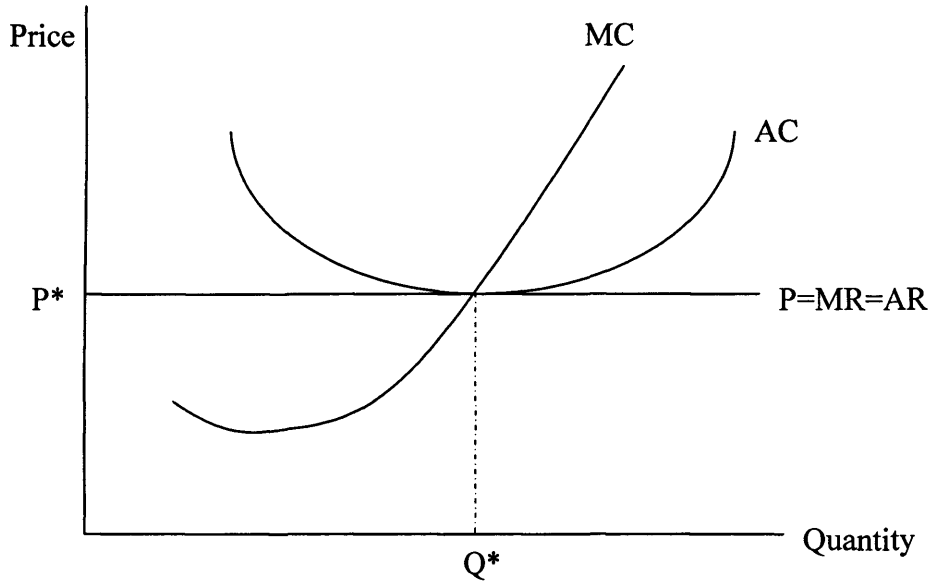
2.1 Perfect competition

Perfect competition is an economic model that describes a hypothetical market form in which no producer or consumer has any market power to influence prices, and this type of market would lead to a completely efficient outcome. There are six

conditions that market has to satisfy to be a perfectly competitive market: 1, the market has to be "atomistic", in which there are large number of small producers and consumers, each so small that its actions have no significant impact on others. 2, the products have to be homogeneous. Goods and services are perfect substitutes, that is, there is no product differentiation. 3, Perfect and complete information. All firms and consumers know the prices set by all firms. 4, all firms have equal access to production technologies, and resources are perfectly mobile. 5, Free entry and exit to the industry. 6, individual buyers and sellers act independently (Katz and Rosen, 1998).

Collusion and cartels are not possible under this market structure. In general, it can be argued that perfectly competitive market results in economic efficiency, which is achieved when each good is produced at the minimum cost and where consumers get maximum benefit from their income. The combination of (long-run) production being at minimum average cost and the marginal cost pricing keeps prices at a minimum, and no economic profit exist anymore, as shown in Figure 5-1.

Figure 5-1 Long-run equilibrium of perfect competition

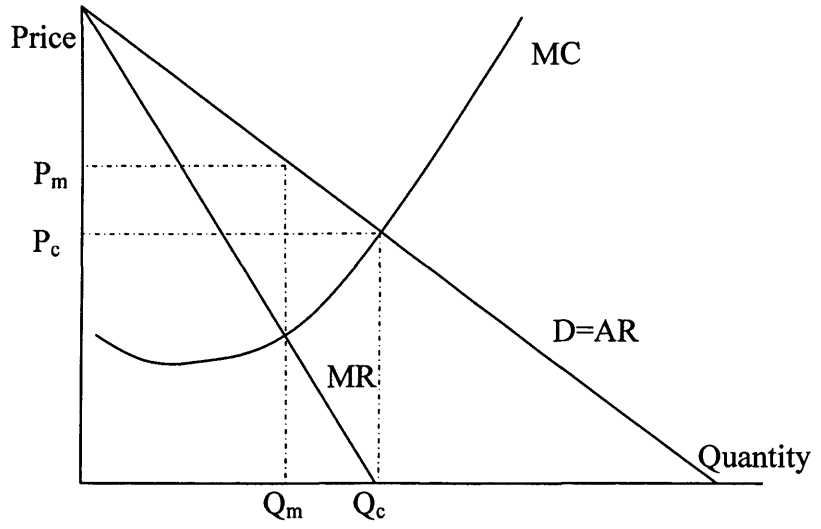


Perfect competition is a case of "survival of the fittest". Inefficient firms will be driven out of the business, since they will not be able to make even normal profits. This encourages firms to be as efficient as possible and, where possible, to invest in new improved technology. However, the basic assumptions of perfect competition are very strict. Few, if any, industries in the real world meet these conditions. One important reason for this has to do with economies of scale. Firms must be small under perfect competition: too small in most cases for economies of scale. Once a firm expands sufficiently to achieve economies of scale, it will usually gain market power. It will be able to undercut the prices of smaller firms, which will thus be driven out of business. Perfect competition is destroyed. Therefore, perfect competition could exist in any industry, only if there were no economies of scale.

2.2 Monopoly

On the other extreme of the market structure line is monopoly. A monopoly exists when there is only one firm (or few firms behave perfectly collusively) in the industry. For a firm to maintain its monopoly position, there must be barrier to the entry of new firms. Since there is only one firm in the industry, the firm's demand curve is also the industry's demand curve. Compared with other market structures, demand under monopoly tends to be less elastic at each price, since the monopolist can raise its price and consumers have no alternative firm to turn to within the industry. Thus the monopoly firm is a 'price maker'. It can choose what price to charge at their best interest. The profit maximising point for a monopolist is still where marginal revenue equal marginal cost, but it could earn supernormal profit due to the downward slopping demand curve, and the economic profit will not be competed away in the long run, since there are barriers to the entry of new firms. These profits will tend to be larger the less elastic is the demand curve. The actual elasticity will depend on whether reasonably close substitutes are available in other industries. Under monopoly, the monopolist is not forced to operate at the bottom of the average cost curve because of the barriers to entry. Thus, other things equal, long-run prices will tend to be higher, hence lower output than the competitive levels. As illustrated in Figure 5-2, monopolist could charge as high as $P_{m,}$ while the competitive price is only at P_c.

Figure 5-2 Long-run and short-run equilibrium of Monopoly



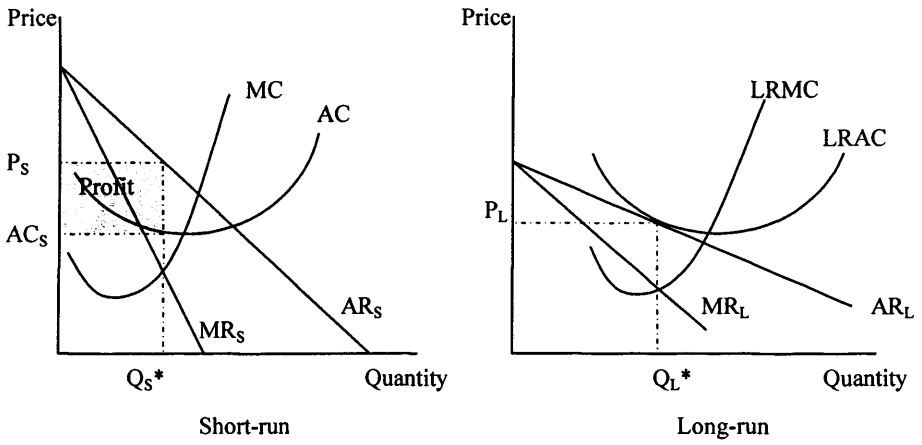
Sheltered by barriers to entry, the monopolist can still make large profits even if it is not using the most efficient technology. It has less incentive to be efficient and the production costs may be higher under monopoly. On the other hand, the monopoly may be able to achieve substantial economies of scale, and it can use part of its supernormal profits for research and development and investment. It may not have the same incentive to become efficient as the perfectly competitive firms which are fighting for survival, but it may have a much greater ability to become efficient than has the small firm with limited funds.

Very few markets in practice can be classified as perfectly competitive or as a pure monopoly. The vast majority of firms do compete with other firms, and yet they are not pure price takers, they do have some degree of market power. Most markets, therefore, lie between the two extremes of market structures, in the realm of 'imperfect competition': monopolistic competition and oligopoly.

2.3 Monopolistic Competition

Monopolistic competition model was developed by American economist Edward Chamberlin (1899-1967) and English economist Joan Robinson (1903-1983). It has the following characteristics: there are quite a large number of firms. Each firm's actions are unlikely to affect its rivals to any great extent. There is freedom of entry, but unlike perfect competition, each firm's product or service is sufficiently different from its rivals', therefore it could raise the price without losing all its customers. Thus its demand curve is downward sloping and relatively elastic. This is known as the assumption of "product differentiation". It is possible for the monopolistically competitive firm to make supernormal profit, but only in the short run. Chamberlin (1962) argued that firms selling differentiated products were qualitatively indistinguishable from classical monopolists, and its actions would satisfy all the conditions of monopoly profit maximization. However, that market equilibriums in the two models were vastly different. The firms set their price so that the output level equalise the marginal cost and marginal revenue. The demand curve facing the individual firm depends upon the prices or quantities of substitute products, while the products are differentiated, the entry or exit of rivals will cause the perceived demand curve to shift in or out, until in the long-run equilibrium, zero economic profit are achieved when demand curve tangent to the average cost curve, the so called "Chamberlinian tangency". Figure 5-3 shows a graphical illustration of short-run and long-run equilibrium conditions for monopolistic competition.

Figure 5-3 Short-run and Long-run equilibrium of Monopolistic Competition



Although economic profits are competed away in the long-run under monopolistic competition, it is still leads to a less efficient allocation of resources than perfect competition. Fewer products will be sold and at a higher price, and also firms will not be producing at the minimum cost level. On the other hand, although the firm facing demand curve is downward sloping, it is still likely to be highly elastic if large number of substitutes exist, and consumers may benefit from having a greater variety of products to choose from. Each firm may satisfy some particular requirements of certain consumer groups. Comparing with monopoly, freedom of entry and hence zero economic profit in the long-run are likely to keep price down and encourage cost saving, however, monopolists are more likely to achieve greater economies of scale and have more profit to invest in research and development.

2.4 Oligopoly

Oligopoly occurs when just a few firms share a large proportion of the market. The firms may produce virtually identical product or differentiated products, and much of the competition between oligopolists is in terms of marketing its own brand. There are two crucial features that distinguish oligopoly from other market types. One is that there are various barriers of entry, of which sizes may vary from industry to industry. The other one is that, under oligopoly, firms are interdependent. Each firm is reacting to its rival's actions, and different firms may react differently and unpredictably. Therefore, there is no single one generally accepted theory of oligopoly.

Oligopolists are pulled into two different directions. One is that the interdependence of firms may make them wish to collude with each other. If they can club together and act as if they were a monopoly, they could jointly maximize industry's profits. A formal collusive agreement is called "cartel", which may agree on prices, market share, advertising expenditure, etc. In many countries, cartels are illegal, as they are seen by the government as a means of driving up prices and profits, and thereby as being against the public interest. Sometimes cartels may be more disadvantageous than monopoly in terms of efficiency, as there may be less scope for economies of scale given the relatively smaller size of each individual oligopolist and high cost maybe involved in extensive advertising. On the other hand, oligopolists could choose not to collude and compete with their rivals to gain a bigger share of industry profits for themselves. If there is some degree of competition or if barriers to entry are weak, oligopoly may provide more social benefits over other market types. For example, like in the monopoly case, they could use the supernormal profit they

have earned for research and development in new technology, and oligopolists have a considerable incentive to improve efficiency due to competition. Additionally, non-price competition through product differentiation may lead to wider range of choices for consumers.

2.5 Contestable markets and the optimal competitive structure for banking market

Economists, like Baumol, Panzar, and Willig (1982), Panzar (1987) and Stigler (1987), have developed the theory of contestable markets, which addresses the importance of the potential competition rather than actual competition. This theory argues that what is crucial in determining price and output is not whether an industry is actually monopoly or competitive, but whether there is threat of potential competition. The threat of competition has a similar effect to actual competition. A market is perfectly contestable when the costs of entry and exist by potential rivals are zero, and such entry can be made very rapidly. In such cases, when the possibility of earning supernormal profit occurs, new firms will enter, thus driving profits down to the normal level. The threat of entry will ensure that the firm already in the market behave as if they were under perfect competition, otherwise new entries would take place, and potential competition would become actual competition. The more contestable the market, the more will a monopoly be forced to produce at low cost and charge low price to the consumers, and hence more efficiency to the society. The theory of contestable markets breaks down the basic assumptions about the link between number of firms or concentration with market competitiveness. Competitive outcomes can be achieved under several circumstances, even in a very concentrated

market, whereas collusive behaviour can happen even when a large number of firms exist.

The optimal competitive structure is always a debatable question, especially for banking market. In a competitive market, banks are price-takers and maximise profit by supplying the greatest quantity of credit and minimising costs. On the other hand, banks with market power can charge a price above its marginal cost level and make supernormal profit; as a result they are normally better capitalized to withstand shocks and relatively more stable. However, the market ends up with less available quantity of credit and at a higher price.

Much of the literature may support that the perfect competition is an ideal market structure, as competitive market is more efficient and could promote economic growth. But as argued by Northcott (2004) that some degree of market power, hence profitability may help maintain stability in the financial sector[73]. The trade-off between economic growth and financial stability highlights that both of the two extremes of market structure could have positive implications, and neither of perfect competition nor pure market power is ideal for the banking market. What may be preferred is "something in-between", an environment that could promotes efficiency and minimise the social cost of market power, meanwhile maintain the stability through profits obtained from any residual market power. Such a market may satisfy the definition of "contestability". Documented by Barth, Caprio and Levine (2004), bank efficiencies are natively related to the level of entry barriers. Tighter entry requirements may lead to high interest margin and high overhead cost, and restrictions

[73] See Padoa-Schioppa (2001) and Northcott (2004) for more detailed reviews on this point,

on foreign participation tend to increase fragility of banking system. These results are consistent with the contestability theory, and emphasize that it is the threat of potential entry that determines banks efficiency and financial stability.

3. Measuring market structure and competition in banking markets

The degree of competition and market structures are empirically tested by using various methods, which could be divided into two major streams: the traditional structural approach and the newly emerged non-structural approaches, which are based on the classic Industrial Organization (IO) theory and New Empirical Industrial Organisation (NEIO) approach correspondingly.

3.1 The structural approaches

Most of the early studies in banking use structural approach, such as structure-conduct-performance (SCP) paradigm. In this model, banks' conduct is determined by market structure which is assumed exogenous, and the combination of market structure and conduct influences banks' performance, normally measured by the price of a particular product or banks' profitability. The one-way causal relationship is empirically tested by regressing profitability measures on the concentration ratio and other control variables. A positive relationship between the concentration ratio and firm's profits indicates that banks operating in concentrated market with greater market power could exercise less competitive pricing behaviour

and generate higher profits. Early empirical applications of SCP approaches in banking mainly use U.S. data and often find the expected positive relationship between bank profits and market concentration. Such studies include Berger and Hannan (1989), who found that higher concentration leads to lower deposit rates for US banks from 1983-1985; Hannan (1991) found that higher concentration ratios result in higher interest rate charged on loans[74].

The SCP paradigm has been criticised in many aspects. Many researchers argued that the strong assumption of exogenously shaped market structures and the one-way causality from market structure to banks' performance distort the validity of the model specification, for example, Scherer (1980), Gilbert (1984), Tirole (1988), and Vesala (1995). Apart from the questionable strong assumption of exogenous market structures, the microeconomic foundation for this positive relationship is weak[75], and could be undermined easily by other theories. For example, in the context of contestable markets mentioned earlier, under the threats of free entry and potential competition, even a monopoly bank would price at competitive level. Price competition between non-collusive oligopolists would also lead to efficient outcomes. Bikker and Haaf (2000) also pointed out that the empirical applications of SCP paradigm to the banking industry often do not explicitly involve bank conduct measurements and only concentrate on the structure-performance relationship.

The shortcomings of SCP paradigm, was firstly challenged by another structural method, which is called efficient-structure hypothesis (ESH), raised by Demsetz

[74] Weiss (1989) provides a review of the early literature.
[75] Bikker and Haaf (2000) presented some theoretical derivation of the positive relationship between market concentration and market performance, but valid under strong assumptions.

(1973) and Peltzman (1977). This theory suggests that the reason why some firms could make super-normal profits over others is because they were more efficient in production and hence were able to acquire larger market share, which leads to concentration. Therefore, it is the market share, which reflects firm-specific efficiency, rather than concentration ratio that should be directly correlated with profitability, and also the concentration is not a direct indicator of market power. Unlike SCP paradigm, this model assumes endogenous market structure, which is formed as a result of exogenous firm-specific efficiencies, and the concentration is a result of efficiency instead of collusion behaviours.

Although both SCP and ESH approaches are largely empirical, applying them to the banking industry incurs several difficulties. The specification and measurement problems are obvious. Many studies use the price of a particular banking product, which ignores cross-subsidisation between different products of a bank, as a measure of bank performance. Others use profitability measures, such as banks' return rate, which consolidates profit and loss from multiple products of individual bank into one single measure, however the profitability is also a poor measure of market power. Theoretically, market competitiveness is characterised by firm's pricing behaviour, i.e. the deviation of output price from marginal cost. The actual profit may be affected by demand and supply of substitute products from other financial institutions or other geographical markets. But the identification of substitutes market and geographical market is particularly difficult for banking industry, where many differentiated and substitutable products are available and some of them are provided by non-bank financial institutions or even non-financial institutions (Northcott, 2004).

Although early studies found the expected relationship between bank profitability and concentration, the results were less convincing when control for factors like differences in bank specific efficiencies and other environmental variables. Later studies using this method normally provide mixed results. Berger (1995) controlled the difference in X-efficiency between banks to distinguish between the SCP and ESH, and found results in contradiction with both theories; concentration is usually negatively related to profits, and the positive relationship between efficiency and profits is also weak. Another study by Punt and Van Rooij (2001), using European banking data, also provide mixed results. The positive relationship between concentration and profitability was not robust to different specifications of profitability measurement. Demirgüç-Kunt, Laeven and Levine (2004) controlled for regulatory policies in a cross-country context, and found that the positive effect of concentration on bank interest margins becomes insignificant.

3.2 The non-structural approaches

New empirical industrial organization (NEIO) theories challenge the theoretical and empirical problems of traditional structural approaches, and examine the market structure directly through the firms' price-marginal cost margin without including any explicit market structure measurement. Vasala (1995) highlights three important aspects that distinguish NEIO from SCP and ESH. One, NEIO assumes that firms' price-marginal cost margin cannot be directly observed from data; instead, it can only be estimated through an economic cost function or proxied by reasonable measurements. Two, unlike the SCP and ESH, which are largely empirical exercises, the estimated equation under NEIO are always derived directly from the economic

imperfect competition theory. The inference about the market structure is precise and the alternative hypothesis can be specified explicitly. Three, NEIO studies typically only concern a single industry. Two most important techniques in NEIO studies include Bresnahan-Lau (BL) mark-up model , developed by Bresnahan (1982) and Lau (1982), and Panzar-Rosse (PR) reduced-form revenue model developed by Rosse and Panzar (1977) and Panzar and Rosse (1982, 1987)[76]. Since both methods are rooted in the profit-maximizing equilibrium first-order conditions, their test-statistics are systematically related to each other, and under certain conditions, they are also related to additional measures of competition, such as the Lerner index[77], through the demand elasticity measures (Shaffer, 1982, 1983).

3.2.1 Bresnanhan-Lau (BL) model

The BL mark-up model assesses market competitiveness through the difference between firms' perceived marginal revenue and the demand price. Given the profit maximising condition that marginal cost equals to marginal revenue, in equilibrium, competitive firms would set the price just at the marginal cost level, which equals to marginal revenue; however firms with market power would not do so, and the marginal revenue and the demand price would be different. A test statistic, λ, ranging from 0 to 1, is calculated to measure the deviations from marginal cost of firms' pricing behaviour. A value of 0 for λ indicates the firms is pricing at marginal cost

[76] The Iwata model, Iwata (1974), is also a popular approach of NEIO, but has not been used in banking industry extensively. Only very few studies of banking industry use this approach, for example, Shaffer and DiSalvo (1994).

[77] The conventional Lerner Index of market power measures the disparity between price and marginal cost as a percentage of the price, and is calculated as (P-MC)/P.

level and hence operating in a perfect competitive market, and value of 1 indicates that the market is a monopoly or perfect collusive market.

One of the earliest BL model applications in banking industry is provided by Shaffer (1989), who found the US banking market, in a long period of 1941-1983, is consistent with perfect competition, and collusive conduct is strongly rejected. In his later work Shaffer (1993), he found that from 1965 to 1989, the Canadian banking market was also consistent with perfect competition structure although concentration level was relatively high, and changes of the Bank Act has improved competition after 1980. In Shaffer (2001), he estimated conduct and excess capacity of the banking industry in 15 industrialized countries in different regions all over the world during 1979-91. Results are mixed for different countries, significant market power was found in five countries and the market is more competitive in other countries. Gruben and McComb (2003) applied the same method to Mexican banking market, and found that the output prices were set below the marginal cost level before 1995. They described this situation as "super-competitive" market.

3.2.2 Panzar-Rosse (PR) model

In this chapter, banking market competitiveness of ASEAN countries are examined country by country using one the most popular non-structural approach, the Panzar-Rosse (PR) model. Unlike the BL model, which is usually applied to aggregate industry data, the PR model utilises firm-specific data, allowing for differences in production function of specific firms, to investigate the relationship between input factor prices and firm's revenue, without requiring information on

equilibrium output price and quantities of the industry. The BL model also has the drawback of producing anticompetitive bias if the sample fails to span complete markets (Shaffer 2001), and in the context of cross-country samples, failure in correcting cross-border competition may result in misleading estimates. The PR model, on the other hand, only uses the firm-level reduced form revenue information, and does not require a specific regional market definition, and is more appropriate for the analysis carried out in this chapter.

Studies using the Lerner Index to measure banking market competitiveness are also popular[78], however the Index is normally applied in a single output context. Studies of this kind usually only concern the traditional banking activity, and take earning assets as the only output. The modern banking business has grown in both scale and scope, the non-traditional off-balance sheet activities has become more and more important, and the single output market power measure may provide limited information of actual competitiveness. Additionally, unlike the PR model, which provides a statistic derived from the general equilibrium condition of profit-maximising, the Lerner Index is only a partial equilibrium measurement of firms' market power, and maybe affected by other conditions, such like firms cost structure and risk preference (Freixas and Rochet, 1997). Given the complexity in the economic environment, Lerner Index may be an incomplete indicator of market power.[79]

The PR model examines the extent to which changes in input factor prices are reflected in (equilibrium) revenues of a specific firm. The key argument is that, an

[78] For example, Kubo, K. (2006). Turk Ariss (2010), and Weill (2011)
[79] The Lerner Indices are also calculated for the ASEAN banking markets, using the marginal cost of loans derived from the cost function estimated in Chapter 3. Results are reported in Appendix B.

increase in input factor prices will increase the marginal cost for all kind of firms, but the reactions to this change is different in different type of markets. In perfect competitive market or contestable market, the marginal revenues will increase by the same amount as marginal costs so that the zero economic profit is still maintained. With free entry condition, the market ends up with fewer firms, each of which still supplies the same amount of product but with a higher price. Therefore for firms remaining in the industry, the total revenue should increase proportionally with the increase in factor prices. On the other hand, monopoly or perfect collusions with full market power would bear all the reduction in equilibrium output demand due to increases in price, and the total revenue is reduced in this case.

The empirical test is based on the comparative static properties of reduced form revenue equations in terms of inputs factor prices and other control variables. The test statistic, H, is calculated as the sum of elasticities of revenue with respect to each input price. Perfect competition is characterised by $H=1$ and $H\leq 0$ indicates monopoly or collusive behaviours, values in between indicate monopolistic competition. Under certain conditions, the magnitude of H-statistic can be interpreted as a measure of the degree of competition. The PR model is better designed to work with firm-specific data, also as pointed by Shaffer (2004), it has another advantage over BL model. The BL model estimates are more like to show an anticompetitive bias in small samples, but the PR approach provides robust results in small sample case. Nevertheless, there are limitations and problems with this widely-used approach[80].

[80] See section 4 for more discussion on the problems associated with the empirical applications of PR approach.

Empirical applications of PR approach to banking industry starts from Shaffer (1982), who estimated the *H*-statistics for New York banks in 1979 and find monopolistic competition. Other early studies are mainly based on developed countries too. Nathan and Neave (1989), who concluded that the Canadian banking industry was characterised as monopolistic competition between 1982 and 1984, and perfect competition could not be rejected in 1982. Similar results are found for other financial institutions. Heffernan (1993) is one of the earliest studies on UK banking market, which examined competition in retail banking in the 1980s, and the situation of 1990s was examined in his later work Heffernan (2002). The findings suggested that the UK retail banking market was best characterized as monopolistic competition. A more recent work by Matthews *et al.* (2007) estimated the *H*-statistic for 12 UK major banks over the period 1980-2004 and also found monopolistic competition for the UK banking market and less intense competition for non-core (off-balance sheet) banking business. Single country studies on developed countries also include Vesala (1995) who evaluated market structure for Finnish banking market and found monopolistic competition for 1985-1988 and 1991-1992, but perfect competition for the period of 1989-1990. Molyneux *et al.* (1996) examined Japanese commercial banking market, and found monopoly or conjectural variations short-run oligopoly in 1986 and monopolistic competition in 1988.

Several multiple-developed country studies have also been found in the literature. Molyneux *et al.* (1994) applied the PR approach to a sample of German, UK, French, Italian, and Spanish banks over period 1986-1989, and suggest monopoly for Italy and monopolistic competition for other countries. Bikker and Groeneveld (2000) found monopolistic competition of varying degrees for 15 EU countries' banking market

from 1989 to 1996. De Bandt and Davis (2000) found monopoly behaviour for small banks in France and Germany while monopolistic competitions are found for small banks in Italy and for large banks in all three countries for the period 1992-1996. Bikker and Haaf (2002) found, in general, monopolistic competition is the best description for banking markets in 23 industrialised countries over 1988 to 1999, but degree of competitiveness varies between big banks and small banks in different countries. They also found a negative relationship between competitiveness and concentration, which support the contestability theory, although the relationship is weak. Another recent study by Casu and Girardone (2009b) tested degree of competition for the 5 largest EU banking markets for the period 2000-2005, using both structural (HHI) and non-structural (PR model) approaches. They found that the deregulation and market integration processes have not increased the competitive pressure and the EU banking market become more concentrated, and the concentration is not necessarily a good proxy for competition.

Empirical studies on developing counties and transition economies using the PR model are relatively few but increasing. Studies again find mostly evidence for monopolistic competition. Belaisch (2003) evaluated the Brazilian banking market and found evidence of non-monopolistic market structure. Yildirim and Philippatos (2007) examined the competitive conditions in the banking industries of 11 Latin American countries for the period 1993–2000. They found monopolistic competition is the best market type to describe the banking industry in those countries, however a decline in competition for Brazil, Chile, and Venezuela in late 1990s due to increased consolidation was observed. Al-Muharrami *et al.* (2006) investigated the banking market structure of Arab Gulf Cooperation Council (GCC) countries during the period

of 1993-2002 and also found evidence for monopolistic competition in general, but there was considerable variation between countries.

A notable comprehensive cross-country study using PR approach in the literature is Claessens and Laeven (2004). They estimated the degree of competitiveness for 50 countries consisting of both industrialised countries and developing/transitional countries, of which three countries (Indonesia, Malaysia and the Philippines) were also included in the present study. They found the *H*-statistics of each country over the period 1994 to 2001are all in the range of 0.60 to 0.80, therefore "monopolistic competition" is the best description for the banking market in those countries. They are also relate the competitiveness measures to several factors and try to identify the factors that influence banking market competitiveness, and found that the competitiveness indicator is positively related to concentration indicator and foreign bank entry, but negatively related to entry and activity restrictions. This result supports the contestability theory. A very recent study, Olivero *et al.* (2011) investigated how the banking market competitive structure affects the monetary implementation through the bank lending channel in 10 Asian countries (including all 5 sample countries in the present study) and 10 Latin American countries over the period 1996-2006, and found increased competition in banking industry weakens the effectiveness of monetary policy. Their GMM[81] estimates for PR *H*-statistic provide similar information as the results in the present study; Singapore has the most competitive banking market and Thailand has the least competitive banking market among the 5 countries selected.

[81] The dynamic GMM estimator for PR model will be discussed later in section 4.4.

4. Methodology

4.1 The basic Panzar-Rosse (PR) model

Rosse and Panzar (1977) and Panzar and Rosse (1987) developed a very general test for market structures through testable restrictions on the firm's reduced form revenue equation, that satisfies the general profit maximising conditions of any firm. In banking firm theory, banks are treated as normal profit maximising firms and therefore follow the general profit maximising rule, which is that the profit is maximised when marginal revenue equals marginal cost. Using non-parametric notations, the relationship can be presented in the following way:

$$R_i'(y_i, z_i) = C_i'(y_i, w_i, t_i) \qquad (5.1)$$

R_i' and C_i' are the first order differentiations of bank *i*'s revenue (R_i)[82] and cost (C_i) functions, i.e. the marginal revenue and marginal cost of bank *i*. A narrower definition of y_i could be simply the level of outputs, but could also include output prices, advertising costs *etc.*, which are decision variables that affect bank *i*'s revenue and cost. w_i represents the vector of input factor prices that are given to the bank. z_i and t_i are vectors of exogenous shift variables in the revenue and cost functions, and they may or may not contain the same variables.

[82] In monopolistic competition case, the revenue function is also affected by the number of firms, *n*, of which the equilibrium value is also a function of exogenous variables, w_i, z_i and t_i.

For competitive outcomes under either perfect competition or Chamberlinian equilibrium of monopolistic competition, the market sustains zero economic profit in equilibrium:

$$R_i^*(y_i^*, z_i) - C_i^*(y_i^*, w_i, t_i) = 0 \qquad (5.2)$$

Where the asterisks (*) denote the equilibrium level of each variable. Employ equation (5.1) and substitute out the endogenous variable y_i^* , a reduced-form revenue equation could be derived in terms of input factor prices and other exogenous variables only, i.e. $R_i^*(w_i, z_i, t_i)$ [83]. The Panzer-Rosse *H*-statistic is defined, in a *J* input factors case, as the sum of factor price elasticities of the reduced form revenue equation.

$$H = \sum_{j=1}^{J} \frac{\partial R_i^*}{\partial w_{ij}} \frac{w_{ij}}{R_i^*} \qquad (5.3)$$

This *H*-statistic measures the extent to which total revenue response to a change in input factor prices. According to the theorem and two propositions of Panzar and Rosse (1987), the *H*-statistic for a monopolist must be nonpositive, indicating an increase in input factor prices will reduce bank's total revenue. The monopoly case is a very generalised result and requires nothing more than the profit maximising hypothesis. In symmetric Chamberlinian equilibrium, the *H*-statistic is less than or equal to unity, indicating reduction in revenue is less than proportion with the increases in input prices. The *H*-statistic equals to unity when the banking market is in

[83] Bikker and Haaf (2002) provides a parametric illustration of this deriving process.

long-run competitive equilibrium, implying bank's total revenue will increase by exactly the same amount as costs. Panzar and Rosse (1987) also attempted a model for oligopoly, and showed that the *H*-statistic is negative, however, there is no evidence of generality and in general the relationship is indeterminate.

The PR *H*-statistic is not only used to reject certain market types. Panzar and Rosse (1987) proves that, under the assumption of constant price elasticity of demand with constant return to scale Cobb-Douglas production technology, the *H*-statistic for a monopoly is a negative function of the price elasticity of demand, *e*, and equals to 1-*e*. Vesala (1995) proves that *H*-statistic is an increasing function of *e*, in the case of monopolistic competition. As the number of banks increases, the demand elasticity increases till the perfect elastic bank facing demand curve of perfect competition reached. Therefore, the magnitude of H-statistic is also of great interest and could be used as a measurement of competition. Table 5-1 summaries the corresponding market structure of each possible *H* values.

Table 5-1 Discriminatory power of H-statistic

Estimated H	Industry equilibrium/ Competitive environment
$H \leq 0$	Monopoly equilibrium(H is a decreasing function of the perceived demand elasticity) or Perfect cartel,
$0 < H < 1$	Monopolistic competition with free entry (Chamberlinian) equilibrium (H is an increasing function of the perceived demand elasticity).
$H = 1$	Perfect competition. Free entry equilibrium with full (efficient) capacity utilization.

4.2 Empirical model specification and variables

The PR model is empirically tested by estimating a log-linear form reduced form revenue function in terms of inputs factor prices and other exogenous variables as follows:

$$\ln R_{it} = \alpha_0 + \sum_{j=1}^{J} \alpha_j \ln W_{jit} + \sum_{k=1}^{K} \beta_k \ln Z_{kit} + \sum_{n=1}^{N} \gamma_n \ln X_{nt} + \mu_{it} \qquad (5.4)$$

This is a typical panel estimation model that contains observations of *i* banks over *t* periods, where $i = 1,2,...,I$ and $t = 1,2,...,T$. W_{jit} represents the price for j^{th} input for i^{th} bank in period *t*. The variables in *Z* are bank-specific exogenous variables that influence bank's revenue and cost functions. Some researchers think that other variables, such as macroeconomic variables may also exogenously affect bank's revenue through demand of credit, and therefore should be included in the reduce-form revenue equation. Those variables are included in the vector *X*.[84] The last term μ_{it} in the equation is a random error term. Since all terms are expressed in the natural log form, the coefficients α_j can be interpreted as the price elasticities of revenue, therefore the PR *H*-statistic is defined as the sum of the estimates for α 's:

$$H = \sum_{j=1}^{J} \alpha_j \qquad (5.5)$$

[84] For example, Matthews, K. *et al.* (2007)

Empirical estimation of the reduce-form revenue equation (5.4) involves variable selections. The typical dependent variables used the most often in the existing literature are interest revenues or total revenues including both interest revenue and non-interest revenue. Most studies, including many of the articles reviewed earlier in the present study[85], have chosen to scale the dependent variable by bank's total assets, or include a scale variable on the right-hand side of the equation to capture the economies of scale, such as natural logarithm of total assets. However, argued by Bikker *et al.* (2006), such practice may distort the nature of the revenue equation and lead to biased estimates of *H*-statistics. Bikker, Spierdijk and Finnie (2006) investigated the consequences of estimating a misspecified revenue equation under each market type and demonstrated that scaling the dependent variable or including scaling variables as explanatory variable would essentially transform the revenue equation into a price equation, since the resulting dependent variable is essentially the lending rate or 'price'. This misspecification would lead to a systematic bias of *H*-statistic towards unity under monopoly or monopolistic competition models. For this reason, in the present study, I choose to use the absolute (total) revenue measure rather than the relative revenue measurements which are scaled by bank's total assets and do not include any size/scale variable on the right-hand side of the equation.

The dependent variable used in the present study is total bank revenue (*TR*), including both interest revenue (*IR*) from the traditional bank business, and other operating income (*OYY*) accounting for the increasingly important non-traditional banking activities, such as fee-based products and other off-balance sheet activities. Following the intermediation approach of Sealey and Lindley (1977) that is used in

[85] Such as Shaffer (1982), Nathan and Neave (1989), Coccorese (2003), Claessens and Leaven (2004) among others.

Chapter 3 and 4, the input variables are still the number of employees (*LAB*), fixed assets (*FA*) and total deposits (*TD*), and their prices *PL*, *PFA* and *PD* [86]are included as the *W* variables in equation (5.4).

Three bank-specific control variables are included in the reduce-form revenue equation. The first bank-specific variable is bank cost efficiencies which are obtained in Chapter 3. According to the ESH, higher efficiency improves bank's profitability to acquire market share, and hence higher market concentration. On the other hand, competition is normally treated as encouragement to foster efficiency in standard economic theory. The empirical evidence also provides mixed results on the relationship between competition and efficiency, especially for banking markets[87]. To account for the effects of bank efficiency level, Casu and Girardone (2006) introduced non parametric DEA efficiency measures into the reduced form revenue equation as a control variable capturing bank's managerial ability, and estimated the PR *H*-statistics for 15 EU countries. They found that including the efficiency measures generally reduces the estimates of *H*-statistics for EU banking markets, but the change is not statistically significant. Since the sample used in this chapter consist of the same banks as those used in Chapter 3 for bank cost efficiency estimations, following Casu and Girardone (2006), I utilise those (normalised) efficiency estimates (*EFF*)[88] obtained in Chapter 3 and use them as one bank-specific control variable in the revenue equation.

[86] See section 4 of Chapter 3 for detailed calculation methods of the input prices.
[87] E.g. Claessens and Laeven (2004), Casu and Girardone (2009a).
[88] The efficiency estimates obtained in Chapter 3 were estimated against a common-frontier, covering all 5 countries and multiple periods for comparison purpose. Here the efficiency scores are normalised by the best-practice bank of each country in each period.

Other bank-specific variables include the ratio of deposits to loans (RD/L) measuring the leverage and the ratio of loans to assets (RL/A) measuring the loan intensity, and these two ratios could be used as a bank's risk preference measurement. Despite the profit situation which may also concerning cost minimisation, the revenue of a bank, especially the interest income is expected to positively correlated with leverage and loan intensity ratio. Bank's revenue and profitability are also very sensitive to the macroeconomic environment, as the demand for banking services and credit is closely related to the business cycle. I include the growth rate of GDP (ΔGDP_{it}) to capture the effect of macroeconomic variations. The one period lagged GDP growth rate ($\Delta GDP_{i,t-1}$) is also included as the repayment of loans and interest payments may last for more than one period and may be affected by the economic situation in previous periods too. The equation estimated for each country is as following:

$$\begin{aligned}\ln TR_{it} &= \alpha_0 + \alpha_1 \ln PL_{it} + \alpha_2 \ln PFA_{it} + \alpha_3 \ln PD_{it} + \beta_1 \ln EFF_{it} + \beta_2 \ln \mathrm{RD/L}_{it} \\ &\quad + \beta_3 \ln \mathrm{RL/A}_{it} + \gamma_1 \ln \Delta GDP_{it} + \gamma_2 \ln \Delta GDP_{it-1} + \mu_{it}\end{aligned} \tag{5.6}$$

and the PR H-statistic is defined as

$$H = \alpha_1 + \alpha_2 + \alpha_3 \tag{5.7}$$

To allow for bank-specific heterogeneity, equation (5.6) is estimated by GLS with cross-sectional fixed effects panel estimation method.

4.3 Long-run market equilibrium test

The validity of PR model and its *H*-statistic depends heavily on the market equilibrium assumption. The predicting power of *H*-statistic is only valid, especially for monopolistic and perfect competition type of market, when the market is in long-run equilibrium. This assumption can be tested empirically by estimating a reduce-form profit equation. The idea of this test is that the (risk-adjusted) rates of return on assets across banks should be equalised under the competitive pressure and no bank can make supernormal return in equilibrium. Therefore the rate of return should not be affected by changes in input prices, if the market is in long-run equilibrium. This test is usually based on an equation that replaces the dependent variable in equation (5.4) with pre-tax profit measurements, e.g. return on assets (ROA), as following:

$$\ln \pi_{it} = \alpha_0' + \sum_{j=1}^{J} \alpha_j' \ln W_{jit} + \sum_{k=1}^{K} \beta_k' \ln Z_{kit} + \sum_{n=1}^{N} \gamma_n' \ln X_{nt} + \varepsilon_{it} \qquad (5.8)$$

Where π is the pre-tax profit measure, and every other variables are still the same as defined in equation (5.4). The test statistic, *E*, is defined as the sum of the price elasticities of profit with respect to each input factor price:

$$E = \sum_{j=1}^{J} \alpha_j' \qquad (5.9)$$

As *E*-statistic measures the sensitivity of pre-tax profit with respect to the input factr prices, when E=0, the market is in long-run equilibrium; while E<0 implies the market disequilibrium in which increases in factor price would lead to decrease in

profit. This market equilibrium test has been widely used in many studies, for example, Shaffer (1982), Claessens and Laeven (2004), *etc.*

In this chapter, the dependent variable used in the profit equation is adjusted return on assets (*ROA*). In the case of negative profits, i.e. accounting losses, the *ROA* could take small negative values, which raises difficulty in the transformation of natural logarithm. To deal with this problem, following Claessens and Laeven (2004) among others, the dependent variable (ROA^*) is adjusted, such as ROA^* =1+ROA. All explanatory variables on the right-hand side are the same as those used in equation (5.6), and the equation is also estimated by GLS with cross-sectional fixed effects panel estimation method:

$$\begin{aligned}\ln ROA^*_{it} &= \alpha_0' + \alpha_1' \ln PL_{it} + \alpha_2' \ln PFA_{it} + \alpha_3' \ln PD_{it} + \beta_1' \ln EFF_{it} \\ &+ \beta' \ln \mathrm{RD/L}_{it} + \beta_3' \ln \mathrm{RL/A}_{it} + \gamma_1' \ln \Delta GDP_{it} + \gamma_2' \ln \Delta GDP_{it-1} \\ &+ \varepsilon_{it}\end{aligned} \tag{5.10}$$

and the *E*-statistic is the sum of the coefficients on logarithms of input prices:

$$E = \alpha_1' + \alpha_2' + \alpha_3' \tag{5.11}$$

4.4 GMM dynamic estimation under market disequilibrium

A natural question to ask after testing the long-run market equilibrium is that what if the market is not always in equilibrium when the data are observed? Particularly for transitional economies, like the sample countries in the present study,

the PR model may not be able to provide a good indicator for the market competitiveness if the adjustment towards market equilibrium is not instantaneous. (Northcott, 2004).

This issue has been discussed thoroughly in a recent paper by Goddard and Wilson (2009). They demonstrated that, by using a Monte Carlo simulation exercise, the fixed effect panel estimation of the PR model tends to produce biased *H*-statistics towards 0, when the data generating process is in partial adjustment towards market equilibrium. They suggested that for unbiased *H*-statistic estimates when market is off equilibrium, one should apply an appropriate dynamic panel estimator, such as Arellano and Bond's (1991) generalized method of moments (GMM) procedure, by including a lagged dependent variable on the right-hand side of the reduce-form revenue equation[89]. Also the speed of adjustment towards equilibrium can be directly assessed through the coefficient estimates on the lagged depend variable. As argued in their study, "this eliminates the need for a market equilibrium assumption, but still incorporates instantaneous adjustment as a special case".

In this chapter, this recommendation is used with caution, and only used when strong evidence of market disequilibrium is found. The equation with the dynamic adjustment is as following, which is estimated by Arellano and Bond's (1991) GMM procedure:

[89] In Goddard and Wilson (2009), whey also suggest that the dynamic adjustment should be made to profit equation too when testing market equilibrium. However, I think this is not necessary since the validity of E-statistic does not depend on the market long-run equilibrium assumption.

$$\begin{aligned}\Delta \ln TR_{it} &= \alpha_0'' + \alpha_1''\Delta \ln PL_{it} + \alpha_2''\Delta \ln PFA_{it} + \alpha_3''\Delta \ln PD_{it} + \beta_1''\Delta \ln EFF_{it} \\ &+ \beta_2''\Delta \ln \mathrm{RD/L}_{it} + \beta_3''\Delta \ln \mathrm{RL/A}_{it} + \gamma_1''\Delta \ln \Delta GDP_{it} + \gamma_2''\Delta \ln \Delta GDP_{it-1} \\ &+ \eta\Delta \ln TR_{it-1} + \Delta\mu_{it}\end{aligned} \tag{5.12}$$

where parameter η is the so-called "persistence coefficient", which measures the adjustment speed towards market equilibrium and plays a crucial role in estimating unbiased *H*-statistic. The cross-bank fixed effects are eliminated by using first-order differences of all variables. The GMM estimator for unbiased *H*-statistic under market disequilibrium is defined as:

$$H' = (\alpha_1'' + \alpha_2'' + \alpha_3'')/(1-\eta) \tag{5.13}$$

5. Data

The data used in this chapter are drawn from the same sample of banks and countries that are used for Chapter 3, containing 1889 bank-year observations from 5 core member countries of ASEAN over the period 1994-2009. Unlike Chapter 3, where a meta-frontier is estimated using cross-country and cross-time pooled data, estimations in this chapter are carried out country by country. Therefore, data in Chapter 3 are adjusted by the PPP exchange rate and converted to a same currency measure (US$), but in this chapter, the data are only adjusted by own country GDP deflator and leave the data still denoted in own country currency. The difference in purchasing power of currencies does not affect the separate country estimations. The numbers of observation for each country in each year are also reported in Chapter 3, Table 3-1. In fact, many variables used in this chapter are used in Chapter 3 too, such as the input factor prices, price of labour (*PL*), price of fixed assets (*PFA*) and price of deposits (*PD*). One of the bank-specific variable included in the present chapter, cost efficiency scores (*EFF*), is the result of Chapter 3 and growth rate of GDP (ΔGDP) is also an environmental variable used in Chapter 3. The basic information on the sample data, input price variables' calculation method and data treatments are detailed in section 4 of Chapter 3, therefore, are not repeated in the present chapter.

There are few variables that did not appear in Chapter 3, but were introduced and discussed in the model specification section earlier. These variables include: the dependent variable of reduce-form revenue equation, total bank revenue (*TR*), which is the sum of total interest revenue (*IR*) and other operating income (OYY)[90]; the

[90] OYY is also used in Chapter 3 as an output.

dependent variable of the profit function, (adjusted) return on assets (*ROA*); bank-specific ratio of deposits to loan ($R_{D/L}$) and of loans to total assets ($R_{L/A}$). Table 5-2- Table 5-6 provide snapshots of all variables used in this chapter for each country. Apart from the descriptive statistics of variables for the whole sample period, Table 5-2- Table 5-6 also present data summaries for the first 5 years (1994-1998) and last 5 years (2005-2009) of each county in order to show the time evolutions in these variables.

Table 5-2 Statistical data description – Indonesia

	1994-2009				1994-1998				2005-2009			
	Mean	S.D	Min.	Max.	Mean	S.D	Min.	Max.	Mean	S.D	Min.	Max.
Dependent variable												
TR	3105	6290	22	51815	3170	5884	50	28968	2923	5135	27	24297
ROA	-0.39	11.24	-112.21	71.32	-3.63	17.45	-112.21	19.75	1.37	5.13	-72.47	8.93
Input Prices												
PL	0.14	0.12	29.01	1316.83	0.15	0.13	0.03	1.02	0.13	0.12	0.03	1.32
PFA	2.98	7.94	-1.50	121.50	3.19	7.54	0.14	81.38	2.05	1.99	0.16	10.86
PD	0.14	0.26	0.00	4.57	0.25	0.31	0.04	2.69	0.06	0.02	0.00	0.12
Bank-specific variable												
EFF	0.94	0.06	0.48	1.00	0.94	0.05	0.75	1.00	0.93	0.07	0.48	1.00
$R_{D/L}$	2.19	5.84	0.07	101.13	1.12	0.98	0.07	8.09	1.54	0.65	0.54	5.17
$R_{L/A}$	0.53	0.20	0.01	0.93	0.65	0.17	0.08	0.93	0.56	0.15	0.05	0.85
Macroeconomic variable												
ΔGDP	3.96	4.98	-13.13	8.22	2.24	8.67	-13.13	8.22	5.65	0.58	4.55	6.35

**TR* and *PL* are measured in bil.IDR. 2005=100

Table 5-3Statistical data description – Malaysia

	1994-2009				1994-1998				2005-2009			
	Mean	S.D	Min.	Max.	Mean	S.D	Min.	Max.	Mean	S.D	Min.	Max.
Dependent variable												
TR	2147	4676	18	40952	1200	1654	22	12236	3098	6197	18	40952
ROA	1.09	1.29	-7.79	7.89	0.98	1.43	-5.99	5.08	1.12	0.62	-0.98	2.45
Input Prices												
PL	0.14	0.28	0.02	3.01	0.22	0.47	0.02	3.01	0.10	0.06	0.02	0.35
PFA	1.95	2.25	-0.29	15.97	1.16	1.16	0.24	9.51	2.66	2.62	-0.29	14.42
PD	0.17	0.98	0.00	9.39	0.06	0.02	0.01	0.13	0.24	1.17	0.00	8.58
Bank-specific variable												
EFF	0.90	0.17	0.01	1.00	0.96	0.04	0.80	1.00	0.85	0.23	0.01	1.00
$R_{D/L}$	2.09	2.21	0.33	24.59	1.37	0.34	0.83	2.87	3.20	5.68	0.15	52.73
$R_{L/A}$	0.53	0.20	0.00	1.61	0.60	0.11	0.24	0.82	0.47	0.24	0.00	1.61
Macroeconomic variable												
ΔGDP	5.11	4.41	-7.36	10.00	5.52	6.87	-7.36	10.00	4.14	2.98	-1.71	6.48

**TR* and *PL* are measured in mil.MYR. 2005=100

Table 5-4 Statistical data description – the Philippines

	1994-2009				1994-1998				2005-2009			
	Mean	S.D	Min.	Max.	Mean	S.D	Min.	Max.	Mean	S.D	Min.	Max.
Dependent variable												
TR	10256	11097	115	50726	11552	11824	241	50726	9697	10742	115	50475
ROA	1.05	2.32	-12.80	31.61	1.70	1.49	-8.72	5.20	0.77	2.55	-12.80	31.61
Input Prices												
PL	0.55	0.29	0.15	3.07	0.55	0.19	0.15	1.07	0.55	0.32	0.21	3.07
PFA	1.46	1.64	0.15	13.83	1.07	1.02	0.20	7.96	1.63	1.82	0.15	13.83
PD	0.06	0.23	0.01	4.60	0.07	0.02	0.01	0.14	0.06	0.28	0.01	4.60
Bank-specific variable												
EFF	0.92	0.09	0.10	1.00	0.92	0.07	0.69	1.00	0.92	0.10	0.10	1.00
$R_{D/L}$	2.09	2.21	0.33	24.59	1.61	0.92	0.86	7.92	2.29	2.55	0.33	24.59
$R_{L/A}$	0.46	0.14	0.03	0.81	0.54	0.13	0.10	0.81	0.42	0.13	0.03	0.71
Macroeconomic variable												
ΔGDP	5.21	2.67	-0.58	12.41	3.74	2.44	-0.58	5.85	5.84	2.52	3.40	12.41

**TR* and *PL* are measured in mil.PHP. 2005=100

Table 5-5 Statistical data description – Singapore

	1994-2009				1994-1998				2005-2009			
	Mean	S.D	Min.	Max.	Mean	S.D	Min.	Max.	Mean	S.D	Min.	Max.
Dependent variable												
TR	1703	2117	14	7616	1597	1305	33	4574	2142	2720	14	7616
ROA	1.44	1.68	-0.77	13.23	1.04	0.66	-0.77	2.43	1.40	1.35	-0.03	6.82
Input Prices												
PL	0.08	0.06	0.00	0.36	0.05	0.04	0.00	0.17	0.08	0.05	0.02	0.27
PFA	3.90	6.15	0.27	36.00	1.49	1.96	0.28	7.17	5.03	7.42	0.27	36.00
PD	0.03	0.01	0.00	0.07	0.04	0.01	0.00	0.05	0.02	0.01	0.00	0.04
Bank-specific variable												
EFF	0.93	0.17	0.11	1.00	0.99	0.01	0.93	1.00	0.85	0.24	0.11	1.00
$R_{D/L}$	1.76	0.88	0.44	6.26	1.72	0.62	0.92	3.84	1.77	1.12	0.44	6.26
$R_{L/A}$	0.52	0.18	0.13	0.93	0.53	0.11	0.25	0.78	0.53	0.21	0.13	0.87
Macroeconomic variable												
ΔGDP	5.43	4.28	-2.39	11.40	6.26	4.79	-1.38	11.40	5.06	4.12	-1.28	8.64

**TR* and *PL* are measured in mil.SGD. 2005=100

Table 5-6 Statistical data description – Thailand

	1994-2009				1994-1998				2005-2009			
	Mean	S.D	Min.	Max.	Mean	S.D	Min.	Max.	Mean	S.D	Min.	Max.
Dependent variable												
TR	27562	31220	24	177937	39544	41962	1418	177937	25085	25410	126	93000
ROA	-0.45	5.28	-34.17	28.16	-1.85	6.89	-34.17	2.87	0.52	1.76	-6.42	4.13
Input Prices												
PL	0.51	0.19	0.01	1.28	0.47	0.14	0.11	0.80	0.54	0.20	0.18	1.28
PFA	1.22	3.05	0.06	45.50	0.84	1.98	0.21	17.60	1.18	0.95	0.06	4.73
PD	0.05	0.04	0.00	0.17	0.10	0.03	0.06	0.17	0.03	0.01	0.01	0.05
Bank-specific variable												
EFF	0.96	0.06	0.23	1.00	0.97	0.03	0.84	1.00	0.95	0.09	0.23	1.00
$R_{D/L}$	1.29	0.87	0.53	12.94	1.02	0.15	0.53	1.40	1.23	0.32	0.69	2.21
$R_{L/A}$	0.70	0.15	0.06	0.98	0.82	0.06	0.56	0.98	0.68	0.13	0.29	0.90
Macroeconomic variable												
ΔGDP	3.46	4.73	-10.51	9.24	1.97	7.69	-10.51	9.24	3.03	2.85	-2.25	5.57

**TR* and *PL* are measured in mil.THB. 2005=100

The 5 countries exhibit very much different changing patterns over time. Having adjusted inflation, total revenues are only higher in the last 5 years in two countries, i.e. Malaysia and Singapore. However, the rates of return on assets are higher in recent years for most of the countries, with the only exception of the Philippines. The bank-specific variables present relatively consistent patterns across countries, that efficiencies and loan to asset ratios are lower but the deposit to loan ratios are higher in recent year on average. The change in ROA, $R_{D/L}$ and $R_{L/A}$ could be seen as a signal of changes in banks' business from traditional loan making to non-traditional activities. The unit prices of inputs are typically lower in the recent years in Indonesia, but tend to be higher in other countries for most the cases. Higher economic growth in recent years has been seen in Indonesia, the Philippines and Thailand, but the average growth rates were slightly higher in Malaysia and Singapore a decade ago.

6. Empirical results of PR model

6.1 Long-run market equilibrium tests and PR *H*-statistics

Before applying the PR model to test market competitive structure for each country, it is important to identify whether the banking markets in those countries are in long-run market equilibrium, since the validity of the PR *H*-statistic depends crucially on the long-run equilibrium assumption. Equation (5.10) and (5.11) are estimated by GLS with cross-sectional fixed effect (FE) unbalanced panel estimation[91] for each country separately, and Table 5-7 reports the test results of long-run market equilibrium for the whole sample period from 1994 to 2009.

[91] All estimations in this chapter are conducted in STATA 10.

Table 5-7 Long-run market equilibrium test, E-statistics (1994-2009)

*ROA**	Indonesia	Malaysia	Philippines	Singapore	Thailand
Intercept	-5.5277	-0.3234	-0.7132	-0.1809	-3.6792
	(-5.5)***	(-3.39)***	(-3.02)***	(-1.03)	(-8.88)***
P_D	-0.0895	-0.0039	0.0086	0.0025	-0.0112
	(-5.63)***	(-2.45)**	(2.68)***	(1.19)	(-2.04)**
P_{FA}	-0.0315	-0.0018	-0.0017	-0.0032	0.0130
	(-2.72)***	(-1.28)	(-0.72)	(-2.05)**	(1.78)*
P_L	0.0235	-0.0032	-0.0038	-0.0014	-0.0291
	(1.05)	(-1.08)	(-0.82)	(-0.92)	(-2.35)**
EFF	1.2001	0.0069	0.0204	0.0059	-0.2337
	(7.5)***	(1.37)	(2.49)**	(1.44)	(-1.84)
$R_{D/L}$	-0.1275	-0.0127	-0.0571	-0.0429	-0.0617
	(-4.59)***	(-1.9)*	(-6.92)***	(-5.13)***	(-1.76)*
$R_{L/A}$	-0.1806	-0.0108	-0.0597	-0.0485	-0.0979
	(-6.17)***	(-1.57)	(-7.57)***	(-6.62)***	(-2.8)***
ΔGDP_t	1.1604	0.0533	0.0867	0.0365	0.3520
	(6.82)***	(3.71)***	(2.07)**	(1.61)	(4.89)***
ΔGDP_{t-1}	-0.0448	0.0142	0.0705	0.0036	0.4199
	(-0.32)	(0.96)	(1.87)*	(0.13)	(5.99)***
OverallR^2	0.2267	0.0056	0.2596	0.4637	0.3106
$H_0:\eta_i=0$	F(58,568)= 1.43**	F(32,329)= 3.44***	F(28,312)= 2.89***	F(7,87)= 2.97***	F(20,229)= 1.34
N_{obs}	635	370	349	103	258
N_{banks}	59	33	29	8	21
E-statistic	-0.0975	-0.0089	0.0031	-0.0021	-0.0273
H_0:E=0	F(1,568)= 12.54***	F(1,329)= 5.27**	F(1,312)= 0.25	F(1,87)= 0.41	F(1,229)= 2.53
Chow-test	F(9,559)= 5.00***	F(9,320)= 2.57***	F(9,303)= 3.01***	F(9,78)= 5.87***	F(9,78)= 5.87***

***, ** and * denotes coefficient is significant at 1%, 5% and 10% significance level accordingly

Estimation results of the profit equation generally exhibit the expected sign for each variable. When the relationship is statistically significant, banks' profitability is typically negatively related to the input factor prices in most cases. Marginal effects of Banks' average efficiency level are only significant in two countries, i.e. Indonesia and the Philippines, and positively affect banks' profitability. Both deposit to loan ratio ($R_{D/L}$) and loan to assets ratio ($R_{L/A}$) are negatively related to banks' profit, implying that banks' profit decreases with relatively high level of liability which incurs high interests costs, and excessive grant of loan with lack of diversity in business may lead to high exposure to default risk. Both current and past favourable macroeconomic environment improves banks' profit due to high demand for credit and better credit risk. The *F*-test (H_0:η_i=0) for bank-specific effect confirms that the cross-bank heterogeneities are highly significant in all countries but one, i.e. Thailand.[92]

The *E*-statistics estimates for the whole sample period (1994-2009) are also reported in Table 5-7, along with a Wald F-test statistic for the null hypothesis that H0:*E*=0. The *E*-statistic estimates are either less than zero or not significantly different from zero, which satisfy the general theory that higher input prices reduce banks' profit or do not affect banks' profit if the market is in equilibrium. According to the Wald *F*-test statistics, market long-run equilibrium over the whole period is only rejected in two countries, which are Indonesia and Malaysia. In the case of the Philippines, Singapore and Thailand, the test fails to reject the market long-run equilibrium over 1994-2009. However, most of the member countries in ASEAN are characterised as developing countries, of which the banking market should involve

[92] Insignificant F-test statistic suggests OLS estimator is appropriate, but in order to be consistent with other results, FE estimates are reported. OLS estimator produces similar results.

continuous dynamic changes over time. Especially, during the 1997 Asian financial crisis, ASEAN countries were among the most affected countries, and the series of large-scale banking sector structural reforms have significantly changed the structure of banking industries in many countries. Therefore, intuitively, the stable long-run market equilibrium is very unlikely to exist in any of the sample countries, even in the case of Singapore, which is the only developed country in this region. A Chow structural break test is carried out for each country to test the stability of the parameters. A nature structural break time point would be year 2001, when most of the countries are recovered from the 1997 financial crises and largely finish the banking sector reforms. The structural break test results are reported in the last row of Table 5-7, and confirm that all countries in the sample have experienced a significant structural change during this period. Therefore, the parameters in the estimating equation are not stable over the whole sample period, neither the parameters for the *E*-statistic. The banking markets in pre- and post-crisis period may be both out of equilibrium or in equilibrium within each sub-sample, but the assumption of long-run market equilibrium for the whole period does not hold.

The market long-run equilibrium assumption is further tested in two sub-periods with the year 2001 as a turning point, i.e.1994-2001 and 2002-2009, and results are reported in Table 5-8. In the sub-period profit equation estimations, most of the explanatory variables exhibit expected signs with a few exceptions in input prices but only of marginal significance. The bank-specific fixed effects are not significant in the first period for Indonesia, Singapore and Thailand, but are significant for other countries and other periods. According to the Wald *F*-test statistics, long-run market equilibrium is rejected in both periods for Indonesia and Malaysia, and in the first

period for Thailand. The test fails to reject market equilibrium in both periods for the Philippines and Singapore, and in the second period for Thailand, however, given the structural breaks, the long-run equilibrium still does not hold for the whole period in these countries. These results have further proved that the banking market in ASEAN countries are continuously or occasionally off the long-run equilibrium, or have moved from one equilibrium to another during the sample period. Therefore following the recommendations by Goddard and Wilson (2009), the Arellano and Bond's (1991) GMM dynamic estimator should be applied in the PR models estimation instead of the conventional fixed effect static panel estimator.

Applying the dynamic GMM estimator to PR *H*-statistic estimation involves taking the first-order difference of each variable and hence removing the bank-specific fixed effect, and the dynamic adjustments towards long-run equilibrium is captured by the lagged dependent variable on the right-hand side of the equation. Equation (5.12) is estimated for each country over the entire period with all variables expressed in the form of first-order differences, and the corresponding dynamic adjusted *H*-statistics are calculated according to equation (5.13). Table 5-9 summaries the results.

The first thing to be noticed in Table 5-9 is that the coefficient estimates of the lagged depended variables, i.e. the "persistence coefficients", are all positive and highly significant in all countries. According to Goddard and Wilson (2009), this further proves that the dynamic adjustments are necessary in the estimation, since the adjustment towards market equilibrium is not instantaneous but partial. The estimated coefficients for input prices have no consistent sign, this is because in the reduce-form

revenue equation, the marginal effects of input factor prices could be either positive or negative depending on the level of market power that a bank has, and the overall effect of increase in input prices on the total revenue is exactly what the PR model tries to find out and use to determine the degree of competitiveness of a particular market.

The coefficient estimates on the three bank-specific variables, EFF, $R_{D/L}$ and $R_{L/A}$, all exhibit positive sign, when the coefficient is statistically significant. It would be no surprise that, other things equal, more efficient banks are more likely to generate more revenue. However, $R_{D/L}$ and $R_{L/A}$ are of the opposite signs as they were in the profit equation estimation results (Table 5-7 and 5-8), and in fact, one should not predict the same effects of the two ratios on both profit and revenue. The reason is that these two ratios involves both revenue (interest income) and cost (interest expenses) in the profit equation, but the dependent variable in the revenue equation is gross revenue from both traditional and non-traditional banking business, without having any interest cost or loan default cost in consideration. Therefore, the $R_{D/L}$ in the revenue equation is merely a measure of banks' risk preference, the higher the value for $R_{D/L}$ the more prudential the bank is, and the positive sign suggest that higher revenue is rewarded to more prudential banks. Positive sign on $R_{L/A}$ implies that the higher proportion of loan in total assets, the higher revenue a bank could generate, and indicates that interest income from loans are still the main income source for most banks in ASEAN.

The estimates for current period GDP growth rate are only significant in two countries, and it seems that the past macroeconomic conditions, indicated by the one-period lagged GDP growth rate, are more relevant and significant in all countries

but one. Recall the argument that was made in Chapter 3, that the impact of economic expansion on banks' performance could be either positive or negative. Demand for financial services tends to grow as economies expand, however immoderate lending in economic boom may create potential non-performing loan problems and jeopardise the loan repayment in future periods. With a relative sophisticated financial system, normally in wealthier countries, banks are more likely to generate stable streams of income even the economic growth rate is relatively low. On the other hand, banks that operate in a fast-growing but unstable economic environment are not guaranteed a high level of income. In this particular case of the 5 core member countries of ASEAN, it can be seen that higher economic growth rate reduces banks' total revenue in Indonesia and Thailand, which could be explained by the negative effects of economic instability; but improves banks' total revenue in Singapore, thanks to the well-developed financial system and relatively stable economic environment. The statistical significance of the past macroeconomic environment brings the reality that the repayment of loans and interests and returns in banks' other investments does not only depend on the economic situation of the time when it is due to maturity, but also the economic situations during the whole life time of the loan and investment. Apparently, it is the latter that is more relevant and continuously advantageous macroeconomic environment significantly improves banks' revenue.

Table 5-8 Long-run market equilibrium test of two sub-periods, *E*-statistics (1994-2001 & 2002-2009)

*ROA**	I		M		P		S		T	
Variable	1994-2001	2002-2009	1994-2001	2002-2009	1994-2001	2002-2009	1994-2001	2002-2009	1994-2001	2002-2009
Intercept	-1.1777	-8.6818	-0.2488	-0.2652	-2.0657	0.2459	-0.1272	-0.1423	-4.5706	-0.5350
	(-0.62)	(-3.36)***	(-1.57)	(-2.01)**	(-5.24)***	(0.58)	(-0.41)	(-0.73)	(-6.57)***	(-1.45)
P_D	-0.2719	-0.0381	-0.0092	-0.0012	0.0013	0.0075	-0.0092	0.0031	-0.0191	-0.0170
	(-5.13)***	(-3.94)***	(-1.98)**	(-0.84)	(0.15)	(1.08)	(-1.24)	(1.1)	(-1.02)	(-3.88)***
P_{FA}	-0.0588	-0.0029	-0.0070	0.0023	-0.0074	-0.0043	0.0013	-0.0037	0.0326	0.0065
	(-2.2)**	(-0.47)	(-1.73)*	(2.06)**	(-2.17)**	(-0.97)	(0.29)	(-1.92)*	(1.8)*	(1.83)*
P_L	0.1117	-0.0128	-0.0020	-0.0075	-0.0056	0.0129	0.0013	-0.0020	-0.1066	0.0066
	(2.09)**	(-0.97)	(-0.28)	(-2.81)***	(-0.84)	(1.37)	(0.79)	(-0.61)	(-3.58)***	(1.07)
EFF	0.3510	1.0659	0.0328	0.0014	-0.0166	0.0432	0.7366	0.0041	-0.2735	0.0020
	(0.55)	(15.73)***	(0.45)	(0.46)	(-0.33)	(3.02)***	(1.11)	(0.92)	(-0.87)	(0.04)
$R_{D/L}$	-0.3707	-0.0529	-0.0318	-0.0102	-0.0591	-0.0399	-0.0279	-0.0168	-0.1934	-0.0489
	(-5.01)***	(-2.42)**	(-1.59)	(-2.14)**	(-2.05)**	(-2.37)**	(-0.61)	(-1.71)*	(-1.73)*	(-3.35)***
$R_{L/A}$	-0.3898	-0.1257	-0.0321	-0.0095	-0.0482	-0.0577	-0.0004	-0.0200	-0.2316	-0.0400
	(-5.3)***	(-5.69)***	(-1.4)	(-1.94)*	(-1.61)	(-3.31)***	(-0.01)	(-1.74)*	(-2.14)**	(-2.92)***
ΔGDP_t	0.3010	0.9155	0.0393	0.0367	0.2352	-0.0392	0.0299	0.0226	0.4531	0.0809
	(0.91)	(1.68)*	(1.53)	(2.05)**	(3.19)***	(-0.6)	(0.91)	(0.65)	(3.45)***	(1.23)
ΔGDP_{t-1}	-0.3150	0.9412	0.0080	0.0173	0.2100	-0.0091	-0.0005	0.0115	0.4903	0.0215
	(-1.36)	(1.96)**	(0.36)	(0.67)	(3.65)***	(-0.16)	(-0.01)	(0.35)	(4.73)***	(0.2)
OverallR2	0.2062	0.2383	0.0529	0.0045	0.0961	0.3172	0.3627	0.0724	0.2943	0.2728
H0:η_i=0	F(51,229) =0.71	F(50,287) =4.55***	F(26,129) =1.68**	F(29,168) =2.83***	F(28,126) =3.20***	F(25,152) =1.78**	F(7,23) =1.03	F(7,48) =3.40***	F(17,92) =1.23	F(19,112) =4.22***
N_{obs}	289	346	164	206	163	186	39	64	118	140
N_{banks}	52	51	27	30	29	26	8	8	18	20
E-statistic	-0.2190	-0.0538	-0.0181	-0.0064	-0.0117	0.0162	-0.0065	-0.0026	-0.0931	-0.0039
H0:E=0	F(1,229) =10.88***	F(1,287) =10.14***	F(1,129) =3.82*	F(1,168) =3.90**	F(1,126) =1.13	F(1,152) =1.36	F(1,23) =0.46	F(1,48) =0.25	F(1,92) =5.20**	F(1,112) =0.23

***, **, and * denotes coefficient is significant at 1%, 5% and 10% significance level accordingly

Table 5-9 PR Market competitiveness test, *H*-statistics (1994-2009) ---- GMM

TR	Indonesia	Malaysia	Philippines	Singapore	Thailand
Intercept	-0.7857	-4.2916	-6.7905	-5.9970	-2.7798
	(-0.30)	(-2.53)**	(-2.51)**	(-1.51)	(-1.3)
TRt-1	0.5998	0.6027	0.5952	0.7442	0.4570
	(12.13)***	(20.04)***	(15.57)***	(14.58)***	(13.36)***
P_D	0.2050	0.2371	0.1084	0.1507	0.0464
	(6.65)***	(9.18)***	(2.67)***	(3.28)***	(1.67)*
P_{FA}	-0.0878	0.1340	0.0916	0.0748	-0.0840
	(-3.45)***	(5.82)***	(2.52)**	(1.86)*	(-2.15)**
P_L	-0.0658	0.0444	-0.0810	0.0700	-0.2928
	(-1.24)	(0.81)	(-1.25)	(1.74)*	(-3.8)***
EFF	0.7798	0.2220	0.7448	-0.0701	1.3092
	(2.34)**	(2.69)***	(5.87)***	(-0.79)	(2.06)**
$R_{D/L}$	0.2414	0.3601	0.2567	-0.1185	-0.2734
	(3.86)***	(3.2)***	(2.26)**	(-0.62)	(-1.48)
$R_{L/A}$	0.3961	0.2129	0.2398	0.0401	0.1305
	(5.63)***	(1.84)*	(2.24)**	(0.24)	(0.69)
ΔGDP_t	-1.3751	-0.0180	0.1982	1.1058	-0.8663
	(-4.55)***	(-0.08)	(0.43)	(2.17)**	(-2.5)**
ΔGDP_{t-1}	2.9587	1.7027	2.1061	0.6926	2.5979
	(9.76)***	(7.58)***	(5.33)***	(1.15)	(7.83)***
N_{obs}	565	333	314	95	237
N_{banks}	59	33	29	8	21
H-statistic	0.1284	1.0460	0.2940	1.1551	-0.6084
H_0:H=0	chi2(1)= 0.70	chi2(1)= 36.73***	chi2(1)= 1.97	chi2(1)= 12.47***	chi2(1)= 11.60***
H_0:H=1	chi2(1)= 18.33***	chi2(1)= 0.07	chi2(1)= 10.35***	chi2(1)= 0.22	chi2(1)= 70.11***
Market condition	M-MC	PC	M-MC	PC	M

***, **, and * denotes coefficient is significant at 1%, 5% and 10% significance level accordingly
M – Monopoly or perfect collusive; MC -- Monopolistic Competition; PC -- Perfect Competition

The *H*-statistics are calculated as the sum of input price elasticities and are tested against each of the market type hypotheses in Table 5-1. Unlike what has been typically found in studies using static fixed effect panel estimations that the *H*-statistics are normally in the range of 0 and 1 for most countries[93], i.e. in favour of monopolistic competition. Having adjusted the dynamics of transition, the results are more diversified. The *H*-statistics for Malaysia and Singapore are greater than 1 in absolute values, but based on the Wald test results regarding null hypothesis H_0:H=1, they are not statistically different from 1, therefore monopoly and monopolistic competition are rejected but perfect competition cannot be rejected in these two countries. Negative *H* has been detected for Thailand, and is statistically less than 0, rejecting both perfect competition and monopolistic competition, thus monopoly or perfect cartel is the best description for Thailand banking market. In the case of Indonesia and the Philippines, the *H*-statistics are 0.1284 and 0.2940, which are in the range of 0 and 1, however, the hypothesis *H*=0 cannot be rejected in both cases. The banking markets in these two countries are characterised by monopolistic competition but with a very low level of competition which towards monopoly or perfect collusive market.

For purposes of comparison, the implied Lerner Index was constructed from the estimated cost function of Chapter 3 and reported in Appendix B. The results are mixed and show confirmation of the findings from the P-R H-statistics for two countries only (Malaysia and Thailand). The Lerner Index being only a partial equilibrium indicator will not have the same generality as the P-R H statistic, however for two countries there was a common message of improved competitiveness.

[93] For example in Claessens and Laeven (2004), the estimates of *H*-statistic for Indonesia, Malaysia and the Philippines are 0.62, 0.68, and 0.66 accordingly for the years 1994-2001.

The first impression one may have is that the banking industries in the 5 core ASEAN countries are of very different competitive structures, which cover both the most competitive structure and the most uncompetitive one. Using the numerical values of *H*-statistics as a measurement of degree of competitiveness, the countries can be ranked from the most competitive to the least competitive as follows: Singapore > Malaysia > the Philippines >Indonesia > Thailand. The notable difference in banking market competitiveness between member countries may impose difficulties on the process of banking market integration. Opening up the cross-border financial market barriers and allowing free capital movements will definitely introduce shocks to the domestic markets. The consequences are difficult to predict, banks from countries with competitive banking market may dominate banks from countries with less competitive market. The reason is that banks in competitive markets are forced to operate on the lowest point of cost curves, and to implement the most efficient production technology and most efficient resources allocation. These banks may have the advantages of crack internal cooperate governance structure and better experiences on quick adaptation to new environment. However it could also be the other way around, banks with high degree of market power in one particular country may be better capitalised through years of accumulation of supernormal profits, and may have established solid relation networks with the cooperate sectors that the foreign competitors hardly break into. Either way it goes, successful integration of the banking markets should foster competition, and the banking market competitiveness should converge toward a common standard for banks to survive in a more open environment.

Differences in market competitiveness of banking sector in member countries may also affect the implementation of monetary policies, and hence the future monetary integration. As stated in Olivero *et al.* (2011), increased competition in banking market weakens the impact of changes in monetary policy for two reasons. One is that the total credit made available to existing customers by large competitive banks is less likely to be affected by monetary tightening on reserves, because the lending decisions of competitive large banks are typically less dependent on the availability of funds from deposits, since they normally have better access to additional funds. The other reason is that, the increased competition may reduce information asymmetries in the market, and in turn reduce the cost of switching between banks for both borrowers and lenders. Therefore, when there is monetary policy tightening, and small banks shrink their loan supply, large banks with better additional funds can easily pick up the excess demand for loans and make the monetary policy less effective. On the other hand, the sensitivity of bank loan and deposit rates to the changes in monetary policies in a competitive market may better transmit the monetary policy and hence help improve its effectiveness. The overall effect of banking market competition on effectiveness of monetary policy will depend on whether the negative effect dominates the positive effect or the other way around. The concern in the present study is not only on the individual countries, but also on the mismatch between countries. For a future monetary alliance, the mismatch of member countries' banking market competitiveness may lead to uneven responses or pass-through of monetary policy from the regional central bank, and could even create more heterogeneity across countries invalidating to the original intention of adopting a currency union in the first place.

6.2 Evolution of banking market competitiveness

Comparing the estimates of PR *H*-statistic of each country for the whole sample period provides valuable information about the competitive nature of the banking market in these countries. Although the dynamic GMM estimator was applied to adjust the biases of *H*-statistic estimates due to market disequilibrium, a single *H*-statistic for the entire sample period does not provide much information about the time evolution of banking market competitiveness. In this section, the dynamics in market competition are captured by conducting a rolling estimation of a 5-year window, and a series of moving *H*-statistics are estimated for each country[94]. Using cross-bank fixed effect panel estimator, equation (5.6) and (5.7) are repeatedly estimated for moving windows of 5 years with moving speed of 1 year, thus 12 windows in total. The estimations are carried out for each country individually, and Tables 5-10- Table 5-14 report the estimations results for each country accordingly.

The rolling estimation results of reduce-form revenue equations show the changing effects of explanatory variables on banks' total revenue over time within one particular country and differences in their effects cross countries. However, there are still some features that all countries sharing in common. The price of deposit (P_D) has the most explanatory power among all three input factor prices in all five countries, and consistently exhibits positive sign whenever it is statistically significant. The positive marginal effect of P_D itself suggests that increasing the interest margin more than proportionally with an increase in the funding price is a common practice in most banks of ASEAN, however, more emphasises should be put on its joint effect

[94] It is assumed that there are moving equilibriums from one 5-year window to another, and the adjustments between window-equilibriums represent the dynamic adjustment towards the long-run market equilibrium.

with other input factor prices on banks' total revenue rather than analysing each one individually. The other characteristic that is common to all countries is that bank-specific efficiency (*EFF*) level positively contributes to banks' total revenue, and its explanatory power increases over time, becoming relatively more significant in the post-crisis period. This is consistent with the typical stylised fact that banks with superior operational efficiency tend to outperform less efficient banks.

Other explanatory variables included in the reduce-form revenue equation show some changing patterns across time and across countries to various degrees. Comparing with the price of deposit (P_D), price of fixed assets (P_{FA}) is less relevant and has positive effect on banks' revenue in most countries and periods, but negative effect in Indonesia for all periods and mixed effects in Thailand. Price of labour (P_L) is of the least explanatory power, which are statistically insignificant for most times, and exhibits mixed signs in the few cases when it is significant. The unstable effects of input factor prices could be due to many reasons, but given the multiple-input and multiple-output nature of banks, it is the joint effect of all input factor prices represent the characteristics of banks' behaviour, hence the degree of competition of the whole market.

Apart from the bank-specific efficiency scores, the two other bank-specific variables also provide mixed results. The ratio of deposit to loan ($R_{D/L}$) consistently has positive effects on banks' revenue in Indonesia, Malaysia and the Philippines in all periods and in some periods for Singapore and Thailand, and this is consistent with its estimated effect for the whole sample period on average. However, negative signs are shown in period 2000-2004 for Singapore and in two period-windows from 1999

to 2004 for Thailand. It is noticed that these exception periods are just after the banking sector structural reforms following the 1997 Asian crisis, and the short-term opposite effects from $R_{D/L}$ could be explained, in Singapore and Thailand particular, by a possible short-term shrink in loan supply or write-offs of bad loans during the crisis period, both of which could lead to a increase in the ratio and a decline in interest revenues.

The loan intensity ratio ($R_{L/A}$) was estimated to have positive effect on banks' revenue for the whole sample period on average, and this is also the case for most 5-year window periods in most countries. The only two exceptions happen in the early years (1994-1999) for Indonesia and immediate post-crisis period 2000-2004, however are all of only marginal significance at 10% level. The effects of macroeconomic conditions in periods of each moving window are basically consistent with the average effect of the whole sample period on banks' total revenue. Mostly negative effects are observed from the current period GDP growth rate which implies high economic growth but relatively unstable environment, and positive effects associated with the past economic growth rates which improves the repayment of loans and interest as a result of better return on investments. Few exceptions did appear but does not change the overall effects for the whole period.

Table 5-10 5-year window rolling PR Market competitiveness test, *H*-statistics for Indonesia

Variable	1994-1998	1995-1999	1996-2000	1997-2001	1998-2002	1999-2003	2000-2004	2001-2005	2002-2006	2003-2007	2004-2008	2005-2009
Intercept	-102.975	17.852	19.225	16.233	17.235	22.127	-83.594	-57.301	-71.667	-95.250	-56.025	-24.133
	(-3.45)***	(6.27)***	(5.59)***	(4.5)***	(5.33)***	(2.04)**	(-2.21)**	(-1.96)*	(-3.03)***	(-4.67)***	(-2.51)**	(-0.98)
P_D	-0.038	0.003	0.211	0.325	0.401	0.399	0.547	0.460	0.482	0.372	0.273	0.179
	(-0.44)	(0.04)	(2.38)**	(3.4)***	(5.29)***	(6.43)***	(7.05)***	(5.9)***	(8.32)***	(5.37)***	(3.54)***	(2.72)***
P_{FA}	0.026	0.028	-0.046	-0.048	-0.029	0.034	0.041	-0.102	-0.163	-0.203	-0.137	-0.095
	(0.6)	(0.75)	(-0.99)	(-1.22)	(-0.94)	(0.9)	(0.86)	(-2.26)**	(-3.9)***	(-5.27)***	(-3.04)***	(-2.08)**
P_L	0.087	-0.076	0.008	0.018	-0.022	-0.069	-0.099	0.051	0.085	0.063	0.045	0.004
	(0.87)	(-0.94)	(0.08)	(0.22)	(-0.29)	(-0.84)	(-0.99)	(0.49)	(0.8)	(0.76)	(0.5)	(0.04)
EFF	1.298	1.442	1.771	0.829	1.674	0.729	1.727	2.261	2.698	5.307	1.673	1.255
	(1.5)	(1.65)	(1.66)*	(0.86)	(2.46)**	(0.99)	(2.49)**	(3.45)***	(4.2)***	(8.46)***	(4.09)***	(3.19)***
$R_{D/L}$	-0.139	-0.091	0.049	0.012	0.145	-0.018	0.275	0.836	1.275	1.269	0.977	0.044
	(-1.08)	(-0.82)	(0.38)	(0.1)	(1.37)	(-0.16)	(2.1)**	(6.76)***	(9.55)***	(10.28)***	(7.14)***	(0.23)
$R_{L/A}$	-0.244	-0.199	0.142	0.108	0.093	0.099	0.417	0.953	1.294	1.244	1.352	0.307
	(-1.74)*	(-1.7)*	(1.12)	(0.88)	(0.91)	(0.89)	(2.98)***	(6.86)***	(9.1)***	(9.53)***	(9.48)***	(1.81)*
ΔGDP_t	-7.383	-2.754	-2.403	-1.630	-1.778	-2.783	15.183	10.632	8.379	12.055	7.491	-5.321
	(-6.67)***	(-6)***	(-4.33)***	(-2.66)***	(-3.23)***	(-1.02)	(2.31)**	(2.45)**	(1.09)	(2.71)***	(1.57)	(-1.89)*
ΔGDP_{t-1}	32.180	1.924	1.318	1.213	1.200	1.220	6.171	4.921	10.269	11.649	7.733	13.616
	(4.4)***	(5.53)***	(3.31)***	(3.44)***	(4.09)***	(2.25)**	(3.15)***	(1.2)	(2.12)**	(2.02)**	(1.87)*	(3.49)***
OverallR2	0.0023	0.0441	0.0808	0.0549	0.1536	0.0210	0.0883	0.2891	0.3441	0.4904	0.2148	0.1116
$H0:\eta_i=0$	F(44,101) =67.34***	F(48,145) =63.04***	F(51,151) =45.19***	F(51,157) =55.96***	F(51,159) =81.87***	F(52,156) =83.55***	F(50,154) =88.69***	F(49,156) =80.57***	F(50,160) =99.33***	F(50,165) =108.99***	F(50,167) =115.87***	F(49,163) =127.98***
N_{obs}	154	202	211	217	219	217	213	214	219	224	226	221
N_{banks}	45	49	52	52	52	53	51	50	51	51	51	50
H	0.0743	-0.0455	0.1729	0.2950	0.3494	0.3640	0.4897	0.4090	0.4047	0.2327	0.1819	0.0876
H0:H=0	F(1,101) =0.41	F(1,145) =0.22	F(1,151) =2.28	F(1,157) =6.42**	F(1,159) =13.51***	F(1,156) =14.54***	F(1,154) =18.89***	F(1,156) =10.55***	F(1,160) =10.58***	F(1,165) =4.71**	F(1,167) =2.43	F(1,163) =0.69
H0:H=1	F(1,101) =63.17***	F(1,145) =115.08***	F(1,151) =52.29***	F(1,157) =36.67***	F(1,159) =46.84***	F(1,156) =44.37***	F(1,154) =20.51***	F(1,156) =22.02***	F(1,160) =22.90***	F(1,165) =51.18***	F(1,167) =49.26***	F(1,163) =74.54***
Market type	M-MC	M	MC	MC	MC	MC	MC	MC	MC	MC	M-MC	M-MC

***, ** and * denotes coefficient is significant at 1%, 5% and 10% level accordingly; M-Monopoly/perfect collusive; MC-Monopolistic Competition; PC-Perfect Competition

Table 5-11 5-year window rolling PR Market competitiveness test, *H*-statistics for Malaysia

Variable	1994-1998	1995-1999	1996-2000	1997-2001	1998-2002	1999-2003	2000-2004	2001-2005	2002-2006	2003-2007	2004-2008	2005-2009
Intercept	-187.275	16.495	15.636	10.468	14.815	13.355	14.509	-16.084	24.993	-29.039	52.791	38.753
	(-8.97)***	(7.38)***	(7.66)***	(4.27)***	(3.81)***	(3.5)***	(2.94)***	(-2.28)**	(1.79)*	(-1.02)	(1.62)	(2.94)***
P_D	0.068	0.359	0.200	0.221	0.198	0.202	0.220	0.385	0.395	0.572	0.662	0.571
	(0.68)	(3.41)***	(2.59)**	(3.36)***	(2.74)***	(2.95)***	(3.27)***	(6.12)***	(5.68)***	(8.22)***	(9.94)***	(7.53)***
P_{FA}	0.025	-0.047	-0.044	-0.033	0.092	0.135	0.174	0.153	0.114	0.013	-0.029	0.013
	(0.55)	(-0.76)	(-0.67)	(-0.49)	(1.21)	(2.11)**	(2.77)***	(3)***	(1.98)**	(0.2)	(-0.47)	(0.26)
P_L	-0.282	-0.644	-0.134	0.030	0.183	0.145	-0.006	-0.015	0.158	0.242	0.116	-0.171
	(-2.52)**	(-5.44)***	(-1.23)	(0.27)	(1.67)*	(1.41)	(-0.05)	(-0.13)	(1.37)	(1.82)*	(1.01)	(-1.38)
EFF	3.118	-0.254	2.983	1.604	1.976	1.220	1.013	0.660	0.287	0.536	0.400	-0.012
	(2.63)**	(-0.19)	(2.74)***	(1.56)	(4.26)***	(6.04)***	(5.4)***	(3.77)***	(2.07)**	(3.65)***	(2.77)***	(-0.08)
$R_{D/L}$	-0.012	0.340	0.559	0.330	0.705	0.877	0.986	0.823	0.030	0.522	0.194	-0.020
	(-0.05)	(1.08)	(2.04)**	(0.75)	(1.83)*	(2.73)***	(2.83)***	(2.51)**	(0.08)	(1.26)	(1.06)	(-0.11)
$R_{L/A}$	-0.071	0.185	0.453	0.419	0.595	0.790	0.995	0.956	-0.211	0.185	-0.029	-0.016
	(-0.18)	(0.42)	(1.38)	(0.94)	(1.45)	(2.14)**	(2.36)**	(2.47)**	(-0.52)	(0.44)	(-0.15)	(-0.08)
ΔGDP_t	-9.651	-1.733	-1.620	-0.818	-1.268	-1.152	-0.994	3.253	-6.088	3.470	-6.481	-1.133
	(-10.74)***	(-3.86)***	(-4.07)***	(-2.07)**	(-2.17)**	(-1.74)*	(-1.54)	(3.16)***	(-1.97)*	(0.95)	(-2.03)**	(-1.18)
ΔGDP_{t-1}	50.813	-0.485	-0.199	0.216	-0.207	-0.009	-0.464	1.993	2.501	4.730	-2.859	-5.391
	(9.63)***	(-1.55)	(-0.71)	(0.72)	(-0.54)	(-0.03)	(-0.72)	(3.05)***	(2.98)***	(1.26)	(-0.64)	(-1.61)
OverallR2	0.2188	0.1007	0.4168	0.1833	0.0107	0.0056	0.0930	0.3178	0.0591	0.1487	0.174	0.1766
$H0:\eta_i=0$	F(26,57) =99.31***	F(26,83) =52.80***	F(26,90) =61.39***	F(26,88) =69.00***	F(26,86) =95.38***	F(29,84) =157.61***	F(29,85) =184.35***	F(28,89) =251.04***	F(29,90) =204.93***	F(28,93) =164.41***	F(27,94) =224.70***	F(26,94) =215.36***
N_{obs}	92	118	125	123	121	122	123	126	128	130	130	129
N_{banks}	27	27	27	27	27	30	30	29	30	29	28	27
H	-0.1881	-0.3315	0.0216	0.2184	0.4739	0.4816	0.3881	0.5230	0.6673	0.8281	0.7493	0.4134
H0:H=0	F(1,57) =1.46	F(1,83) =4.39**	F(1,90) =0.02	F(1,88) =2.30	F(1,86) =12.02***	F(1,84) =13.76***	F(1,85) =5.63**	F(1,89) =14.17***	F(1,90) =21.63***	F(1,93) =32.00***	F(1,94) =28.20***	F(1,94) =8.29***
H0:H=1	F(1,57) =58.14***	F(1,83) =70.74***	F(1,90) =48.39***	F(1,88) =29.40***	F(1,86) =14.81***	F(1,84) =15.94***	F(1,85) =13.99***	F(1,89) =11.79***	F(1,90) =5.37**	F(1,93) =1.38	F(1,94) =3.16*	F(1,94) =16.69***
Market Type	M	M	M-MC	M-MC	MC	MC	MC	MC	MC	MC-PC	MC	MC

***, ** and * denotes coefficient is significant at 1%, 5% and 10% level accordingly; M-Monopoly/perfect collusive; MC-Monopolistic Competition; PC-Perfect Competition

Table 5-12 5-year window rolling PR Market competitiveness test, *H*-statistics for the Philippines

Variable	1994-1998	1995-1999	1996-2000	1997-2001	1998-2002	1999-2003	2000-2004	2001-2005	2002-2006	2003-2007	2004-2008	2005-2009
Intercept	-112.573	14.017	13.967	10.374	34.743	14.623	0.829	1.521	5.979	36.371	12.274	63.295
	(-6.83)***	(1.78)*	(1.88)*	(1.55)	(3.16)***	(3.21)***	(0.19)	(0.31)	(1.25)	(5.51)***	(1.02)	(3.87)***
P_D	0.534	0.863	0.543	0.397	0.027	0.240	0.210	0.100	0.293	0.172	0.193	-0.138
	(3.39)***	(4.3)***	(3.05)***	(2.5)**	(0.22)	(2.65)**	(2.5)**	(1.02)	(2.5)**	(1.6)	(1.58)	(-1.24)
P_{FA}	0.061	-0.020	-0.082	-0.102	-0.113	-0.011	-0.048	0.126	0.274	-0.024	-0.103	-0.094
	(1.11)	(-0.26)	(-1.18)	(-1.11)	(-1.2)	(-0.13)	(-0.55)	(1.4)	(3.67)***	(-0.33)	(-1.38)	(-1.13)
P_L	0.172	-0.052	-0.079	0.117	0.342	0.339	0.257	0.003	-0.325	-0.333	-0.274	-0.170
	(1.47)	(-0.33)	(-0.51)	(0.89)	(2.55)**	(3.02)***	(2.37)**	(0.03)	(-2.69)***	(-2.68)***	(-1.62)	(-0.88)
EFF	1.792	0.538	0.792	1.056	1.764	1.296	0.942	0.184	0.604	0.696	0.552	1.220
	(1.34)	(0.33)	(0.75)	(1.19)	(2.03)**	(1.75)*	(2.08)**	(0.38)	(2.57)**	(3.27)***	(2.27)**	(4.39)***
$R_{D/L}$	-0.064	-0.059	0.216	1.369	3.090	3.536	2.679	0.399	0.466	0.175	0.125	-0.178
	(-0.12)	(-0.09)	(0.38)	(2.3)**	(5.93)***	(8.3)***	(6.41)***	(1.75)*	(1.91)*	(0.75)	(0.57)	(-0.59)
$R_{L/A}$	-0.064	-0.030	0.517	1.876	3.236	3.439	2.554	0.188	0.405	0.268	0.352	-0.012
	(-0.12)	(-0.04)	(0.83)	(2.91)***	(5.77)***	(7.45)***	(5.67)***	(0.78)	(1.51)	(1.09)	(1.47)	(-0.04)
ΔGDP_t	-0.446	0.464	-0.707	-0.302	-4.987	1.147	0.486	0.257	0.187	-3.378	2.954	-2.942
	(-0.42)	(0.31)	(-0.51)	(-0.24)	(-2.57)**	(1.4)	(0.68)	(0.31)	(0.24)	(-3.54)***	(1.1)	(-1.58)
ΔGDP_{t-1}	26.919	-1.063	-0.044	0.350	-0.376	-2.080	1.460	1.292	0.541	-2.440	-3.546	-8.819
	(7.32)***	(-0.81)	(-0.04)	(0.39)	(-0.39)	(-2.01)**	(2.53)**	(2.04)**	(0.89)	(-3.33)***	(-4.11)***	(-3.21)***
OverallR2	0.1643	0.0072	0.0709	0.3069	0.6425	0.5057	0.4288	0.0483	0.015	0.1247	0.1203	0.4084
H0:η_i=0	F(24,54) =59.98***	F(27,77) =25.77***	F(28,83) =35.87***	F(28,85) =47.16***	F(28,86) =39.98***	F(27,89) =52.07***	F(26,89) =65.77***	F(25,87) =66.29***	F(25,88) =93.11***	F(25,86) =79.07***	F(25,81) =59.30***	F(24,79) =50.33***
N_{obs}	87	113	120	122	123	125	124	121	122	120	115	112
N_{banks}	25	28	29	29	29	28	27	26	26	26	26	25
H	0.7672	0.7911	0.3830	0.4121	0.2561	0.5688	0.4187	0.2285	0.2429	-0.1851	-0.1841	-0.4022
H0:H=0	F(1,54) =14.38***	F(1,77) =9.22***	F(1,83) =2.94*	F(1,85) =3.49*	F(1,86) =1.88	F(1,89) =15.05***	F(1,89) =7.07***	F(1,87) =1.43	F(1,88) =1.57	F(1,86) =0.92	F(1,81) =0.95	F(1,79) =2.75
H0:H=1	F(1,54) =1.32	F(1,77) =0.64	F(1,83) =7.62***	F(1,85) =7.11***	F(1,86) =15.89***	F(1,89) =8.65***	F(1,89) =13.63***	F(1,87) =16.33***	F(1,88) =15.21***	F(1,86) =37.53***	F(1,81) =39.11***	F(1,79) =33.45***
Market Type	MC-PC	MC-PC	MC	MC	M-MC	MC	MC	M-MC	M-MC	M	M	M

***, ** and * denotes coefficient is significant at 1%, 5% and 10% level accordingly; M-Monopoly/perfect collusive; MC-Monopolistic Competition; PC-Perfect Competition

Table 5-13 5-year window rolling PR Market competitiveness test, *H*-statistics for Singapore

Variable	1994-1998	1995-1999	1996-2000	1997-2001	1998-2002	1999-2003	2000-2004	2001-2005	2002-2006	2003-2007	2004-2008	2005-2009
Intercept	7.418	47.418	22.512	11.048	12.293	10.635	11.970	2.653	1.660	19.124	41.092	40.395
	(0.33)	(5.81)***	(2.81)**	(1.37)	(1.34)	(1.38)	(1.85)*	(0.26)	(0.17)	(0.85)	(1.75)*	(2.89)***
P_D	0.360	0.497	0.238	0.326	0.122	0.216	0.248	0.324	0.602	0.779	0.829	0.732
	(1.81)	(1.67)	(0.65)	(1.76)*	(0.76)	(2.5)**	(3.46)***	(2.19)**	(4.97)***	(4.01)***	(4.28)***	(4.05)***
P_{FA}	-0.138	0.082	0.607	0.536	0.374	0.447	0.377	0.301	0.186	0.189	0.168	0.132
	(-1.16)	(0.99)	(1.89)*	(2.95)***	(2.93)***	(4.5)***	(6.21)***	(2.92)***	(2.02)*	(1.92)*	(1.9)*	(1.49)
P_L	0.007	0.036	0.127	0.027	0.207	0.259	0.104	-0.192	0.017	0.104	0.057	0.100
	(0.34)	(1.15)	(0.51)	(0.17)	(1.76)*	(2.18)**	(0.86)	(-0.79)	(0.08)	(0.56)	(0.37)	(0.62)
EFF	-24.825	-10.546	-24.833	23.063	15.649	3.286	2.218	0.445	-0.104	0.160	0.205	0.072
	(-1.27)	(-0.32)	(-0.83)	(1.49)	(1.82)*	(3.17)***	(4.48)***	(0.67)	(-0.28)	(0.49)	(0.74)	(0.31)
$R_{D/L}$	5.907	1.392	3.106	1.494	0.297	-0.657	-0.896	-0.103	0.977	0.498	0.254	0.394
	(3.28)**	(0.72)	(1.02)	(0.9)	(0.41)	(-1.69)	(-2.72)**	(-0.18)	(1.61)	(1)	(0.62)	(1.03)
$R_{L/A}$	6.871	2.147	2.630	1.215	0.778	0.135	-0.136	-0.109	1.052	0.391	0.201	0.647
	(3.54)**	(0.97)	(0.86)	(0.8)	(1.32)	(0.35)	(-0.44)	(-0.22)	(1.45)	(0.61)	(0.32)	(1.31)
ΔGDP_t	-2.734	-3.428	-1.602	-0.272	-0.189	0.178	0.360	1.571	0.995	0.181	-3.340	-2.799
	(-3.68)**	(-3.01)**	(-1.03)	(-0.36)	(-0.2)	(0.17)	(0.47)	(0.96)	(0.44)	(0.07)	(-1.69)	(-1.52)
ΔGDP_{t-1}	3.098	-4.809	-1.578	-0.473	-0.850	-0.833	-1.404	-0.780	0.470	-2.299	-3.456	-3.844
	(0.73)	(-5.05)***	(-1.28)	(-0.44)	(-0.71)	(-0.87)	(-1.47)	(-0.59)	(0.36)	(-0.65)	(-0.93)	(-1.45)
OverallR2	0.2290	0.0103	0.1054	0.0142	0.0524	0.3058	0.2560	0.2994	0.011	0.0020	0.0212	0.0137
$H0:\eta_i=0$	F(4,4) =55.23***	F(5,9) =65.35***	F(7,11) =28.12***	F(7,15) =56.75***	F(7,19) =116.08***	F(7,22) =278.56***	F(7,24) =387.13***	F(7,24) =118.55***	F(7,24) =168.93***	F(7,24) =149.69***	F(7,24) =177.69***	F(7,24) =172.38***
N_{obs}	17	23	27	31	35	38	40	40	40	40	40	40
N_{banks}	5	6	8	8	8	8	8	8	8	8	8	8
H	0.2296	0.6152	0.9717	0.8899	0.7034	0.9216	0.7287	0.4328	0.8057	1.0724	1.0540	0.9637
H0:H=0	F(1,4) =0.87	F(1,9) =4.08*	F(1,11) =6.94**	F(1,15) =6.24**	F(1,19) =6.49**	F(1,22) =20.57***	F(1,24) =23.16***	F(1,24) =1.99	F(1,24) =8.21***	F(1,24) =10.74***	F(1,24) =14.47***	F(1,24) =12.53***
H0:H=1	F(1,4) =9.84**	F(1,9) =1.60	F(1,11) =0.01	F(1,15) =0.10	F(1,19) =1.15	F(1,22) =0.15	F(1,24) =3.21*	F(1,24) =3.42*	F(1,24) =0.48	F(1,24) =0.05	F(1,24) =0.04	F(1,24) =0.02
Market Type	M-MC	MC-PC	MC-PC	MC-PC	MC-PC	MC-PC	MC	M-MC	MC-PC	PC	PC	MC-PC

***, ** and * denotes coefficient is significant at 1%, 5% and 10% level accordingly; M-Monopoly/perfect collusive; MC-Monopolistic Competition; PC-Perfect Competition

Table 5-14 5-year window rolling PR Market competitiveness test, *H*-statistics for Thailand

Variable	1994-1998	1995-1999	1996-2000	1997-2001	1998-2002	1999-2003	2000-2004	2001-2005	2002-2006	2003-2007	2004-2008	2005-2009
Intercept	-8.735	1.438	-2.983	-1.187	22.928	6.059	4.587	15.088	1.167	67.888	61.057	22.767
	(-1.46)	(0.36)	(-0.59)	(-0.19)	(2.88)***	(0.65)	(0.44)	(1.2)	(0.08)	(2.19)**	(2.81)***	(2.14)**
P_D	-0.329	-0.403	0.711	0.592	0.046	0.054	0.064	-0.032	0.705	0.465	0.378	0.421
	(-1.67)*	(-1.24)	(4.03)***	(4.09)***	(0.28)	(0.47)	(0.85)	(-0.33)	(5.82)***	(3.62)***	(2.92)***	(3.65)***
P_{FA}	0.185	0.023	-0.027	-0.135	-0.129	-0.327	-0.235	0.001	0.137	0.007	0.032	0.213
	(2.42)**	(0.21)	(-0.24)	(-1.33)	(-1.44)	(-3.59)***	(-2.73)***	(0.01)	(1.28)	(0.07)	(0.38)	(2.68)***
P_L	-0.264	-0.265	-0.142	-0.019	0.058	0.168	-0.078	-0.112	-0.419	-0.223	-0.227	-0.030
	(-1.9)*	(-1.25)	(-0.74)	(-0.11)	(0.39)	(1.25)	(-0.54)	(-0.93)	(-2.77)***	(-1.31)	(-1.54)	(-0.17)
EFF	2.004	3.562	3.799	2.655	7.344	4.574	3.791	5.647	3.465	2.507	3.064	1.551
	(1.69)*	(2.04)**	(2.1)**	(1.49)	(2.55)**	(1.82)*	(1.85)*	(3.88)***	(1.59)	(2.25)**	(3.03)***	(1.83)*
$R_{D/L}$	-0.516	0.417	0.890	0.084	-0.258	-0.771	-0.713	0.149	0.630	0.787	0.797	0.903
	(-1.23)	(0.53)	(1.22)	(0.12)	(-0.5)	(-2.11)**	(-2.26)**	(0.51)	(1.78)*	(2.21)**	(2.24)**	(2.57)**
$R_{L/A}$	0.066	0.818	1.004	0.227	-0.196	-0.575	-0.553	0.375	0.890	0.941	1.272	0.832
	(0.1)	(1.11)	(1.44)	(0.33)	(-0.4)	(-1.57)	(-1.71)*	(1.22)	(2.5)**	(2.74)***	(4.12)***	(2.1)**
ΔGDP_t	-5.127	-2.274	1.098	0.445	-3.014	0.557	0.670	-1.133	-8.305	-10.170	-4.661	-2.129
	(-5.61)***	(-2.02)**	(1.05)	(0.41)	(-2.47)**	(0.32)	(0.46)	(-0.75)	(-2.58)**	(-3.25)***	(-2.02)**	(-0.91)
ΔGDP_{t-1}	8.946	3.911	2.096	2.273	0.176	0.216	0.381	-0.074	10.679	-1.967	-6.048	-0.351
	(4.64)***	(4.59)***	(3.66)***	(3.44)***	(0.23)	(0.39)	(0.25)	(-0.04)	(4.06)***	(-0.37)	(-1.09)	(-0.09)
OverallR2	0.0711	0.3718	0.1937	0.2001	0.4753	0.2819	0.2850	0.5830	0.0389	0.1333	0.1533	0.0143
$H0:\eta_i=0$	F(16,39) =144.61***	F(17,56) =35.53***	F(17,60) =31.25***	F(17,62) =30.24***	F(17,62) =27.45***	F(18,62) =56.44***	F(18,61) =69.71***	F(18,59) =61.17***	F(19,58) =48.70***	F(19,59) =48.87***	F(18,60) =58.67***	F(17,62) =77.93***
N_{obs}	64	82	86	88	88	89	88	86	86	87	87	88
N_{banks}	17	18	18	18	18	19	19	19	20	20	19	18
H	-0.4080	-0.6446	0.5421	0.4386	-0.0249	-0.1060	-0.2486	-0.1433	0.4236	0.2489	0.1828	0.6036
H0:H=0	F(1,39) =3.19*	F(1,56) =2.78	F(1,60) =3.53*	F(1,62) =2.75	F(1,62) =0.01	F(1,62) =0.34	F(1,61) =1.89	F(1,59) =0.76	F(1,58) =5.14**	F(1,59) =1.94	F(1,60) =1.01	F(1,62) =8.65***
H0:H=1	F(1,39) =37.99***	F(1,56) =18.07***	F(1,60) =2.52	F(1,62) =4.50**	F(1,62) =17.64***	F(1,62) =37.48***	F(1,61) =47.60***	F(1,59) =48.11***	F(1,58) =9.51***	F(1,59) =17.68***	F(1,60) =20.09***	F(1,62) =3.73*
Market Type	M	M	MC-PC	M-MC	M	M	M	M	MC	M-MC	M-MC	MC

***, ** and * denotes coefficient is significant at 1%, 5% and 10% level accordingly; M-Monopoly/perfect collusive; MC-Monopolistic Competition; PC-Perfect Competition

A Series of PR *H*-statistics are calculated for each country, based on the moving 5-year windows and tested accordingly against each of the market type hypothesis in Table 5-1. The Wald test statistics are reported in the separate country results in Table 5.10-Table 5-14, and for comparison convenience, those *H*-statistics and the estimated market structures are reproduced and summarised in Table 5-15. According to Vesala (1995), the magnitude of *H*-statistic could serve as a measurement of the degree of market competitiveness, in the sense that higher values of *H*-statistics indicate a higher level of competition. The changing patterns in *H*-statistics over time could also be treated as a representative of changes in degree of market competition over time.

The results in Table 5-15 clearly shows that the 5 core ASEAN countries have experienced very different evolution processes in terms of banking market competitiveness level. For most of the time, Indonesian banking market can be characterised by monopolistic competition. The degree of market competition was very low at the beginning, but keeps on improving and reaches a peak with an *H*-statistic of 0.4047 in period 2002-2006. However, the degree of competitiveness has been weakened again in recent years, and the market structure moves towards monopoly or perfect cartel. Banking market competitiveness in Malaysia also show a improving trend from zero degree of competition (monopoly or perfect cartel) in early periods to a market that is statistically perfect competitive in the period 2003-2007. The improvement in competitiveness is the most significant among countries in this region.

Situation in the Philippines is very different from other countries, and it is the only country that shows a clear continuers declining trend in banking market

competitiveness over the sample period. *H*-statistics in the beginning periods were high enough to statistically accept the perfect competition hypothesis, but started decreasing around the 1997 Asian crisis and picked up a little after the structural reforms, however, followed by a long-term decreasing till the end. As a result, the banking market in the Philippines could be described as a monopoly market or perfect collusive market for nearly a decade starting from 2001.

The degree of competitiveness of Singaporean banking market is relatively stable and maintains a high level of competitiveness over time. The small value of *H*-statistic in the beginning period is largely due the extremely small sample size, which only contains 17 bank-year observations in 5 years, and therefore does not necessarily reflect true market structure of that time. Other periods are mostly characterised as perfectly competitive market with only a short period decline in competitiveness during the banking structural reform process after the 1997 Asian crisis.

The least competitive banking market is the one of Thailand, which show the most monopoly or perfect collusive market type that evidenced by negative values for *H*-statistic. The Thai banking market maintains a level of competitiveness in general, but with a few fluctuations. Interestingly, the most competitive period is 1996-2001, which covers the 1997 crisis period and the structural reforms after it, but then the market is back to monopoly for a relatively long period until recently an improving tendency has been seen.

The differences in the evolution time paths may be less relevant if they could eventually lead each country's banking market towards a similar competitiveness level. Unfortunately, even in the most recent period 2005-2009, the 5 banking markets still show high level of heterogeneity, ranging from perfect competition/oligopoly with contestability to monopoly or perfect cartel. Furthermore, there is not even obvious evidence for a converging tendency in terms of banking market competition level. The policy implications made earlier in the previous section still hold and have been further proved by these more detailed investigations. The trend of financial integrations in ASEAN countries since the 1997 Asian financial crisis only improved competitiveness in a few countries, and the dispersion in terms of banking market competition is still substantial. The convergence in banking market competition is still weak, indicating a low degree of integration in ASEAN banking markets.

Table 5-15 Summary of rolling regression *H*-statistics and market structures

	1994-1998	1995-1999	1996-2000	1997-2001	1998-2002	1999-2003	2000-2004	2001-2005	2002-2006	2003-2007	2004-2008	2005-2009
H-statistic												
I	0.0743	-0.0455	0.1729	0.2950	0.3494	0.3640	0.4897	0.4090	0.4047	0.2327	0.1819	0.0876
M	-0.1881	-0.3315	0.0216	0.2184	0.4739	0.4816	0.3881	0.5230	0.6673	0.8281	0.7493	0.4134
P	0.7672	0.7911	0.3830	0.4121	0.2561	0.5688	0.4187	0.2285	0.2429	-0.1851	-0.1841	-0.4022
S	0.2296	0.6152	0.9717	0.8899	0.7034	0.9216	0.7287	0.4328	0.8057	1.0724	1.0540	0.9637
T	-0.4080	-0.6446	0.5421	0.4386	-0.0249	-0.1060	-0.2486	-0.1433	0.4236	0.2489	0.1828	0.6036
Market Type												
I	M-MC	M	MC	MC	MC	MC	MC	MC	MC	MC	M-MC	M-MC
M	M	M	M-MC	M-MC	MC	MC	MC	MC	MC	MC-PC	MC	MC
P	MC-PC	MC-PC	MC	MC	M-MC	MC	MC	M-MC	M-MC	M	M	M
S	M-MC	MC-PC	MC-PC	MC-PC	MC-PC	MC-PC	MC	M-MC	MC-PC	PC	PC	MC-PC
T	M	M	MC-PC	M-MC	M	M	M	M	MC	M-MC	M-MC	MC

M-Monopoly/perfect collusive; MC-Monopolistic Competition; PC-Perfect Competition

7. Market competition and concentration

This section examines how concentration affects the degree of competition in ASEAN banking market. The structural approaches of measuring competition links competition to concentration, and predicts a positive relationship between concentration and banks' performance, hence a negative relationship to the competition level. They emphases on, either the causal relationship from market structure (concentration) to banks' performance through their conduct (the SCP paradigm), or the endogenously shaped market structure/concentration as a result of higher market share due to superior efficiency (the ESH approach). The concentration measurement plays an important role in both of the two structural approaches but is typically ignored in the NEIO non-structural approaches of measuring market competition.

The NEIO approaches identify the degree of market competition directly from the banks' pricing behaviour without any explicit structural measure. The relationship between market concentration and market competitive conditions, however, is not clear cut, and not been paid much attention until recent years. The theory of contestable markets argues that the degree of market competition is not determined by the existing market structure, but the potential threat of entry. If the market is perfectly contestable, even a monopolist bank would behave competitively, since the potential threat of competition could become actual competition at anytime if there is economic profit existing. On the other hand, a seemingly competitive market with large number of banks could exercise collusive behaviour when there is relatively high entry cost. In NEIO theories, competition is not necessarily impaired by

concentration, and competitive outcomes could be achieved under various market structures. To the best of the my knowledge, Bikker and Haaf (2002) is one of earliest studies that relates the PR *H*-statistic to concentration indices (*CI*), such as Herfindahl-Hirschman Index (*HHI*) and the *k* bank Concentration Ratio (CR_k), and found evidence from a sample of 23 developed countries, supporting for the conventional view that concentration weakens competition. Claessens and Laeven (2004) also use the 5-bank concentration ratio (among other variables) as an explanatory variable in a regression on the PR *H*-statistic, and the relationship between competition and concentration becomes positive in a larger sample of 50 countries including many developing and transitional countries.

Market concentration could be measured in many ways, but generally a market concentration measurement should reflect elements like the number of banks which measure the "fewness of banks", and size distribution of banks which measure the size inequality among banks[95]. The two most frequently used concentration indices (*CI*) in banking industry are the *k* bank Concentration Ratio (CR_k) and the Herfindahl-Hirschman Index (*HHI*). These two indices are both sum of market shares of banks, but reflect different information.

The *k* bank Concentration Ratio sums only the market share of the *k* largest banks with equal (unity) weight for each bank:

$$CR_k = \sum_{i=1}^{k} s_i \qquad (5.14)$$

[95] Bikker and Haaf (2000) provide an excellent detailed review on various concentration measurements.

where s_i is market share of bank *i*. The choice of *k* is typically arbitrary without theoretical rules, and in the present study, both 3-bank and 5-bank concentration ratios are calculated. The CR_k is a decreasing function of the number of banks, and in the range of 0 (when there is infinite number of banks) and 1(when the market is entirely occupied by the banks included in the ratio calculation). This measurement is simple to use, but totally ignores the market share of small banks that remaining in the industry. The argument is that calculation using entire bank size distribution would be unnecessary if a market is dominated by a small number of banks, since the market behaviour is very unlikely to be affected by the total number of banks. However, ignoring the structural changes of the industry may lead to misleading conclusions. The larger banks may be forced to behave competitively by competitive behaviour of smaller banks (Bikker and Haaf, 2000).

The Herfindahl-Hirschman Index (*HHI*) is a "cumulative" measurement[96] of concentration, indicating market concentration using the entire bank-size distribution, i.e. all banks in the market. Another difference from CR_k is that *HHI* assigns different weights to individual banks by using banks' own market share as it weight, thus greater weights are attached to larger banks if market share is measured based on assets. It takes the form:

$$HHI = \sum_{i=1}^{n} s_i^2 \qquad (5.15)$$

which is simply the sum of squares of banks' market shares. The *HHI* is also a decreasing function of bank numbers, ranging from $1/n$ and 1. When there are n

[96] The CR_k is said to be a discrete measure as it can be considered as on point on the concentration curve.

equal-size banks, HHI reaches its lowest value of $1/n$. The *HHI* takes all banks into account in calculation, and is the most widely used measurement for concentration, especially for policy-making purpose.

In order to examine the relationship between NEIO measurements of market competition and the traditional market structure measurements in the ASEAN banking markets, the PR *H*-statistics estimates (*H*) obtained in the rolling regression of 5-year windows are regressed on the corresponding time period concentration index (*CI*) and the natural logarithm of the number of banks (*Ln(n)*) in the sample[97]:

$$H_{jt} = \theta_0 + \theta_1 CI_{jt} + \theta_2 Ln(n)_{jt} + \omega_{jt} \qquad (5.16)$$

where j= 1,...5 denotes each country in the sample, t=1,...12 denotes each 5-year window and ω_{jt} is the random error term. This test is not doable for each individual country due to limited number of observations, but a panel estimation using all countries' data is only meaningful if they were in a single market.

The inclusion of number of banks in the regression is because of three reasons. Bikker and Haaf (2001) illustrated that the concentration indices are "one-dimensional measures taking account of two dimensions", which are the density and skewness of the banking market. The density is normally measured by the number of banks, and skewness is measured by the size distribution of banks. Describing the market structure by using both concentration index and the number of banks would restore this two-dimensionality. Another reason is that both *H*'s and *CI*'s are estimated or

[97] Similar specification can be found in Bikker and Haaf (2002)

calculated from the available sample rather than the true population. The limited sample size may introduce biases in these measures, and including the number of banks in the sample could correct this bias in the regression. The last but not least function that the number of banks variable serves is that it could be treated as a natural measure of entry barrier, and thus a measure of the potential threat of competition which is the key factor in contestable market theory.

Robustness of the test is checked by using three different asset-based[98] concentration indices, *HHI*, 3-largest bank concentration ratio (*CR3*) and 5-largest bank concentration ratio (*CR5*). The CI's are calculated on yearly bases for each country individually, and the average of 5-year window averages of each CI is used in order to match the *H*-statistics. Table 5-16 represents the average CI's of each 5-year window. The values of *CR3* and *CR5* are always higher than HHI. This is because HHI attaches less weight to smaller banks while *CR*'s treating them equally important. One may notice that the market concentration indices are extremely high for Singapore, in some case are close to unity. Given the limited sample size, which only contains 8 banks at most and only 4 banks in the early periods, these indices do not necessarily represent the true market structure, and this is also the reason why including the number of banks in the regression equation (5.16) is necessary. Concentration indices of other countries do not show dramatic differences between countries. HHI's fluctuate around 0.1000 with the most deviation to 0.1434, the total market share occupied by the largest 3 banks are about 40-50% of the total market and 55-70% for the largest 5 banks.

[98] Calculated based on banks' total assets.

Table 5-16 5-year window averages of CI's

		1994-1998	1995-1999	1996-2000	1997-2001	1998-2002	1999-2003	2000-2004	2001-2005	2002-2006	2003-2007	2004-2008	2005-2009
	I	0.1089	0.1205	0.1275	0.1347	0.1401	0.1434	0.1296	0.1198	0.1090	0.1000	0.0956	0.0939
	M	0.1042	0.1025	0.0992	0.0987	0.0955	0.0927	0.0911	0.0899	0.0910	0.0944	0.0971	0.1004
HHI	P	0.0840	0.0846	0.0859	0.0893	0.0911	0.0928	0.0912	0.0896	0.0864	0.0893	0.0927	0.0961
	S	0.3497	0.3525	0.3534	0.3505	0.3458	0.3366	0.3302	0.3252	0.3217	0.3195	0.3205	0.3207
	T	0.1289	0.1236	0.1206	0.1193	0.1177	0.1171	0.1173	0.1152	0.1140	0.1123	0.1101	0.1089
	I	0.5028	0.5250	0.5350	0.5500	0.5613	0.5707	0.5401	0.5188	0.4924	0.4690	0.4562	0.4517
	M	0.4432	0.4470	0.4451	0.4421	0.4366	0.4279	0.4164	0.4086	0.4199	0.4364	0.4512	0.4681
CR3	P	0.3672	0.3751	0.3825	0.4128	0.4204	0.4289	0.4213	0.4130	0.4019	0.4138	0.4269	0.4388
	S	0.9907	0.9852	0.9800	0.9724	0.9671	0.9647	0.9642	0.9627	0.9647	0.9637	0.9625	0.9617
	T	0.5240	0.5096	0.5025	0.4997	0.4974	0.4958	0.4925	0.4812	0.4732	0.4668	0.4579	0.4560
	I	0.6652	0.6790	0.6891	0.6973	0.7052	0.7127	0.6922	0.6709	0.6490	0.6287	0.6194	0.6164
	M	0.5792	0.5692	0.5662	0.5699	0.5693	0.5650	0.5574	0.5544	0.5643	0.5809	0.5947	0.6094
CR5	P	0.5436	0.5481	0.5560	0.5854	0.5953	0.6054	0.5996	0.5912	0.5754	0.5875	0.6005	0.6124
	S	0.9992	0.9975	0.9959	0.9943	0.9926	0.9917	0.9917	0.9918	0.9921	0.9922	0.9921	0.9918
	T	0.7200	0.7058	0.6979	0.6944	0.6886	0.6850	0.6839	0.6743	0.6700	0.6653	0.6605	0.6598

The results of the various indices show similar ranking among countries. In general, the concentration indices for Indonesia and Thailand are slightly higher than those for Malaysia and the Philippines. The correlation coefficients between each two indices are reported in Table 5-17. HHI and CR3 have the highest correlation coefficient, which is of the value 0.9958, and lowest correlation is between HHI and CR5, but still has a large magnitude of 0.9801. Although various concentration indices measures the market concentration by taking in different information, based on the high correlation coefficients, these indices should reflect similar market structure for each country.

Table 5-17 Correlation coefficient between concentration indices (CI)

	HHI	CR3	CR5
HHI	1.0000	0.9958	0.9801
CR3	0.9958	1.0000	0.9878
CR5	0.9801	0.9878	1.0000

The strong correlation between various concentration indices is a warning message that they should not be simultaneously included in the same regression both as explanatory variables, which may raise the problem of multicollinearity. Therefore, the *H*-statistic is only regressed on one concentration index, with the natural logarithm of number of banks, at once by using fixed-effect panel estimation[99]. Table 5-18 summaries the estimation results.

[99] Experiments on multiple CI's have been conducted and confirmed the existence of multicollinearity problem.

Table 5-18 Relationship between competition and concentration (dependent variable is H-statistics)

	HHI	CR3	CR5
Intercept	-4.1548	-4.5421	-5.3885
	(-2.49)**	(-2.51)**	(-2.76)***
CI	-0.8260	0.2299	1.2768
	(-0.23)	(0.15)	(0.74)
Ln(n)	1.4908	1.5337	1.5600
	(3.20)***	(3.34)***	(3.47)***
OverallR2	0.1805	0.1565	0.1285
H0:η_i=0	F(4,53)=5.35***	F(4,53)=5.57***	F(4,53)=7.24***

***, **, and * denotes coefficient is significant at 1%, 5% and 10% significance level accordingly

Regression results in Table 5-18 using various concentration indices produce somehow consistent results. The coefficient estimates on the three concentration indices are either positive or negative; however, none of them is statistically significant, which means market concentration does not have significant impact on the level of market competition measured by PR *H*-statistics. On the other hand, the number of banks is always highly significant no matter what concentration index is used, and the effect is always positive under all circumstances. Fixed-effect *F*-test statistics are all significant, confirms the existence of cross-country heterogeneity and the appropriateness of the estimation method.

Clearly, if the ASEAN banking market was treated as if it was a single market, the level of competition is not determined or even affected by the market structure. The concentration measurements do not have any explaining power on the competition measurements. If the existing number of banks could be treated as a measure of threat of entry, and therefore the threat of potential competition, then clearly, that is the threat of potential competition that improves the level of competition in the ASEAN banking market. These relationships are evidence for a "contestable market", which may be good news for further banking market integration in this region. Banks already operating in contestable market under the pressure of potential competitions maybe relatively well prepared for adjusting themselves whenever the new competition comes in, even the current competition is not at the optimal level. Further integration will surely bring the foreign rivals into domestic market and strengthen the threat of potential competition, and to some extent the competition was potential may become actual. No matter under what conditions the banks are operating currently, they all need to adjust their behaviours towards the competitive level, and the degree

of competitiveness for the entire ASEAN banking market would be improved accordingly.

8. Conclusion

In this chapter, the research focus is on market competitiveness of ASEAN member country's banking market. Applying the non-structural Panzar-Rosse (PR) reduced-form revenue model, to each country, the *H*-statistics are estimated, firstly for the whole sample period as an average measure of banking market competitiveness in the one and half decades, secondly for a rolling period window of 5 years to investigate the time evolution in banking market competition. The cross-country comparison shows that both the static degree of competitiveness and the dynamic evolution process vary significantly from country to country, and the ongoing process of ASEAN financial integration has not improved banking market competitiveness and the convergence tendency is also weak. The current degree of banking market integration for ASEAN countries is still low in terms of the competitive structures.

The optimal competitive structure for banking market is still a debatable question, due to the trade-offs between economic efficiency and financial stability. When neither perfect competitive nor monopoly can dominate the other, the contestable market seems like a compromising optimal. Through the investigation on the relationships between market competition and concentration under a strong assumption of an existing single market, evidence has been found in favour of the contestable market structure in ASEAN banking markets. This may be a relatively positive aspect for further banking market integration. Banks already operating in

contestable market under the pressure of potential competitions maybe relatively well prepared for adjusting themselves whenever the new competition comes in, even the current competition is not at the optimal level.

Chapter 6 Conclusions

The regional coordination toward financial integration began in the aftermath of the 1997 Asian crisis. Together with significant banking structural reforms in individual countries after the crisis, several regional financial integration initiatives were launched to promote regional financial stability and economic growth. Arguably, a well integrated financial system could improve the efficiency of the economy through lower cost of capital and better allocation of financial resources, and deeper financial integration could also improve the financial stability of the region. Given that most ASEAN economies have underdeveloped capital markets, the banking system is still the principal vehicle of financial intermediation. Furthermore the banking system is also the principal channel of monetary policy pass-through, and therefore the degree of integration in banking markets is crucially important. Improvement in banking integration itself is also important for further real economic, financial and monetary integration in the region.

As pointed out by Bayoumi and Mauro (2001), "it may also be easier to integrate countries...whose financial systems work in a similar manner". In addition, Madhur (2002) outlined few important constraints in ASEAN that may make the future sustaining of a monetary union difficult, one of which is the weakness in the financial sector of many countries. Arguably, a healthy and well-balanced financial system would help reap the maximum benefits from further monetary cooperation, respond to asymmetric shocks, and maintain the financial stability in an open capital market environment.

This thesis examines the impact of national banking structural reforms and ASEAN regional financial integration on the performance in financial markets, particularly, in the banking market. It contributes to the literature in three specific ways: First, it evaluated the effectiveness of the national banking reforms and financial integration process through the evolution of bank efficiency and competitiveness. Specifically it addressed the question, have the national banking reforms and financial integration process improved bank efficiency and banking market competitiveness level? Second, it, investigated the convergence properties of ASEAN bank efficiency, which is used as an indicator of banking market integration at the institutional level. Third, it identified the weakness and strengths of the current ASEAN banking market, and draw policy implications for further regional integration toward the ultimate ASEAN community 2015.

Chapter 3 examined the cost efficiencies of ASEAN banks by using the Battese and Coelli (1995) Stochastic Frontier Approach (SFA). The cost efficiency scores were then used to test for efficiency convergence properties. In Chapter 5, the banking market competitiveness is modelled by the new empirical industrial organisation (NEIO) non-structural approach, Panzar-Roasse (PR) reduced-form revenue model. The degree of similarity in banking market competitiveness across major ASEAN countries is assessed by comparing the estimated *H*-statistics. In addition, the market contestability of the whole ASEAN banking industry is tested by examining the relationship between market competitiveness and market concentration.

In terms of bank efficiency, ASEAN banking markets were found to be converging at the aggregate level, i.e. market of each country as a whole is converging

towards a regional best-practice. However, a different inference can be made when individual banks were taken into consideration, as no strong evidence has been found to support the micro-level convergence. Individual countries' banking sectors are in very different stages of the convergence process, and the cross-country dispersions of individual bank efficiencies are actually worsening over time. The current competitive structure of ASEAN countries' banking market was also found to be uneven with perfect competition in Singapore and Malaysia but pure monopoly or collusive behaviour in Thailand. ASEAN banking markets have also experienced very different evolution process of market structure. Competitiveness of the banking markets of some countries have improved, such as in Malaysia, whereas others are worsened, such as in the Philippines. In addition, the dynamics in banking market competitiveness did not show any clear trend of convergence toward a common standard. Therefore, the main conclusion of this thesis is that the banking national structural reforms and the financial integration efforts after the 1997 Asian financial crisis had not significantly improved the convergence trend in ASEAN banking markets, as measured by pre- and post-crisis convergence properties. The degree of banking market integration is still relatively low.

However, more effective economic and financial integration could be achieved through a number of ways. The positive effect of foreign ownership on bank efficiency, which was found in both the cross-country case and in the single country case, indicate that the increase in foreign ownership, associated with the opening up of banking markets, may lead to the improvement of the overall efficiency level of the whole ASEAN banking market and hence their convergence properties. Although the policies towards more open financial markets have made the banking markets become

less protective and restrictive since the 1997 Asian crisis, the current ASEAN banking markets do not exhibit sufficient degree of convergence. Therefore further financial policy enforcement for cooperation and integration between ASEAN countries are still needed. The other positive news is that the ASEAN banking market as a whole has been found to be contestable, which implies that, under the pressure of potential competition, the existing banks maybe relatively well prepared for adjusting themselves whenever new competition arises.

ASEAN may still have a long way to go towards an ultimate monetary union. The policy encouragements for further integration should be strengthened but with caution. It was noted that the production scale of the ASEAN banking market at aggregate level is just to the right of the optimum point on the long-run average production cost curve, i.e. a mild degree of diseconomy of scale. This may indicate that further banking integration should not encourage further expansion of the banking market, since the cost would increase more than proportionally. However, to moderate the increase in costs, banks should diversify more in their business and engage more in non-traditional banking business. Since the total cost is less sensitive to the increase in output of non-interest income compared with those from the traditional banking activities.

Policy encouragements to improve bank efficiencies and competitiveness should also be made by individual countries. However, policies at country-level should be more specific and take individual bank issues into account. The emphasis on the importance of individual banks was further investigated in a more detailed single country study in Chapter 4, using Indonesia as a sample country to investigate the

evolution of bank-level efficiency and its convergence properties, as well as the impact of the major economic events, such as the 1997 Asian crisis on bank efficiencies. Bank efficiencies were modelled by using an alternative method of non-parametric DEA with Simar and Wilson (2007) double bootstrap method, and the empirical results and implications for Indonesian banks were similar with what was found in the cross-country study in Chapter 3 using parametric method. Therefore the policy implications are robust since using two different methods ends up with similar results.

By distinguishing and comparing the arithmetic mean and weighted average of bank efficiencies, it clearly showed that concentrating only on big banks or the aggregate banking market, but ignoring small bank properties, may distort the awareness of the actual situation of a county's banking market. A major structural change was found following the 1997 Asian crisis, with small and foreign banks become more efficient after the crisis, but large banks which occupy larger market share are relatively less efficient. The worsening dispersion of bank efficiency within one country may be one of the reasons why the ASEAN banking market as a whole lack of micro-level convergence.

The 1997 Asian financial crisis clearly had a major impact on the banking markets of ASEAN countries, governments were active in the banking structural reforms in the aftermath of the crisis, however, the policies seemed not very effective in improving bank efficiencies. Furthermore the speed of convergence within the country slowed in the post-crisis period. Successful regional banking market

integration also requires efforts from each individual participating country, and in order to maintain the comparative advantages in an integrated market, participating countries may also need to strengthen their own banking system.

Appendix

Appendix A. σ-convergence versus β-convergence[100].

Apply the β-convergence defined in Sala-i-Martin (1996) to bank efficiencies, if β-convergence holds across countries/banks $i = 1, \cdots, N$, the partial correlation between growth in efficiency level over time and its initial efficiency level is negative, i.e. -1< β<0 in the following equation:

$$\ln(eff_{it}) = a + (1+\beta)\ln(eff_{it-1}) + u_{it} \qquad \text{(A1)}$$

where $u_{it} \sim iid(0, \sigma_u^2)$. For estimation convention, manipulating equation A1 yields,

$$\ln(\frac{eff_{it}}{eff_{it-1}}) = a + \beta\ln(eff_{it-1}) + u_{it} \qquad \text{(A1')}$$

The sample variance of (log) efficiency in time t is given by

$$\sigma_t^2 = \frac{1}{N}\sum_{i=1}^{N}[\ln(eff_{it}) - \mu_t]^2 \qquad \text{(A2)}$$

where μ_t is the sample mean of (log) efficiency[101]. The evolution of variance can be derived from equation A1,

$$\sigma_t^2 \cong (1+\beta)^2\sigma_{t-1}^2 + \sigma_u^2 \qquad \text{(A3)}$$

This difference equation is stable, only if -1< β<0, therefore β-convergence is necessary for σ-convergence. The steady-state variance is

$$(\sigma^2)^* = \frac{\sigma_u^2}{[1-(1+\beta)^2]} \qquad \text{(A4)}$$

[100] This demonstration follows strictly Young et al. (2008), but with different notations accordingly.

[101] When N is large, the sample variance is close to population variance.

From this equation, we can notice that the cross-sectional dispersion decreases with the coefficient β but increases with random shock σ_u^2. Substitute equation A4 back into equation A3, and yield a first-order linear difference equation with constant coefficients:

$$\sigma_t^2 \cong (1+\beta)^2 \sigma_{t-1}^2 + [1-(1+\beta)^2](\sigma^2)^* \qquad \text{(A5)}$$

The solution for this difference equation is

$$\sigma_t^2 = (\sigma^2)^* + (1+\beta)^{2t}[\sigma_0^2 - (\sigma^2)^*] + c(1+\beta)^{2t} \qquad \text{(A6)}$$

where c is an arbitrary constant. The stability of σ_t^2 is ensured, as long as -1< β<0[102], since

$$|1+\beta| < 1; \qquad \lim_{t\to\infty}(1+\beta)^{2t} = 0, \qquad \text{(A7)}$$

and $$\lim_{t\to\infty} \sigma_t^{\ 2} = (\sigma^2)^* \qquad \text{(A8)}$$

Therefore, given β-convergence exist, the variance will increase or decrease toward its steady-state value depending on the initial variance σ_0^2. If the initial dispersion of efficiency levels is smaller than the steady-state dispersion level, i.e. when σ_0^2 is smaller than the variance of random shocks, σ_u^2, which determines the steady-state dispersion, the dispersion will converge towards steady-state form below.

[102] Also mentioned in Young et al. (2008), as (1+ β)>0, the approach to steady-state is monotonic.

Appendix B. Lerner Index

The Lerner indices are derived based on the estimation results of the Cobb-Douglas cost function in Chapter 3, equation (3.3)

$$\ln\frac{C_{it}}{p_{3it}} = \beta_0 + \beta_1 \ln y_{1it} + \beta_2 \ln y_{2it} + \beta_3 \ln y_{3it} + \chi_1 \ln\frac{p_{1it}}{p_{3it}} + \chi_2 \ln\frac{p_{2it}}{p_{3it}} + (v_{it} + \mu_{it}) \quad (3.3)$$

Where is C is total variable cost, y_1 is total loans, y_2 is other earning assets and y_3 is other operating income. The output y_3 can be thought of as the flow counterpart of a capitalised stock value for non-interest earnings.

The Lerner index is calculated using only the price and marginal cost of the first output, (LOANS), for the following reasons. The third output, Other Operating Income (OYY), is an income flow variable, which represents the non-traditional banking business, and contains the price information in the output measure. A separate measure of Other Earning Assets (OEA) is also included in the cost function, but on the assumption that banks are normally price-takers in this market, e.g. fixed interest rates on bonds[103] the bank faces a perfectly elastic demand curve for this kind of product.

The marginal cost of producing Loans can be derived by

$$MC_{Lit} = \frac{\partial C_{it}}{\partial y_{1,it}} = \beta_1 (\frac{C_{it}}{y_{1it}}) \quad \text{(B1)}$$

[103] Proportion of other kind of investment is relatively small in banks' asset portfolio for ASEAN banks.

The price information on Loans is not directly available, only Total Interest Revenue (*TIR*) from total earning assets ($TEA=y_1+y_2$) is available. To derive the interest rate for loan (r_L), I use the fact that that the price for total earning assets (P) is a weighted average of the price for each earning assets. The price of OEA is denoted by (r_O) therefore,

$$TIR_{it} = r_{Lit}(y_{1it}) + r_{Oit}(y_{2it}) \tag{B2}$$

Divided both sides by TEA gives,

$$P_{it} = r_{Lit}(\frac{y_{1it}}{TEA_{it}}) + r_{Oit}(\frac{y_{2it}}{TEA_{it}}) \tag{B3}$$

As discussed above, r_O is given and equals to the marginal cost of OEA, and

$$MC_{Oit} = \frac{\partial C_{it}}{\partial y_{2it}} = \beta_2(\frac{C_{it}}{y_{2it}}),$$

Equation (B3) can be written as

$$\begin{aligned} P_{it} &= r_{Lit}(\frac{y_{1it}}{TEA_{it}}) + \beta_2(\frac{C_{it}}{y_{2it}})(\frac{y_{2it}}{TEA_{it}}) \\ &= r_{Lit}(\frac{y_{1it}}{TEA_{it}}) + \beta_2(\frac{C_{it}}{TEA_{it}}) \end{aligned} \tag{B4}$$

and rearranging the equation to solve for r_L,

$$r_{Lit} = P_{it}(\frac{TEA_{it}}{y_{1it}}) - \beta_2(\frac{C_{it}}{y_{1it}}) \tag{B5}$$

And the Lerner Index (LN) can now be derived as:

$$LN_{it} = \frac{P_{it}(\frac{TEA_{it}}{y_{1it}}) - (\beta_1 + \beta_2)(\frac{C_{it}}{y_{1it}})}{P_{it}(\frac{TEA_{it}}{y_{1it}}) - \beta_2(\frac{C_{it}}{y_{1it}})} \tag{B6}$$

The yearly average of the calculated Lerner Indices for each country is reported in Table B-1. The negative values for Lerner index indicate that the banks were making losses during that period on loans, and this is a sign of the serious non-performing loan problem that existed during the Asian financial crisis. This may also imply that surviving, banks needed to generate revenue from other activities. Ignoring those non-traditional banking activity, which on average constituted 17% of gross revenue over the sample period, may produce misleading results.

Table B-1 Lerner Index

	Indonesia	Malaysia	Philippines	Singapore	Thailand
1994	0.1587	0.1732	0.0183	0.0541	0.3078
1995	0.1264	0.2658	0.0387	0.0441	0.2372
1996	0.1119	0.3028	0.0781	0.2533	0.2416
1997	0.1089	0.3146	0.1472	0.2479	0.1909
1998	-8.1551	0.2856	0.1140	0.2514	-0.3417
1999	-3.5992	0.2721	-0.0820	0.3663	-0.6928
2000	-0.1300	0.3383	-0.2378	0.2769	-0.2985
2001	0.1199	0.3151	-0.2198	0.2213	-0.1516
2002	0.1034	0.1935	-0.4187	0.3761	0.0077
2003	0.1752	0.1771	-0.2961	0.3949	0.1122
2004	0.3102	0.1440	-0.1234	0.3613	0.2849
2005	0.2373	0.1081	-0.0965	0.2758	0.3564
2006	0.2413	0.1410	-0.1176	0.1950	0.2546
2007	0.2656	0.1486	-0.1239	0.1976	0.2338
2008	0.2944	0.2173	-0.0410	0.3282	0.3146
2009	0.3253	0.2170	0.0521	0.4532	0.2967

To compare the Lerner Index with the PR H-statistics, I take the average value of each in the pre-crisis (1994-1998) and post-crisis (1999-2008). The results are mixed and not consistent. But, the increase in competition from Lerner index is only evidenced in Malaysia and Thailand which are consistent with the result from PR *H*-statistics. Results for other countries do not show significant correlations. The

Lerner index is only a partial indicator for bank's market power, and the PR H-statistics provide more precise information on the measurement of market competitiveness.

Table B-2 Comparison between Lerner index and PR *H*-statistic

		1994-1998	1999-2008
LN	Indonesia	-1.5298	-0.1982
	Malaysia	0.2684	0.2055
	Philippines	0.0793	-0.1757
	Singapore	0.1702	0.2993
	Thailand	0.1272	0.0422
H	Indonesia	0.0743	0.2730
	Malaysia	-0.1881	0.6155
	Philippines	0.7672	0.1924
	Singapore	0.2296	0.9878
	Thailand	-0.4080	0.0384

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