PAK Publishing Group
Growing Knowledge for Future

Proceedings Book of ICEFMO, 2013, Malaysia
Handbook on the Economic, Finance and Management Outlooks
ISBN: 978-969-9347-14-6

Post Asian Crisis Experience on Bank Efficiency and Competition

Shazida Jan Mohd Khan
School of Economics, Finance and Banking, Universiti Utara Malaysia, Kedah, 06010, Malaysia
Norazlina Wahab
Islamic Business School, Universiti Utara Malaysia, Kedah, 06010, Malaysia

Abstract

The transformation in Asian banking came with the aim to recover and improve the banking system performance and soundness. The structural changes in SEA has improved the region banking industry performances and brought significant effects through the regulatory changes as it spur a trend towards consolidation, resulting in the recent wave of mergers and acquisitions. This study investigates the impact of post crisis (1997 – 2005) banking reform on competition and performance of the banking system. Competition level is assessed by employing Panzar and Rosse methodology, while the efficiency is evaluated using Data Envelopment Analysis (DEA) that adjusted to allow slack or surpluses due to the environment variables. Our analysis shows that the region has successfully transformed the banking sectors as the efficiency indicates score displays positive changes. However the relation between efficiency and competition may not be a straightforward impact.

Key words: Efficiency, Competition, Post Asian Crisis
JEL Classification: G21, G28, D24

1. Introduction

Bank in SEA economy have always been prone to crisis. SEA crisis is said to be different and this can explained by Radelet and Sachs(1998, p.g. 1);

"*The East Asian Financial crisis is remarkable in several ways. The crisis had hit the most rapidly growing economies in the world. It has prompted the largest financial bailouts in history. It is the sharpest financial crisis to hit the developing world since the 1982 debt crisis. It is the least anticipated financial crisis in years".*

The Asian financial crisis of 1997[1] is now sees as one of the most significant economic events in recent world history. At the time, one common interpretation was that the crisis debunked the "Asian

[1] The 1997 Asian economic crisis was initially a financial one as speculation caused fund to drain out of Thailand and Korea currencies and stock markets. Due to this event, the crisis eventually caused economic growth rates to collapse in several Southeast Asian countries. There have been distinct phases to the Asian crisis: the first from mid-July 1997, when it first struck Thailand then followed by neighboring country, Malaysia, Indonesia and the Philippines, and the second since mid-

miracle". Capitalism and globalization were repudiated and blamed for the busting of currency and property bubbles and the resultant difficulties (Anthony B. Kim, (2007). Asian and the western government, the private sectors, and the International Monetary Fund (IMF) established to provide temporary financial assistance to help countries ease balance of payments adjustments (Bhumika Muchhala, 2007).The financial crises severely undermine public finances in a number of Asian countries and prompted the IMF to organize a rescue package, involving Thailand, Korea, Indonesia and the Philippines. Due to this assistance, IMF has played a major role in changing the Southeast Asian economies mainly through restructuring the banking system. Asian crisis has also agreed to a proposal which allow global standards for banking regulation, enhancing the quality of economic statistics and improving the levels of information available to investor in emerging market economies. However, Malaysia refused to liberalized and open its capital and financial markets and instead took capital control measures as the country believed it is the movement of short term money that caused the crisis (Seok Yoon, 2005).

Asian banking has always known for their strong presence beside has the largest number of deposit taking institutions and banks across region in the world, despite closure of fairly large number of institutions following the 1997 economic crisis.

Table-1. Trends in Banking System

	East Asia[1]		**Latin America[2]**		**Central Europe[3]**		**Advanced[4]**	
	1990	1999	1990	1999	1990	1999	1990	1999[5]
Number of deposit taking institutions[6]	10,100	11,761	1,344	1,741	2,087	1,154	39,766	30,361

[1]Sum or simple average of Korea, Malaysia, the Philippines and Thailand; [2]Sum or simple average of Brazil, Chile, Columbia, Mexico and Peru; [3]Sum or simple average of Czech Republic, Hungary and Poland; [4]Sum or simple average of Australia, Euro Area, Hong Kong, Japan, Singapore, Switzerland and the United State; [5]1998 data, other than for Hong Kong and Singapore; [6]Including commercial, savings and various types of mutual and cooperative banks, and similar intermediaries such as building societies, thrifts, savings and loan associations, credit unions, post banks and finance companies but excluding insurance companies, pension funds, unit trusts and mutual funds.

Source: BIS Questionnaire, British Bankers'' Association; Building Societies Association and bseindia.com/downloads/AsianBanking.pdf**.**

Despite the crisis in 1997, Asian banking has continuously experienced a significant growth. Domestic credit provided by banking as a percentage of GDP, reflects the significant of banking in the economy. Table 2 explained the deposit spurt in the ratio and despite severe crisis that plagued the entire SEA region, this ratio remains rather high.

Table-2. Domestic Credit Provided by Banking Sector.

Country	**% GDP**			
	1990	**1997**	**2000**	**2005**
Indonesia	46.67	59.55	60.68	46.20
Korea, Rep.	51.90	59.33	74.70	133.36
Malaysia	72.67	163.35	138.37	117.66
Philippines	23.23	78.54	58.34	47.25
Thailand	94.08	177.58	138.27	119.18

Source: World Development Indicators

1998, when the turbulence has spread beyond the region as Russia, China and Brazil have shown signs of contagion. Measures had to be taken to improve overall economic system as depression became uncontrollably serious and prolonged.

As soon as the crisis hit in mid-1997, these countries took immediate action towards recovery. Actions are taken by introducing mergers and acquisition which prevails new era of consolidation in the financial sectors which raised concerns about competition in their banking sector. Banking competition is expected to provide welfare gains by reducing monopoly rents and cost inefficiencies. The higher the degree of competition wills results in a lower monopoly power of banks and therefore a decrease in banking prices. However, from policy point of view, how this structural development may affect the competitive environment and how they may influence the efficiency is still in question (Casu and Girardone, 2005).

This study investigates the impact of post crisis (1997 – 2005) banking reform on competition and performance of the banking system. This study is motivated by the gap in past literature which most has concentrated the study on the effects of concentration, competition and market structure of banking industry on developed markets (Molyneux et al., 1994; Hempell, 2002; Biker and Groeneveld, 2000) and less attention given towards developing Asian and the crisis region. This search will contributes to the literature by looking into the behaviour of competition in the SEA during post crisis by investigating the most affected country. Secondly, this study provide cross country analysis on SEA bank competition by utilising non-structural approach, Panzar and Rosse *H*-statistics. With the emerging of consolidation in the banking sectors through the restructuring planned, competition is an area that needed to look upon especially after the region crisis and recovery experienced.

While the performance based on the efficiency is evaluated using Data Envelopment Analysis (DEA) that adjusted to allow slack or surpluses due to the environment variables. We apply the four-stage methodology proposed by Fried et al. (1999), whereby we account for the impact of environmental variables in a DEA- based study. The aim is to incorporate the influences of the external variables on South East Asian banking efficiency measurements. In doing so, we allowed slack or surpluses due to the environment variables and used it to calculate adjusted values for the primary inputs. In other words, the new radial efficiency measures incorporate the environmental variables (see appendix for further explanation).

Our analysis shows that the region has successfully transformed the banking sectors as the efficiency indicates score displays positive changes. However the relation between efficiency and competition may not be a straightforward impact.

2. Methodology and Data

Development in new empirical industrial organisation (NEIO) has offer new techniques that infer the competitive conduct of market participants directly without the need the information on market structure. The NEIO provides several approaches to examine the existing market power and to quantify the degree of competition in the market place (Martin, 1993). There are two main methods within this approach that are used in the empirical analysis of banking: the Panzar and Rosse method (1987) H-statistic, and the Conjectural Variations approach (Iwata, 1974; Bresnahan, 1982; Lau, 1982 or CV approach). Whilst both the structure-conduct-performance (SCP) paradigm and the Panzar and Rosse method are reduced-form analyses, the conjectural variation approach is a structural approach. However, based on the most referred approach, we employed Panzar and Rosse approach for the following analysis.

2.1. Panzar and Rosse H-statistics

The new empirical industrial organisation (NEIO) approach provides non-structural tests to circumvent the problems of measuring competition provided by the traditional industrial organisation approaches. In comparison, NEIO approaches infer banks' conduct directly and allow researcher to consider the actual behaviour of the banks by taking contestability into account. Claessens and Laeven (2004) argued that the actual behaviour of a bank is not only related to market structure but also to the barriers to entry influencing the likelihood of the entry of new competitors and therefore the behaviour of incumbents forecasting such an entry. The measures from NEIO include the Panzar and Rosse [2]

[2] The Panzar-Rosse approach has been widely applied to assess competitive conditions in the banking systems of the United States, Canada and Japan since early 1980s, with later work focusing on European countries, transition economy and still few

(PR) model, which provide an aggregate measure of competition, and the Lerner index, an individual measure of market power.

Panzar and Rosse (1977), uses firm (or bank) - level data and uses a test statistic *H* which at appropriate condition can be used and served as a method to measure competitive behaviour of banks. *H* statistics indicate the nature of the market structure under certain assumption[3] as showed in Table 3. It investigates the extent to which a change in factor input prices is reflected in (equilibrium) revenues earned by a specific bank. PR model are calculated from a reduced form revenue equation and measures the sum of elasticity of total revenue of the firm with respects to the firm's input prices. The test is derived from a general banking market model, which determines equilibrium output and the equilibrium number of banks, by maximising profits at both the bank level and the industry level. This implies, first, that bank *i* maximises its profits, where marginal revenue equals marginal cost (Bikker and Haaf, 2002, pp. 2193):

$$R_i'(x_i, n, z_i) - C_i'(x_i, w_i t_i) = 0 \qquad (1)$$

R_i refers to revenues and C_i to costs of bank i (the prime denoting marginal), x_i is the output of bank *i*, n is the number of banks, w_i is a vector of m factor input prices of bank *i*, z_i is a vector of exogenous variables that shift the banks revenue function, t_i is a vector of exogenous variables that shift the banks cost function. Secondly, at the market level, it means that, in equilibrium, the zero profit constraint holds:

$$R_i^*(x^*, n^*, z) - C_i^*(x^*, w_i t_i) = 0 \qquad (2)$$

This can be summarised in the following equation with * indicate equilibrium values:

$$H = \sum_{k=1}^{m} \frac{\delta R_i^*}{\delta W_{ki}} \frac{W_{ki}}{R_i^*} \qquad (3)$$

Where R_i^* is the revenue of the bank i, W_i is a vector of m factor input prices of bank *i*. Market power is measured by the extent to which a change in factor input prices δW_{ki} is reflected in the equilibrium revenue δR_i^* earned by bank *i*. According to PR model provides a measure of "*H*-statistic" which ranges between 0 and 1 of the degree of competitiveness of the industry:

$$H = \sum_{k=1}^{m} \beta_k \qquad (4)$$

The *H*-statistic abridges in a single figure the overall level of competition prevailing in the market under consideration (Rozas, 2007). *H*-statistics is negative ($H \leq 0$) for a neoclassical monopolist, or perfect collusive oligopolies (Cartel). Explaining that one percentage increase of input prices leads to precisely a one percentage increase of marginal cost. The profit-maximizing monopoly sets output price so that it operates at an output level where perceived marginal revenue equals marginal cost. In perfectly competitive market, H=1, shows any increase in input prices increase both marginal and average cost. One percentage increase in input prices induces one percentage increase of average cost. Under perfectly competitive market assumption, firm is a price taker and have the opportunity to enter and exit from the market freely. This has left the firm with loss even at its profit maximization level. If *H* lies between zero and unity (or $0<H<1$), the market structure is characterised as monopolistic.

---

in Asian region. Most of these banking systems exhibited characteristics of monopolistic competition (Bikker and Haaf, 2002).

[3] (1) banks are profit maximizing, single product firm facing normally distributed revenue and cost functions; (2) banks produce revenue using labour, capital and deposits (intermediated funds) as inputs; (3) higher input prices are not associated with higher quality services that operate higher revenue; and (4) banks are in long run equilibrium. Nonetheless, product differentiation is allowed in the monopolistic competition model (Gelos and Roldos, 2002).

Table-3. The Panzar-Rosse *H*-statistic

Value of H Index	**Competitive Conditions**
$H \leq 0$	Monopoly or conjectural variations short-term oligopoly. Each bank operates independently as under monopoly profit maximizing conditions. *H* is a decreasing function of the perceived demand elasticity.
$0<H<1$	Monopolistic competition Free entry (Chamberlain) equilibrium excess capacity. *H* is an increasing function of the perceived demand elasticity
$H=1$	Perfect competition, or natural monopoly in a perfect contestable market, or sales maximizing firm subject to break even constraint. Free entry equilibrium with full (efficient) capacity utilization.
	Equilibrium Test
$H<0$	Long Run Equilibrium
$H=0$	Disequilibrium

Sources: Molyneux et al., 1994.

The critical feature of PR model besides being static model, the banks or firm observations need to be in long run equilibrium. The long run equilibrium test is carried out using the *H* statistic where it measures the sum of elasticity of return on assets with respect to input prices. Values of *H* statistic equal to zero would indicate equilibrium while less than zero meant disequilibrium. If the results shows not in long run equilibrium, it is true that $H<0$ no longer proves monopoly, but remains true that $H>0$ disproves monopoly or conjectural variation short run oligopoly.

PR methodology assumed that banks are treated as a single product firms and it is consistent with the intermediation approach to banking where banks are viewed mainly as financial intermediaries. Two approaches can be found in measuring bank output, production approach and intermediaries approach. In the **Production approach** banks are treated as firms that use capital and labour to produce different categories of loan and deposit account where the number of accounts or related transaction measures the output. Total cost is operating costs used to produce these output. **Intermediation approach** treated banks as in intermediaries for financial services. Therefore, labour and capital are inputs and operating cost plus interest cost are the relevant cost measure (De Bandt and Davies, 2000, pp.1048).

PR model is being considered valuable tools in evaluating market conditions owing to its simplicity and transparency without lacking efficiency[4] (Delis, 2009). The main advantage of PR model is data availability which is less needed since it more rely on bank total revenue and input price (does not required data on output price and quantities). Since *H* statistics does not contain any specific hypothesized definition of the market structure, it is robust with respect to any implicit market definition (Shaffer, 2004; Kasekende et al., 2009). The non-necessity to define location of the market a priori implies that the bias cause by the misspecification of market boundaries is avoided; hence for a bank that operates in more than one market, the *H* statistic will reflect the average of the bank's conduct in each market (Delis, 2008:4). Under PR model, utilising the bank level data has allows for

[4] The PR approach has been extensively utilised in evaluating competition in mature banking systems in North America (for example U.S. banking system study by Shaffer (1989); and on Canada, Nathan and Neave, 1989) and various European Countries (for example, in European countries, Molyneux et.al. (1994) which look into banking system in France, Germany, Italy, Spain and United Kingdom, Vesala (1995) concentrate on Finland, Coccorese (2002) on Italy, De Brandt and Davis (2000) investigate the banking competition in France, Germany and Italy; Egli and Rime (1999) look upon Switzerland; Hondroyiannis et al. (1999) in Greece; Bikker and Groeneveld (1998) on 15 EU countries; Hempell (2002) on Germany; and Maudos, Pastor and Perez (2002) in Spain and Japan by Molyneux et al., 1996. More recent interest in the model has used it to analyse emerging markets' banking system (for example Gelos and Roldos (2002) on Central Europe and Latin America; Belaisch (2003) on Brazil; Yildirim and Philippatos (2002) investigate the country in Central and Eastern Europe; Levi Yeyati and Micco (2003) in Latin America; and Zambrano Sequin (2003) in Venezuela. Cross country studies including studies by Claessens and Laeven (2003), and Bikker and Haaf (2002).

bank-specific differences in the production function. The assumption on single product firm is also consistent with the intermediaries approach to banking (De Bandt and Davies, 2000).

2.2. Model Specification

We estimate the following reduced form revenue equations on pooled samples for each country[5]:

$$\ln TREV = \alpha + \beta_1 \ln P_{1,it} + \beta_2 \ln P_{2,it} + \beta_3 \ln P_{3,it} + \gamma_1 \ln ETA_{it} + \gamma_2 \ln AST_{it} + \gamma_3 \ln \ln TLA_{it} + \gamma_4 \ln LLPL_{it} + \varepsilon_{it} \quad (5)$$

For t = 1 …T, where T is the number of periods observed and I = 1….I, where I is the total number of banks. Subscripts i and t refer to bank i at the time t. The dependent variable is lnTrev which is total revenue over total assets (proxy for output price for loans). Molyneux et al. 1994 and Bikker and Haaf, 2002, treat interest as dependent variable whereas following Casu et al. (2006), Nathan and Neave (1989) and De Bandt and Davies (2000), argues the differences between interest and non-interest income is becoming less significant in more competitive environment. Recent developments in banking industry have given great interest in accounting non-interest income along with non-interest income from fee-based products and off balance sheet activities to total revenue (Casu and Girardone, 2006).

Output variables are treated as dependent variables and divided by total assets in order to account for the differences in the banks sizes. Three input used in the analysis under intermediation approach, $\ln P_1$ as the average labour cost (personnel expenses/total assets); $\ln P_2$ as the average cost of deposits (interest expenses/ total deposit and money market funding); and $\ln P_3$ as the ratio of other operating expenses and administrative expenses to total assets (proxy for input price of equipment/fixed capital).

Bank specific factor are used to give overall view on banking industry and act as the control variable at the individual bank level, we include (1) lneta, the ratio of total equity to total assets (to control for different risk propensity); (2) lnast, logarithm of total assets (to control for potential size effects and considered as a proxy for scale economies); (3) lnltla, ratio of total loans to total assets (to show proportion of loan and revenue); and (4) lnllpl, ratio of loan loss provision over total loan. *H*-statistics measures are calculated as the sum of the input prices coefficient $\beta_1+\beta_2+\beta_3$.

An important feature of the *H*-statistics is that the test must be undertaken on observations that are in the long-run equilibrium. Nathan and Neave (1989) point out that this interpretation assumes that the test is undertaken on observations that are in long-run equilibrium. According to the past studies (Molyneux et al., 1994; De Bandt and Davies, 2000; Bikker and Haaf, 2002), the test is based on the proposition that in the competitive capital markets risk-adjusted rates of returns will be equalized across banks. We estimate the equilibrium test by recalculating the PR *H*-statistics by replacing the dependent variable total revenue over total assets with the natural log of return on assets (ROA),

$$\ln ROA = \alpha + \beta_1 \ln P_{1,it} + \beta_2 \ln P_{2,it} + \beta_3 \ln P_{3,it} + \gamma_1 \ln ETA_{it} + \gamma_2 \ln AST_{it} + \gamma_3 \ln \ln TLA_{it} + \gamma_4 \ln LLPL_{it} + \varepsilon_{it} \quad (6)$$

It is important to realised the verification for the cases of perfect competition (*H*=1) and monopolistic competition (*H*>0), while *H*<0 is a long run condition for monopoly. If the sample is not in the long-run equilibrium, *H*<0 no longer establishes monopolistic market conditions, but will remains true that *H*>0 disproves monopoly or conjectural variation short run oligopoly (Shaffer, 1982). Following Claessens and Laeven (2004), the measure of ROA is (1+ROA) which adjusted to any negative values due to losses in any year. The long-run equilibrium test measures the sum of the elasticity of return on assets with respect to input prices. If the E-statistic ($\beta_1+\beta_2+\beta_3$) = 0, the banking market is in long run equilibrium. If rejected, the market is assumed not to be in equilibrium

[5] We followed similar specification of dependent variables of Luc Laeven (2006), Casu et al. (2006) and Claessens and Laeven (2004). The empirical application of the P-R approach usually assumes log-linearity in the specification of the marginal revenue and cost functions. ln denotes the natural logarithm. For estimation purposes, the log-specification is intended to avoid heteroskedasticity (Luis Gutierrez de Rozas, 2007).

(Claessens and Laeven, 2004). We test whether $E = \sum_{j=1}^{j} \beta_j$ is equal to zero again using the F- test. If rejected, the market is not in equilibrium, and if accepted, then it indicates that in equilibrium prices of input are not related to banks return on assets.

2.3. Accounting for Bank Efficiency

Recent research testing for financial sector competition has expanded including more interest in the developing country. However, as highlighted earlier there is a lack of literature that investigates the relationship between competition and concentration in SEA especially after the experienced of 1997 financial crisis. In this section we aim to explore the link between the efficiency (EFF) and competition in SEA crisis effected country. The frontier efficiency is estimated using the non-parametric techniques (DEA)[6] and include such score in the reduced form equation (5).

$$\ln TREV = \alpha + \beta_1 \ln P_{1,it} + \beta_2 \ln P_{2,it} + \beta_3 \ln P_{3,it} + \gamma_1 \ln ETA_{it} + \gamma_2 \ln AST_{it} + \gamma_3 \ln \ln TLA_{it} + \gamma_4 \ln LLPL_{it} + \gamma_5 \ln EFF + \varepsilon_{it} \quad (7)$$

The equilibrium test has to be carried out again, recalculating the PR *H*-statistics replacing the dependent variable total revenue over assets with the natural log of return on assets (ROA) as shown in equation (6).

$$\ln ROA = \alpha + \beta_1 \ln P_{1,it} + \beta_2 \ln P_{2,it} + \beta_3 \ln P_{3,it} + \gamma_1 \ln ETA_{it} + \gamma_2 \ln AST_{it} + \gamma_3 \ln \ln TLA_{it} + \gamma_4 \ln LLPL_{it} + \gamma_5 EFF + \varepsilon_{it} \quad (8)$$

The results of efficiency used are estimated using the four stage analysis as in appendix.

3. Data and Descriptive Analysis

The following Table 4 reflect the sample used and followed by the descriptive analysis of all the variables used in analysing the relationship of competition and efficiency. DEA estimation has include the impact of environmental variables in the efficiency estimations as showed in Table 5.

Table-4. Sample Used for Empirical Analysis

Countries	Average number of banks (1999-2005)	Total number of banks	Per cent of total	Average size of banks (millions US$)
Indonesia	51	355	37.6%	2519.35
Korea	16	114	12.1%	46911.34
Malaysia	27	192	20.4%	7148.12
Philippines	24	171	18.2%	2197.47
Thailand	16	110	11.7%	11209.16
Total	134	942	100%	69985.44

Table-5. Descriptive Statistics of the Variables

Variable	Mean	Std. Dev.	Min	Max
ix	365.096	842.977	0.300	7637.000
nix	121.679	281.104	-0.800	2645.800
ii	533.397	1381.590	0.300	14279.600
nii	154.369	488.554	0	5466.100
TRA	0.096	0.073	-0.368	1.061
p1	0.011	0.007	0	0.123
p2	0.108	0.602	0.005	12.678
p3	0.030	0.073	-0.005	1.009

[6] The efficiency estimation is estimated using the four stage analysis as in appendix. The results is upon request.

ETA	11.026	11.717	-129.210	99.720
TAST	9791.377	21799.980	6.500	201215.100
TLA	51.666	18.599	0.620	89.820
LLPTL	0.014	0.270	-5.133	4.182
ROA	0.841	4.519	-30.440	66.960

ix [interest expenses]; nix [non- interest expenses]; ii (interest income); nii [non-interest]; TRA [total revenue over total assets]; p1 [the ratio of personnel expenses over total assets acted as average labour cost] ; p2 [the ratio of interest expense over total deposits and money market funding]; p3 [the ratio of other operating expenses and administrative expenses over total assets]; ETA [the ratio of total equity to total assets]; TAST [total assets]; TLA [the ratio of loans to total assets]; LLPTL [the ratio of loan loss provision to total loans]; ROA [return on assets].

3.1. Analysis and Results

Due to some country sample are too small therefore we are only able to implement this approach by pooling country-level data over several years. As a consequence, we only estimate changes in competition over time across all countries in the region, not for individual countries. The regression models are estimated using the fixed effect (FE) estimators[7]. Table 6 report the H-Statistics results. The Estimated *H*-statistics for all selected country is 0.479, indicating a monopolistic competition. Such results are confirmed by the country level estimations. The value of *H*-statistics ranges from 0.663 in Korea to 0.060 in Malaysia. *F*-test results indicate that hypothesis for H-statistics is equal to zero (monopoly) is rejected in all countries. Therefore the hypothesis of $1<H<0$ (monopolistic competition) holds in all selected countries The results is consistent with the study by Claessens and Laeven (2004) and other studies on developing country where the *H*-statistics ranges between zero and one (Al-Muharammi et al., 2006; Parera et al., 2006). The results also imply that the banking sector earned their revenue in market condition of monopolistic competition and any form of conjectural variation oligopoly and monopoly can be clearly rejected during the period of study. Malaysia turns out to be the least competitive country whereas Korea are the most competitive followed by Indonesia, Philippines and Thailand.

Table-6. H-Statistics Fixed Effects 1999-2005

	Indonesia	**Korea**	**Malaysia**	**Philippine**	**Thailand**	**All**
lnp1	0.080	0.084	-0.025	0.054	0.189	0.044
	(0.076)	(0.051)	(0.862)	(0.164)	(0.119)	(0.416)
lnp2	0.424***	0.505***	-0.057	0.428***	0.180***	0.300***
	(0.383)	(0.089)	(0.078)	(0.088)	(0.060)	(0.027)
lnp3	0.130**	0.074**	0.142***	0.160	-0.085	0.135***
	(0.056)	(0.037)	(0.036)	(0.184)	(0.084)	(0.021)
lneta	-0.082	0.222***	-0.273***	0.046	0.133*	-0.020
	(0.074)	(0.058)	(0.075)	(0.119)	(0.071)	(0.037)
lnast	-0.224***	-0.018	-0.177**	0.047	-0.547***	-0.110**
	(0.067)	(0.110)	(0.088)	(0.137)	(0.128)	(0.042)
lntla	0.253	-0.380*	0.271*	-0.015	0.348***	0.155***
	(0.041)	(0.194)	(0.137)	(0.126)	(0.097)	(0.003)

[7] Hausman test were used to choose between fixed (FE) and random effect (RE). FE is reasonable thing to do with panel data and it give consistent results. RE may give a better P-value as these are more efficient estimator. Hausman test the null hypothesis that coefficient estimated by the efficient RE estimators are the same as the ones estimated by the consistent FE estimator. We found that they are significant with P-value, Prob 〉 chi2 is smaller than 0.05, therefore it is safe to use FE.

lnllpl	0.025*	0.030	-0.020	0.046	0.011	0.014
	(0.015)	(0.018)	(0.218)	(0.029)	(0.017)	(0.009)
cons	0.641	1.356	-1.568	-0.548	1.556	-0.420
	(0.655)	(1.162)	(1.005)	(1.457)	(1.021)	(0.390)
H statistics	0.633	0.663	0.060	0.642	0.283	0.470
	(0.631)	(0.662)	(0.030)	(0.612)	(0.279)	(0.129)
F test (*H* stat = 0)	40.990	15.270	14.310	9.440	3.050	52.56
F test (*H* stat = 1)	249.040	285.070	548.140	50.790	212.770	910.84
Equilibrium test:						
F value for H=0	1.36	3.45	1.46	1.56	1.96	0.600

Notes: * p<0.10, ** p<0.05, *** p<0.01; Standard errors in parentheses.

Even though Malaysia has aggressively involved in consolidation through merger and acquisition, it has definitely reduced the number of banks operated in the country which led to lower competition among banks. This result is suggesting the same conclusion with finding by Suffian et al. (2006, pp.16). Their finding indicates that even though the results pointed to the monopolistic competition in the banking, it does not show any indication of the change in the market lead to increase in market competition in the recent years.

The Philippines, despite the generally difficult regional conditions which prevailed as a result of the onset of the Asian financial crisis in 1997, the Philippines has emerged as among the most resilient economies in the region. The country has started it pursued to encourage greater competition and strengthen their supervisory and regulatory system since 1980s and getting more intensified during the 1990s. During the crisis, the Philippines implement mergers and consolidation in order to create stronger financial and a well-managed banking institutions. Even though big mergers has increased market concentration the overall competition levels is stable since market share remained relatively well dispersed among the remaining players. The commercial banking industry seems to progressing in mergers and consolidations without necessarily inhibiting effective competition (Reyes, 2001; pp.116).

As reveal in the analysis Thailand H-statistic just 0.263 which remains low for a country that received financial support from IMF. However the same conclusion made by Koji Kubo (2006) where he evaluate the Thailand banking competition using Bresnahan's (1989) conjectural variation model. Thailand has been seen to have implemented two biggest changes which both have aid to have impact on the degree of competition. First, changes to ownership structure of financial institutions through nationalising and liquidating distress banks and also abolished the restriction on the foreign ownership of commercial banks in order to invite foreign banks and investors to recapitalize the distressed banks. Second, changes in the financial authorities towards entry to the banking sector. Kubo (2006, pp.21) concludes that in spite of changes in the competitive environment of the banking industry in terms of ownership structures and regulations, these changes may make it difficult to maintain collusion, if any, between banks and preliminary estimation results reveal the possibility of a decline in competition.

The majority of other bank-specific variables report a mixed result. In the estimation (Table 6) the ratio of total revenue over total assets (TREV) is used as the dependent variables. The dependent variables is divided by assets is to account for size differences. Although interest revenues still constitute the principal source of banks' earning, recent studies on banking activities report a dramatic increase of other income from fee-based products and off-balance sheet activities in recent year given the increased level of competition in financial markets (Majid and Sufian, 2007, pp.110, Sufian et al., 2006, pp.13, Nathan and Neave, 1989; De Bandt and Davies, 2000). Another justification for the

increased is the desire of financial services firms to expand their revenue generating sources without altering their risk and thus their capital structure.

An analysis of the sign and significance of the regression coefficients indicates that the price of funds is always positive for all the countries (with the exception of Malaysia) and statistically significant in most countries. The price of labour shows a positive sign and not statistically significant in all the countries (with exception of Malaysia). The impact of price of labour and price of capital seems to be minimal compared to the price of funds (again with the exception of Malaysia). Nevertheless, these results do comply with previous studies, which found that the impact of capital factor input varies by countries and least important variables of *H*-statistics (Molyneux et al., 1994; Bikker and Haaf, 2002; Sufian et al., 2007). One explanation for the occurrence may due to the poor quality of capital expenses and fixed assets data (Casu and Girardone, 2006, pp. 458).

The coefficients of ETA is positive in Korea, Philippines and Thailand whereas negative in Malaysia and Indonesia. The results suggested that during the years of recovery well-capitalised banks are exposed to riskier operations and may involve in holding more equity as a safety measures which in turn decrease the cost of funds. Regulatory changes during the process of recovery may force high risk banks to carry more equity. AST (total assets) is used to show differences in bank sizes which may induce to lower total revenue per unit of assets and can be considered as a proxy to economy of scale (De Bandt and Davies, 2000; Shaffer, 2002). The coefficient has a negative sign in almost all the country (exception to Philippines) which suggested that that the larger the assets and the larger the banks seem to be less efficient compared to smaller banks. Loan over total assets (TLA) results show mixed results too where positive sign in Indonesia, Malaysia and Thailand, whereas negative sign in Korea and again in the Philippines. The higher the ratio will envisages greater interest income and total revenue. The inclusion of loan loss provision has provided positive results to all the countries (with exception to Malaysia). Past literature provides mixed results on the expected sign of the coefficient of this variable. The coefficient can be negative if banks spend more resources on credit underwriting and loan monitoring, and consequently fewer problem loans at the expense of higher operating costs (Mester, 1996). The coefficient of this variable can be positive if banks have high ratio of loan loss provisions to net loans, indicating poor loan quality that calls for higher operating costs related to credit risk and loan loss management (Berger and DeYoung, 1997).

3.2. The Panzar- Rosse H- statistics and Efficiency

The inclusion of efficiency as one of the independent bank specific variables in the calculation of the H-statistics is motivated theoretically because it can be assumed to be one of the exogenous variables that shift the banks's cost (Casu and Girardone, 2005, pp. 14). The crisis experiences and restructuring that effective during the process of recovery is significantly changed the way banking operated in the SEA region. The impact of these changes reflect the changes in the degree of efficiency level of each country and as shown in Table 7, the inclusion of efficiency indicates significant changes to the competition measurement and reflect the successfulness of the recovery programmed in each country. Interestingly the degree of *H* is decreasing in the country highest efficiency level, Korea and followed by the Philippines for being the least effected country by the crisis. The overall results also show an increased in the degree of *H* statistics in Malaysia, Indonesia and Thailand.

Indonesia was worst hit by the crisis. It has a significant impact on commercial banks both publicly and privately owned as indicated by the collapsing during and after the crisis. Creed (2000) highlighted the weaknesses in Indonesia banking system which is prone to excessive loan concentration, weak management system and inadequate information. As a result the Indonesia government proposed financial liberalisation as strategies to increase bank efficiency, performances and competitiveness. Through new restructuring program, it is assumed that competitive environment will encourage bank to be more efficient by lowering costs and increase revenue with better allocation of resources (Viverita, 2008, pp. 3). The major financial restructuring taken by the Indonesian government is through merger and acquisition which also being considered as the way to achieve performance improvement (De Long, 2001; Houston et al., 2001). Indonesia government has also made changes to their competition policy since 1997 crisis and with hope that the new policy would attract more involvement from the foreign entry and to assist Indonesia banking sector developed far better than before the financial crisis. Competition policy plays an important role in increasing

competitiveness and economic efficiency and this has motivated Indonesia in making substantial changes in raising competitiveness.

Table-7. H-Statistics Fixed Effects 1999-2005 with DEA

	Indonesia	**Korea**	**Malaysia**	**Philippine**	**Thailand**	**All**
lnp1	0.131**	0.083	0.037	0.181	0.285**	0.106***
	(0.066)	0.051	0.097	0.182	0.111	2.66
lnp2	0.435***	0.495***	-0.062	0.398***	0.269***	0.324***
	(0.033)	0.091	0.078	0.089	0.059	12.550
lnp3	0.142***	0.062	0.137***	0.055	-0.034	0.140***
	(0.048)	0.039	0.022	0.195	0.077	6.940
lneta	-0.095	0.225***	-0.268***	0.001	0.075	-0.052
	(0.063)	0.058	0.074	0.123	0.066	-1.490
lnast	-0.166***	-0.015	-0.160*	0.034	-0.465***	-0.093**
	(0.058)	0.110	0.088	0.146	0.118	-2.310
lntla	0.248***	-0.387*	0.250*	0.028	0.080	0.151***
	(0.035)	0.194	0.137	0.129	0.112	4.880
lnllpl	0.240*	0.033	-0.024	0.043	-0.002	0.010
	(0.013)	0.019	0.022	0.030	0.016	1.110
lneff	0.457***	-0.109	0.196	0.331	0.536***	0.425***
	(0.059)	0.128	0.143	0.214	0.137	8.62
cons	0.996*	1.222	-1.298	0.311	3.171***	0.141
	(0.567)	1.175	1.020	1.553	1.014	0.380
H statistics	0.708	0.640	0.112	0.633	0.520	0.570
	(0.173)	0.173	0.038	0.173	0.180	0.117
F test ($H = 0$)	0.380	2.780	3.190	0.810	0.410	67.520
F test ($H = 1$)	0.120	1.080	2.630	0.070	0.240	965.270
Equilibrium test:						
F value for $H = 0$	1.31	3.82	2.33	1.87	1.64	0.45

Notes: * p<0.10, ** p<0.05, *** p<0.01
Standard errors in parentheses.

The *H*-statistics for Indonesia increased from 0.633 to 0.708 after the inclusion of efficiency variables and have a positive relationship with TREV. Thus lead us to reject the monopoly hypothesis and the conjectural variations oligopoly hypothesis, as concluded Indonesia commercial banking revenues behaved as if earned under monopolistic competition. The same conclusion also can be seen in the results for Malaysia and Thailand. Thailand banking sector have encounter tremendous changes since the financial crisis in 1997. During the post crisis reforms, family ownership in a number of banks was replaced with state and foreign ownership and also allowing new entrants into the industry. These changes have given biggest impact towards their competitiveness in the sector. Our finding also shows that the inclusion of efficiency has increased competitiveness *H*-statistics and agreed that the structural changes has affected the overall performance of Thailand banking sector. The improvement in Thailand banking competitiveness is crucial for the industry to adapt and improve all their operations. In the past ten years the structure of Thailand banking sector has changed where domestic banks no longer dominating the industry in fact the banking system has altered into foreign ownership of Thai banks. Wonglimpiyarat (2008) suggested that the higher of competition in Thailand banking

industry is the results of (1) the rise in non-banks in retail banking which mostly involved credit card and personal loan business and (2) the heightened competition from foreign banks. The H-statistics of the market competition in Malaysia is also showing positive changes before and after the inclusion of efficiency. This is again consistent with Claessens and Laeven (2004) and other previous studies (Al-Muharrami et al., 2006; Parera et al., 2006).

Korea also experienced significant consequences during the financial crisis and for the past decades they have gone through financial deregulation, financial crisis and restructuring. Prior to the crisis the concentration ratio has increased significantly due to declining in number of banks due to consolidation and banks closure. Inclusion of efficiency variables has slightly decreased the *H*-statistics from 0.663 to 0.640. The process of restructuring taken place after the crisis has significantly increased the concentration ratio, however our study shows that competition has deteriorate and efficiency has negatively affected the bank total revenue which imply consolidations has left negatively affected the banking industry. The entry of foreign banks and increasing foreign ownership of domestic banking may have help to maintain Korean banks competitiveness despite deterioration after the inclusion of efficiency variables. The results for the Philippines also indicates a decreased in *H*-statistics, however it still maintain positive relation between the DEA efficiency with the revenue.

To validate both of our analysis, we conducted the equilibrium test for all the banking markets and for the five (5) selected country and found that the banking system are in long run equilibrium. The reason for this is that if the market is in equilibrium, a dependent variable will have no correlation with prices of input factor. For both analysis of PR, the estimated yield of *H* value during the post crisis period studied has rejected the hypothesis of $H = 0$ even though the value of *H* is close to zero. It may be inferred from the findings that the selected SEA commercial banking was in long run equilibrium before the crisis and fell into disequilibrium during the crisis period. However, it made a rapid adjustment to a new equilibrium which similar to what Molyneux et al., (1996) found with Japanese commercial banking and Park (2009) on Korean commercial banking.

4. Conclusion

For more than ten years there have been so many study analysing the 1997 financial crisis and have come out with many conclusion on the cause and consequences of the crisis. However, very few have concentrated on the relationship between competition and efficiency during the post crisis. Our intention is to look upon the relationship between efficiency and competition in the selected 1997 Asian crisis worst effected countries and run a cross country analysis as there are almost none of past literature has done the analysis.

The structural changes in SEA has improved the region banking industry performances and brought significant effects through the regulatory changes as it spur a trend towards consolidation, resulting in the recent wave of mergers and acquisitions. An analysis on the efficiency using DEA indicates that the efficiency of the banking market has increased during the post crisis study period.

To investigate the impact of increased efficiency on the competitive condition in SEA banking markets, we employed the non-structural Panzar and Rosse (PR) statistic. The estimated *H*-statistics for the five (5) selected SEA countries is 0.570, thus indicating monopolistic competition. Such results, confirm by the by country estimations, are consistent with the current literature. When the DEA efficiency score are included in the bank specific factors, we found that the overall results have decreased slightly almost not affected. Whereas, the values of *H*-statistics resulted for each country has increased with exceptions to Korea and the Philippines. An analysis of the sign and significance of the regression coefficient indicates that the DEA efficiency scores are negative in Korea, whereas positive to all other selected countries and not significance to all (with exception to Indonesia and Thailand). This indicates as Korean banks efficiency estimated the highest scores, it's also generates the lowest total revenues. These results may be explained by the fact that banks that show the highest inefficiencies and incur higher cost might be able to generate greater profits than more cost efficient banks (Girardone and Casu, 2005, pp. 16).

5. Aknowledgement

The author would like to thank Dr Barbara Casu Lukac (Cass Business School, London) and Prof. Phillip Molyneux (Bangor University) for their guidence and advice while writting up and analysis on the research.

References

Adams, C. (2008), Emerging East Asian Banking Systems Ten Years after the 1997/98 Crisis. ADB Working Paper Series on Regional Economic Integration No. 16, Office of Regional Integration, Asian Development Bank, Manila.

Asian Development Bank (2010), Global Economic and Financial Crisis: Impact on Developing Asia and Immediate Policy Implications.

Al-Muharrami, Saeed, Matthews, Kent and Khabari, Yusuf (2006), Market Structure and Competitive Conditions in the Arab GCC Banking System. Journal of Banking & Finance, Elsevier Vol. 30(12), Pp. 3487-3501

Barry, T.A., Dacanay III S.J., Lepetit, L. and Tarazi A. (2008), Ownership Structure and Bank Efficiency in the Asia Pacific Region Http://Ssrn.Com/Abstract=1244163.

Beck T., Demirgüc-Kunt A. and Levine R. (2006), Bank Concentration, Competition, and Crises: First Results. Journal of Banking & Finance 30, pp. 1581–1603.

Berger, A.N., Demirgüc-Kunt A., Levine, R. and Haubrich J.G. (2004), Bank Concentration and Competition: An Evolution in the Making. Journal of Money, Credit, and Banking 36, pp. 433-451.

Bikker, Jacob A. and Haaf, Katharina (2002), Competition, Concentration and Their Relationship: An Empirical Analysis of the Banking Industry. Journal of Finance, Elsevier Vol. 26(11), pp. 2191-2214, November.

Coccorese, Paolo (2004), Banking Competition And Macroeconomic Conditions: A Disaggregate Analysis. Journal of International Financial Markets, Institutions And Money, Elsevier. Vol. 14(3), pp 203-219, July.

Claessens, Stijn and Laeven, Luc (2004), What Drives Bank Competition? Some International Evidence. Journal of Money, Credit and Banking Vol. 36(3), pp 563-83, June.

Chirathivat, S. (2007), Ten Years after the Asian Crisis: Toward Economic Sustainability in Southeast Asia. Dialogue and Cooperation, Friedrich Ebert Stiftung, Singapore. Pp.1-24.

Chansarn S. (2008), The Relative Efficiency of Commercial Banks in Thailand: DEA Approach. International Research Journal of Finance and Economics, ISSN 1450-2887 Issue 18.

Drake, L. (2001), Efficiency and Productivity Change In UK Banking. Applied Financial Economics. Vol. 11, Pp.557-71.

Drake, L. and Hall, M.J.B. (2003). Efficiency in Japanese Banking: An Empirical Analysis. Journal of Banking and Finance. Vol. 27, Pp.891-917.

Drake, L., Hall, M.J.B. and Simper, R. (2006), The Impact of Macroeconomic and Regulatory Factors on Bank Efficiency: A Non-Parametric Analysis of Hong Kong's Banking System. Journal of Banking and Finance ,Vol. 30, Pp.1443-66.

Gelos, R.G. And Roldo´ J. (2004), Consolidation and Market Structure in Emerging Market Banking Systems. Emerging Markets Review, Vol. 5, Pp. 39–59.

Girardone, C. and Casu, B., 2005. Bank Competition, Concentration and Efficiency in the Single European Market. The Manchester School Vol. 74, No. 4, pp. 441-468

Bikker J.A. and Groeneveld J.M. (1998), Competition and Concentration in the EU Banking Industry. 8, Netherlands Central Bank, Directorate Supervision.

Kim, Soo-Myung, Ji-Young Kim and Hoon-Tae Ryoo (2006), Restructuring and reforms in the Korean banking industry. BIS Papers,No. 28.

Kubo, Koji. 2006, The Degree of Competition in the Thai Banking Industry before and After the East Asian Crisis. IDE Discussion Paper. No. 56.

Laeven, Luc (2005), Banking Sector Performance in East Asian Countries: The Effects of Competition, Diversification, and Ownership. Mimeo.Washington, DC:World Bank.

Molyneux P, Thornton J. and Lloyd-Williams D. M. (1996), Competition and Market Contestability in Japanese Commercial Banking. Journal of Economics and Business, Vol. 48, Pp.33-45

Molyneux P, Thornton J. and Lloyd-Williams D. M. (1994), Competitive Conditions in European Banking. Journal of Banking and Finance, Vol. 18, Pp. 445-459.

Nakhun T. and Avkiran N. (2009), Measuring the Impact of Restructuring and Country-Specific Factors on the Efficiency of Post-Crisis East Asian Banking Systems: Integrating DEA with SFA. Socio-Economic Planning Sciences, Vol. 43, pp. 240–252.

Muhamed-Zulkhibri M.A., Sufian, F. and Mohd Norfian Alifiah (2007), Consolidation, Market Structure and Competition in the Malaysian Banking Industry: Empirical Evidence from Malaysia. The 15th Annual Conference PBFEAM, July 20-21, Vietnam.

Pasadilla, G. and Milo, M. (2005), Effect of Liberalization on Banking Competition. Philippine Institute for Development Studies, Discussion Paper.

Pangestu, Mari (2003), The Indonesian Bank Crisis and Restructuring: Lessons and Implications for Other Developing Countries. G-24 Discussion Paper Series, United Nations Conference on Trade and Development.

Satsanguan, P and Lewis S. (2009), Thailand's Financial and Banking Systems. Thammasat Univerty Thailand.

Sufian, Fadzlan (2004), The Efficiency Effects of Bank Mergers and Acquisitions in a Developing Economy: Evidence from Malaysia. International Journal of Applied Econometrics and Quantitative Studies, Vol.1-4.

Sufian, Fadzlan (2006), The Efficiency Of Non-Bank Financial Institutions: Empirical Evidence From Malaysia. International Research Journal of Finance and Economics, ISSN 1450-2887, Issue 6.

Viverita (2008), Proceedings of Annual American Business Research Conference, April.

Appendix

Data Envelopment Analysis- Four Stage Methodology

Our approach is based on the four-stage methodology proposed by Fried et al. (1999), whereby we account for the impact of environmental variables in a DEA- based study. The aim is to incorporate the influences of the external variables on South East Asian banking efficiency measurements. In doing so, we allowed slack or surpluses due to the environment variables and used it to calculate adjusted values for the primary inputs. In other words, the new radial efficiency measures incorporate the environmental variables.

The following section explains the four-stage formal procedure for intermediation DEA approach with input oriented models.

Stage One. We calculate a DEA frontier using the traditional inputs and outputs according to standard production theory. Specifically, we followed the non-parametric DEA approach to measure inefficiency with an input minimization orientation. The choice of a DEA can be based on several considerations; *First*, DEA works well with a small sample. The sample chosen in this study involved five SE Asian crisis-affected countries and those experiencing retrieval from the 1997 financial crisis. The restructuring process has caused the numbers of these countries commercial banks to decrease significantly due to consolidation and closing down of some insolvent banks. *Second*, DEA does not require any assumption about the functional form of the frontier or of the inefficiency component. The recovery period, which involved regulatory changes have increased the market competition, therefore cutting costs becomes the firm's main focus (Casu & Girardone, 2006). Based on changes that were expected on input levels, the input oriented is chosen to reflect the differences in the market structures. We employed the intermediation approach as we view banks as intermediaries with loans and other earning assets as output, and capital, labour and deposits as inputs (Sealey & Lindley, 1977). The same approach is also applied in similar banking efficiency studies such as Altunbas et al. (2001), Casu et al. (2004), and Drake et al. (2006).

In this stage, we exclude the external variables[8], while computing for Farrell Technical Efficiency (TE) score, as well as input slacks and output surpluses for each observation. According to Banker, Charnes and Cooper[9] (1984) variable returns to scale envelopment problems can be expressed as the following Linear Programming (LP):

$$\begin{aligned} \min_{\theta,\lambda} \quad & \theta \\ \text{subject to } & \theta x^k \geq X\lambda \\ & Y\lambda \geq y^k \\ & e\lambda = 1 \\ & \lambda \in R_+^K, \end{aligned} \tag{1.1}$$

where $x \geq 0$ is producer's (N x 1) vector of inputs; $y \geq 0$ is producer's (M x 1) vector of outputs; $X = [x_1,\ldots,x_I]$ is an (N x K) matrix of input vectors in the comparison set; $Y = [y_1,\ldots, y_I]$ is an (M x K) matrix of output vectors in the comparison set; $\lambda = [\lambda_1,\ldots,\lambda_I]$ is an (K x 1) vector of weights or activities variable; $e = [1,\ldots,1]$ is an (1 x K) vector, and there are producers in the comparison set. The data of the producer being evaluated are superscripted "k". The optimal solution of the above problem in terms of non-negative and bounded to one optimal values θ allows to evaluate total slack (radial plus non-radial) for each input as the non-negative scalar $s_{nk} = x_{nk} - X_n\lambda$; where $n = 1,\ldots,N$ and $k = 1,\ldots,K$.

Stage Second. We focus on estimating N input equations using an appropriate econometric technique. The dependent variables are total (radial plus non-radial) Stage 1 slack $[x - X\lambda] \geq 0$ and $[Y\lambda - y] \geq 0$; the dependent variables are measures of external variable applicable to the particular input. The objective of Stage 2 analysis is to quantify the effect of external conditions on the excessive use of inputs. The N equations are specified as:

$$\begin{aligned} E_j^k &= f_j\left(Z_j^k, \beta_j, u_j^k\right), \qquad j = 1,\ldots,N \\ & \qquad\qquad k = 1,\ldots,K \end{aligned} \tag{1.2}$$

where E_j^k is unit k's total input slack (radial plus non-radial) for input j based on the DEA results from Stage 1, Z_j^k is a vector of variables characterizing the environmental variables for unit k that may affect the utilization of input j, β_j is a vector of coefficients, and u_j^k is a disturbance term. Since the total slack for each input is censored at zero, we estimate E_j^k using Tobit regressions[10]. Following Fried et al. (1999), using the efficiency measures derived from the DEA estimations as the dependent variables, we then estimate the following Tobit regression model[11]:

$$\hat{E}_j^k = \beta_0 + \beta_1 ETA^k{}_{jt} + \beta_2 LTD^k{}_{jt} + \beta_3 LLPL_{jt} + \beta_4 GDP^k{}_{jt} + \varepsilon_{jt}^k \tag{1.3}$$

Where,

[8] There are other variables which influence the ability of a firm to transform inputs into outputs, but they are uncontrollable. These variables are the external environment such as ownership, location, or regulatory regime. There are two possibilities, first a firm with favorable external environmental variables, and second unfavorable external conditions. Due to fact that external environmental variable are inconsistence/unpredictable, the radial efficiency score generated by the initial model may have (under)overstated the efficiency of producers operating under (un)favorable conditions (Fried et al., 1999).

[9] The use of the CRS specification when not all firms are operating at optimal scale, results on measure of Technical Efficiency (TE) that are confounded by Scale Efficiencies (SE). The use of VRS specification permits the calculation of TE devoid of these SE effects" (Coelli et al., 2005)

[10] If the total slack for each input is influenced by the same measures of external conditions, each equation can be estimated separately using Tobit regression.

[11] Tobit is used as it can take the censored nature of dependent variables, which is the efficiency estimations scores ranging from zero to one, thus reportedly yielding consistent estimations.

$\hat{E}^k_j$ = Efficiency scores of banks (dependent variable); subscript k denote individual banks, j countries and t time horizon;
B_0 = constant;
ETA = Equity over total assets;
LTD = Loan over total deposits;
LLPL= Loan Loss Provision over loans
GDP = Gross Domestic Product ($mill)
ε = error term

Stage Three. In this stage we will use the estimated coefficients from the regression in (1.3) to predict total input slack for each input and for each unit based on its external variables;

$$\hat{E}^k_j = f_j\left(Z^k_j, \hat{\beta}_j\right), \qquad j = 1,...., N$$
$$k = 1,...., K \tag{1.4}$$

where $\hat{E}^k_j$ is predicted total input slack for input j based on Tobit regression results from Second Stage, Z^k_j is a vector of variables characterizing the environmental variables for unit k that may affect the utilization of input j, and $\hat{\beta}_j$ is predicted coefficients. Predictions on total input slacks are then used to adjust the primary input data for each unit according to the differences between maximum predicted input slack, $\hat{E}^{k\,Maximum}_j$ and predicted slack, $\hat{E}^k_j$;

$$\Delta\zeta = Max^k\left\{\hat{E}^k_j\right\} - \hat{E}^k_j \qquad \mathrm{j} = 1,...., \mathrm{N}$$
$$\mathrm{k} = 1,...., \mathrm{K} \tag{1.5}$$

Using the differences in (1.5),the primary input unit data for each unit is adjusted;

$$x^{kadj}_j = x^k_k + \Delta\zeta \qquad \mathrm{j} = 1,...., \mathrm{N}$$
$$\mathrm{k} = 1,...., \mathrm{K}$$
$$\Delta\zeta = Max^k\left\{\hat{E}^k_j\right\} - \hat{E}^k_j \tag{1.6}$$

Adjusting the input using equation (1.5) creates an equal base for all DMUs in regards to all their non-controllable factor surroundings. Adjusting generates an identical pseudo environment which is the least favourable for all DMUs.

Stage Four. Once the primary input unit data has been adjusted, we re-run the DEA model (1.1) under the initial input-output specification according to equation (1.5) and generate new radial measures of inefficiency. These radial measure scores measure the inefficiency that is attributable to external variables.