Technological Progresses and Cost Efficiencies in Commercial Banks: The Emerging Markets Comparison

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Abstract

A three-stage procedure is used to investigate the dynamic behavior of cost efficiencies in commercial banks, measure their economies of scope and scale, and analyze how technological progresses, scope and scale economies, and other economic factors affect cost efficiencies, using panel data from Asian emerging markets over the time period from 1988 to 1999. We also find it interesting that the cost inefficiencies in the emerging markets may well explain the occurrence of the Asian financial crisis.

Keywords: Technological Changes; Cost (In)Efficiencies; Scope Economy; Scale Economy; Financial Crisis

1. Introduction

During the past decade, technological progresses and the integration of the global markets have adopted the strategic partners of commercial banks all over the world. The technological progresses, such as electronic bill-paying, home banking, internet transactions and stored value cards, have provided customers with efficient and long-distance access to the financial systems. The integration of the financial markets, triggered by the European Economic Area (EEA) and later the World Trade Organizations (WTO) , has fostered a harmonization of regulations of the financial intermediaries across nations. Furthermore, the progress of the technologies of telecommunication and data processing are fueling globalization and integration of the international trading blocs, globalization of the banking markets is an inevitable tide. Therefore, in order to capture the momentum of commercial banks, we have to incorporate both technological progresses and globalization into the banking study.

Accompanied with technological progresses, the financial services industry is undergoing a drastic shift in the cost structure (Allen and Gale, 1999). On the other hand, the cost efficiency of commercial banks can capture the trend of the globalization and integration of the banking markets (Berg et al., 1993; Bergendahl, 1995; Bukh et al., 1995; and Allen and Rai, 1996; among others). The market integration hypothesis can be tested via the cost efficiency: if the international banking markets are integrated, then their cost efficiencies would be statistically indifferent; and if the markets are segmented, the cost efficiencies should be different. Hence, the cost efficiency is a very important performance or business value measurement in both technology management and international banking studies.

This research incorporates both macroeconomic (i.e., country-level) and microeconomic (i.e., firm-specific) data into the exploration of cost efficiencies, whereas most existing studies on cost efficiencies have been restricted to microeconomic and performance variables. First, we can analyze the impacts of technological progresses along with the macroeconomic turmoil within the framework of an international comparison. Second, methodologically, this research inherits the generalized stochastic cost frontier approach adopted by Lin and Lin (2001), which has been shown as a more accurate measure in estimated and comparing cost (in)efficiencies, unlike the traditional (one-equation) stochastic cost frontier approach used in previous research. Third, this paper is interested in the dynamic behavior of cost efficiencies, while most previous studies on cost (in)efficiencies and financial crises is built on a static setting and adopts a macroeconomic approach. Fourth, the present study helps explore the cause of Asian financial crises.

The remainder of this article is structured as follows. Section 2 briefly describes the theoretical foundation of the three-stage procedure. Section3 specifies the model. In Section 4, the empirical results are reported and analyzed. Finally, in Section 5, conclusions with some remarks are given.

2. Theoretical Foundation: The Three-Stage Procedure

This paper follows the three-stage procedure of Lin and Lin (2001). The foundation of the procedure is formed by a two-equation stochastic cost frontier model, the measurements of the scale and scope economies (Clark and Speaker, 1994; and Willig, 1979; respectively), and the limited dependent variable regression initiated by Tobin (1958) and extended by Amemiya (1973).

2.1 Stage 1: The Generalized (Two-Equation) Stochastic Cost Frontier Approach

There are two major groups of approaches used to estimate cost efficiencies. The first group consists of the non-parametric (or deterministic)methods, including the data envelopment analysis (DEA), free disposal hull, index number, and mixed optimal strategy. In essence, in the group the cost frontier is represented by Equation (1):

(1) $$C_i = f(y_I, p_i; \beta_i) + u_i$$

where C_i : the logarithm of the total cost of production of the ith financial firm,

y_i : a vector of outputs (e.g., loans, deposits,and financial investments),

p_i : a vector of input prices (e.g., the wage of labor and price of capital),

β_i : a vector of unknown parameters to be estimated,

u_i : a deterministic variable to account for the cost inefficiency of the ith bank, and

$f(.)$: the optimized cost function of a vector given outputs and a vector of given input prices.

The second group of approaches is composed of the parametric (or stochastic) methods, such as the stochastic cost frontier approach, distribution-free approach, and thick frontier approach. This group of models, represented by the traditional cross-sectional (one-equation) stochastic cost frontier model, is denoted by:

(2) $C_i = f(y_I, p_i; \beta_i) + u_i + v_i$

where v_i is the normally distributed random error which describes uncontrollable factors, different from u_i which is the cost inefficiency component representing the factors that are under the control of the firm, and assumed to be exponentially distributed with $E(u_I) = 1/\theta$ and $Var(u_i) = 1/\theta^2$. The functional form of the cost function $f(y_i, p_i; \beta)$ is specific as a translog function in all of these studies.

The pros and cons of these two groups of methodologies have been well discussed in Lovell (1993), Shao (2000), Berger and Humphrey (2000), Lin and Chen (2001), and Lin and Lin (2001). Rai (1996) and Allen and Rai (1996) have shown that traditional (one-equation) stochastic cost frontier approach is particularly appropriate for an international comparison of financial intermediaries. But Lin and Lin (2001) have further demonstrated that the generalized (two-equation) stochastic cost frintier is more desirable than the traditional one-equation frontier approach. Therefore, the generalized stochastic cost frontier incorporating time series and cross-sectional data (namely, panel data) is represented by Equation (3) and (4):

(3) $C_{it} = f(y_{it}, p_{it}; \beta) + u_{it} + v_{it}$

and

(4) $u_{it} = g(T_{it}, z_{it}; \alpha) + \varepsilon_{it}$

where C_{it} is the logarithm of the total cost of production of firm i at time t. T_{it} in the g-function is the time trend used to serve as the proxy of technological changes (Hunter and Timme, 1991; and Merton, 1995) or as general economic conditions (Lin and Chen, 2001), and z_{it} includes a broad set of microeconomic (firm-specific) variables and macroeconomic variables common to all firms as mentioned earlier (cf. Lin, 1992), which explain the differences in cost (in)efficiencies over time and across banks. In addition to those mentioned above, the z_{it} vector may consist of financial management and innovation (Merton, 1995), profitability (Miller and Noulas, 1997), financial factors (Lin and Chen, 2001), and possibly those macroeconomic variable used in Frankel and Rose (1996), Lin and Chen (1998), and Kaminsky and Reinhart (1999). Finally, α is a vector of unknown parameters and e_{it}, like u_{it}, is exponentially distributed.

The generalized two-equation stochastic cost frontier model as described by Equation (3) and (4) provides an avenue to sensitivity analysis and captures the dynamics of cost efficiencies. Moreover, by introducing the T proxy in the g-function, it is wholly possible to measure the influence of technological changes over time. Therefore, we adopt this (two-equation) stochastic cost frontier approach to estimate the cost (in)efficiencies of the commercial banks over time.

2.2 Stage 2: Measurements of Scope and Scale Economies

The second stage requires the measurements of scope and scale economies. First, suppose that we have three outputs, outpot1, output2, and output3, then according to Willig's (1979) formula, the scope economy of bank i at time t ($SCOPE_{it}$) is specified by Equation (5):

$$(5)\ SCOPE_{it} = \frac{f(output\,1_{it}) + f(output\,2_{it}) + f(output\,3_{it}) - f(output\,1_{it}, output\,2_{it}, output\,3_{it})}{f(output\,1_{it}, output\,2_{it}, output\,3_{it})}$$

In Equation (5), the ratio (SCOPE) describes the proportion of cost saving caused by the multi-production over the total optimal cost. Consequently, the higher SCOPE represents the higher cost saving from the outputs of commercial banks. For example, if the SCOPE is 2, then the cost saving is equivalent to two times of the total optimal cost.

Second, Equation (6) below denotes the measurement of the scale economy of bank i at time t ($SCOPE_{it}$) is estimated by the overall scale economy:

$$(6)\ SCALE_{it} = {\partial C_{it}} \big/ {\partial \ln y_{it}}$$

where C_{it} is the logarithm of the total cost, as defined above, and $\ln y_{it}$ is the logarithmic form of one component in the output vector y_{it}. The exact functional form of Equation (6) depends on the functional form of the cost function. When SCALE is larger than one, the cost function falls into the range of the decreasing returns to scale; when it is smaller than one, the cost function is located at the range of the increasing returns to scale; and when SCALE equals one, the cost function is situated at the range of the constant returns to scale.

2.3. Stage 3: The Tobit Regression

We would like to examine how the cost (in)efficiency is influenced by the scope and scale economies and other economic variables. But, since the cost (in)efficiency is a truncated random variable, the regression of cost (in)efficiencies on the scope and scale economies and other variables calls for the application of the Tobit regression model (Tobin, 1958; Amemiya, 1973; and Greene, 1993). In general, we can also observe and analyze how elements of z_{it} appearing in Equation (4) affect the cost (in)efficiency.

3. Specification of the Model

In Equation (3), C_{it} is the logarithm of the sum of the operating and interest costs of bank i at time t, following the intermediation approach. In practice, the output vector y_{it} consists of three outputs, namely, loans (LN_{it}), total deposits (TD_{it}), and financial investments (FI_{it}). LN_{it} includes personal loans, commercial loans, property and real estate loans, and industrial loans. TD_{it} is normally constituted by demand and term deposits. Due to the limitation of date availability, we are forced to use total deposits rather than demand deposits which have often been used in some related studies.

The elements of the input price vector (p_{it}) includes the wage of labor (w_{it}) and the price of capital (r_{it}). The wage of labor is calculated by dividing the total annual personnel expenses by the reported number of employees, which are collected from the financial statements of the banks. The price of capital is measured by the average interest rate of deposits and loans.

In Equation (4), T_{it} is utilized to describe the progress of technology over time, as mentioned earlier. The factor of z_{it} accounting for the cost efficiency involve the macroeconomic factors (the variables at the country-level common to all banks in a country or an economy) and microeconomic variables (the firm-specific variables). Examples of the former are the manufacturing productivity index (PROD), the returns on the indices (STK), and the ratio of foreign exchange reserves to imports (TRIM), among others. The microeconomic variables may be represented by the debt-to-equity ratio (RDE), the return on assets (ROA), etc.

The cost function in Equation (3) takes a translog form, the most frequently used form of the cost function in the banking literature, while the g-function in Equation (4) is assumed to be linear.

The translog functional form used in our empirical analysis is given by

(7) $C_{it} = \beta_0 + \sum_{k=1}^{2} \beta_{1k} \ln p_{kit} + \sum_{s=1}^{3} \beta_{2s} \ln y_{sit} + \frac{1}{2} \sum_{k=1}^{2} \sum_{k'=1}^{2} \beta_{3kk'} \ln p_{kit} \ln p_{k'it}$

$+ \frac{1}{2} \sum_{s=1}^{3} \sum_{s'=1}^{3} \beta_{4ss'} \ln y_{sit} \ln y_{sitt} + \sum_{k=1}^{2} \sum_{s=1}^{3} \beta_{5ks} \ln p_{kit} \ln y_{sit}$

$+ \alpha_i T + \frac{1}{2} \alpha_2 T^2 + ... + v_{it} + \varepsilon_{it}$

where $y_{it} = LN_{it}$, $y_{2t} = TD_{it}$, $y_{3t} = FI_{it}$, $p_{1it} = w_{it}$, $p_{2it} = r_{it}$, and T is the trend variable representing the general economic conditions and technological progresses.

Following the cost function specification of Equation (7), the measurement of scale economy in Equation (6) can be re-written

(8) $SCALE_{it} = \sum_{s=1}^{3} [\beta_{2s} + \sum_{s'=1}^{3} \beta_{4ss'} y_{s'it} + \sum_{k=1}^{2} \beta_{5ks} \ln p_{kit}]$

where $y_{it} = LN_{it}$, $y_{2it} = TD_{it}$, $y_{3it} = FI_{it}$, $p_{1it} = w_{it}$, $p_{2it} = r_{it}$,

Finally, u_{it} is not considered as a good measurement of the cost inefficiency. Therefore, based on Berg et al. (1993), we offer a formula to calculate the cost efficiency via u_{it} . This is

(9) $E_{it} = efficiency_{it} = \exp(u_{it}^{\min} - u_{it})$

or

(10) $inefficiency_{it} = \exp(u_{it})$

where $u_{it}^{\min}$ is the minimal u_{it} and is used as the benchmark to calculate the comparative efficiency for t=1,…,T (time periods) and I=1,…,N (banks). All estimates of the cost efficiency calculated from Equation (9) fall between zero and one, and those of the cost inefficiency from Equation (10) are larger than one to denote the extent to which the actual cost exceeds the ideal cost.

4. Results and Analysis

4.1 Selection of countries

The countries under study are composed of seven countries (or referred to as the emerging economies interchangeably), such as South Korea (KO), Singapore (SG), Taiwan (TW), Hong Kong (HK), Australia (AU), and Indonesia (IN). While the time periods available vary from 1981 to 1999, the observations available for all the countries considered fall into the period from 1988 to 1999. Also due to the problem of missing values, unequal numbers of panel data points are used. All data observations are dated at the end of the year. For each of the countries, we select the commercial banks based on the data available.

4.2 Data Sources

The firm-level variables (ROA and RDE) were based on the financial statements that come from the World Scope CD. The PROD was collected from international Financial Statistics (IFS) published by the IMF and the STK from the World Stock Exchange Fact Book printed by the Meridian Securities Markets. The only exception is TW. Because TW is not a member of the IMF, we obtained the data directly from its Central Bank of Taiwan.

The base year of the IFS data for all countries and all variables has been adjusted to 1995, and all monetary values have been denominated in the 1995 US dollars, in order to conduct meaningful cross-national comparisons.

4.3 Descriptive Statistics

Among the emerging economies, AU has won the highest C, LN, FI, and TD, indicating that the commercial banks in AU have enjoyed the largest scale. The TRIM for AU is the smallest while that for TW the largest. In other words, TW has adopted the same international trade strategy as Japan and accumulated a lot of foreign reserves. The wage level (W) ranks the first place for KO and the last for IN. IN also has the highest cost capital (19.0640%) among the emerging countries in the sample, While SG has the lowest (3.4065) since it benefits from its good international credit rationing and robust financial infrastructure.

As far as PROD is considered, TW has demonstrated as the most productive country due possibly to the growth of its computer and technology industries.

During the time span under study, HK has suffered from a negative return of the stock market (STK=-0.13%), while IN has won an annual average of 11.33%. On the contrary, the commercial banks in HK has enjoyed a largest ROA of 1.6603% and their counterparts in IN have earned a negative return of 1.0064%, the smallest in the subsample of emerging countries. RDE indicates the firm specific risk level. The average RDE for KO is the highest (21.75%), while that for HK the lowest (8.84%).

4.4 The Estimated Cost Functions, Equation (2): The Popular One-Equation Stochastic Cost Frontier Approach

For purposes of comparison, however, We first consider the traditional one-equation stochastic cost frontier estimation, i.e., we first present the estimates of Equation (2). The estimated cost function based on Equation (2) for each country is presented in Table 1.

4.5 The Estimated Cost Functions of the Two-Equation Stochastic Cost Frontier

In the case of emerging economies, 7 out of 23 under Specification (i), 7 out of 27 under specification (ii), and 11 out of 29 estimates under Specification (iii) are significant at either 5% or1%. The three specifications are appropriate for developing countries, and that Specification (iii), i.e., the generalized (two-equation) model, has increased the number of significant estimates, consistent with what Lin and Lin (2001) have observed, namely, the generalized stochastic cost frontier increases statistical efficiency.

The results given in Table 2, we can observe a number of interesting points: First, disregarding the numerical figures, the same conclusions can be drawn across the three specifications. Second, an increase (decrease) in the squared price of capital (RSQ), in the squared total deposits (TDSQ), or in the product of financial investment and wage (FI*W) would lead to a rise (decline) in the total cost of the bank. Third, the technology proxies, from T to T^4, are insignificant for the developing countries in the sample, strongly suggesting that the progresses of technologies are not fully utilized for the commercial banks in developed countries. Fourth, ROA is negatively significant at the 1% level, while RDE is positively significant. The reasoning of this last phenomenon is that the financial institutions own many financial tools to hedge their risks or arbitrage from market imperfection. For instance, Osterberg and Thomson (1998) have found that the amount of municipal bonds could explain the RDE of commercial banks. These points certainly have important implications for the banking and loan policies and investments plans of the bank.

4.6. Cost Efficiencies and Economies of Scope and Scale

Given the estimation results as reported in Table 3, we are able to compute the measure of cost efficiency and inefficiency as shown in Table 4. Also included in Table 4 are economies of scope and scale required by Stage 2. In Table 4, statistical tests indicate that the measure of inefficiency u for each country differs statistically from zero, meaning that the actual costs of commercial banks deviate from the optimal level and, therefore, cost inefficiencies do exist for all countries, implying that the market integration hypothesis is not supported by the data. The estimated scope economies for all countries are significant at the 5% level, and all of them are either greater than or close to 2.30. The calculated scale economies have been tested equal to one statistically, unanimously supporting that, for all the countries considered, their cost functions fall closely to the range of the constant returns to scale. Thus, we conclude that the economies of scope are all positive and cost functions fall in the range of the constant returns to scale. These findings may suggest that the cost efficiency and scope economy are more important measures than the economy of scale. Only two, KO and SG, have their scope economies exceeding 2.30. The SCOPE's of other five developing countries (AU, HK, MA, TW, and IN) range between 2.24 and 2.30.

We can once more apply the revealed preference analysis in Figure 1. Say higher SCOPE and lower cost inefficiency indicate a good condition of the commercial banks in a country. In other words, the northwestern dots in the diagram are most desirable. Among the emerging economies, there is no doubt that SG outperforms any other developing countries, and AU and IN are situated along the most southeastern area, which indicates that they operate at the least efficient level among all the countries under study.

4.7. The Tobit Model

The results of the Tobit regressions are obtained in two ways: First, the results calculated based on the group panel data to reveal the international differences among countries; and second, the results to conduct a country-specific analysis featuring the properties of different banks within a country. The results are presented in Table 5. We can observe from Table 5 that the R^2 s are not considered high. This is common to all research on cost efficiency.

Technology influences the cost efficiency negatively for the group of developing countries as a whole. In developing countries, due to slow adjustment to the new technologies or the poor management of the advanced technology, technological changes mitigate the cost efficiencies of their commercial banks.

At the country level, the directions of the impact of the SCOPE on the cost efficiency are mixed: it is positive and significant for HK, MA, and IN, while it is not statistically significant for KO, SG, TW, and AU. In Lin and Lin (2001), the results are also mixed: for Taiwan, the SCOPE is positively related to cost efficiencies, but for China a negative relationship between the SCOPE and cost efficiencies is observed. As far as we know, no theory can clearly explain this phenomenon. The impact of the SCOPE on the cost efficiency is not statistically significant. This may be caused by the internal control problem. When a commercial bank creates new items of operations, that is, when the economy of scope increases, its ability to control the cost decrease, thereby the cost efficiency declines.

Interestingly enough, the SCALE influences the cost efficiency significantly and negatively in KO, where the cost function fall into the range of the decreasing returns to scale, i.e., SCALE>1. We may infer that the SCALE of decreasing returns contributes negatively to the cost efficiency. In contrast, the impact of the SCALE upon the cost efficiency are seen to positive and significant in TW, HK, MA, and IN, all with SACLE<1 (see Table 3). More specifically, the scale economy has an insignificantly effect on the cost efficiency. The expansion of the scale, however, is not unlimited. In practice, there is a trade-off between scale economy and cost efficiency. When a commercial bank expands its scale, it becomes more allocatively efficient, that is, its cost efficiency increases due to cost sharing or cost saving of the overhead and IT inputs. When the expansion leads to the SCALE exceeding one, the commercial bank would operate in the range of the decreasing returns to scale and, consequently, the situation in which the SCALE impacts positively on the cost efficiency is reversed. Such a trade-off between the cost efficiency and the scale economy is consistent with the light shed by Berger et al. (2000) who have found that the scale economy exists in some mid-sized banks. That is, the bigger player in the banking industry may not always win: it gains in terms of its cost efficiency but loses in its scale economy.

The results of the components of z_{it} serving as the control variables of cost inefficiencies also suggested several interesting findings which are worth noting. The TRIM, representing the degree of foreign exchange liquidity, is negatively significant for MA, and IN. TRIM explains the variations of the cost efficiency significantly and positively. This implies that the central banks must maintain sufficient foreign exchange reserves on the behalves of their domestic commercial banks. This is probably one of the reasons why cost efficiencies are not integrated among different countries. As long as the central banks of different countries keep different levels of foreign exchange reserves, their cost efficiencies will differ.

The PROD affects the cost efficiencies positively and significantly for TW, HK, AU, MA. The manufacturing industries have expanded much faster than the development of financial systems. In particular, after the financial crises, the cost efficiencies have drastically decreased, but the productivity indices have still increased in the developing countries considered.

4.8. Dynamic Patterns of Cost Inefficiencies and The Asian Financial Crisis

Equation (4) actually represents the generalized composite inefficiency term of the cost function. Since the cost efficiency of banks reflects the financial bubbles (Allen, 2001), we are able to describe the patterns of the cost efficiencies and to observe the trend and the existence of the bubble. Figures 3 depict the time-varying patterns of cost inefficiencies derived from Equation (7).

However, in Figure 2, the results for deteriorated countries are totally different. The cost efficiencies deteriorated after 1994 and became even worse after1997, the Asian financial crisis. The cost inefficiencies for all the developing countries considered have displayed an upward trend during the financial crisis period. It is easy to observe a turmoil where the cost efficiencies for MA and IN skyrocketed to 2 in 1999 and 1998, respectively. The commercial banks for SG, TW, and HK outperformed those for other countries in terms of cost inefficiencies. The slopes of their cost inefficiencies from 1997 to 1998 where also smaller. In other words, the banking systems for these three countries are more robust than other developing countries.It seems to us that the Asian financial crisis was fostered by the uprising trend of cost inefficiencies of the commercial banks in the developing countries. Nevertheless, the signal of the financial crisis should have been revealed prior to the occurrence of the crisis in1997.

Interestingly enough, this finding coincides with the dilemma discussed in Kaminsky and Reinhart (1999). Many emerging economies attempted to improve their efficiencies of banking systems by liberalization from the regulations and privatization of the ownerships of their financial firms so that their cost inefficiencies decreased. This revolution of the liberalization exposed theses commercial banks to the foreign exchange risks. Consequently, after 1993, the banks in emerging economies had become more vulnerable than before. Thus, when the currency crisis takes place, the balance of payment and their cost efficiencies devastate quickly. Thus, we may foresee the occurrence of the financial crisis if the cost efficiencies of the commercial banks in a country (or a group of countries) grow substantially.

5. Conclusion and Remarks

This research is driven by three forces. First, cost efficiencies and economies of scope and scale in the banking industries have been well documented.

Second, methodologically, previous research on this subject is restricted to a one-equation stochastic cost frontier model, including the specification of a translog cost function. Within the framework of the one-equation model, it is difficult to investigate how the cost (in)efficiency is impacted dynamically by certain economic variables, including technological progresses.

Third, the advancement of technologies, e.g., the internet banking, has reshaped the cost structure of commercial banks. Since technological progresses have diffused and flourished around the world, a comprehensive comparison of the impacts of technological changes upon the cost efficiencies in the banking industries is of special interest and importance. This is totally possible to do within the framework of the two-equation stochastic cost frontier model.

Like Lin and Lin (2001), this paper has successfully applied a three-stage procedure to (i) explore the dynamic patterns of the cost (in)efficiencies of the commercial banks across different countries with two different levels of economic growth, (ii) simultaneously determine the existence of scope and scale economies, (iii) analyze how technological progresses, scope and scale economies, and other economic variables influence the dynamic behavior of the cost efficiencies, and (iv) explain why the Asian financial crisis is an unavoidable phenomenon as judged in terms of cost inefficiencies.

Moreover, we found no evidence supporting the market integration hypothesis. As in-depth analysis of the performance of the commercial banks in different countries is accomplished by using a revealed preference analysis composed of cost inefficiencies and scope economies (see Figure 1) .The figure discloses the strengths and weakness of the commercial banks in different countries.

Technological progresses, measured by the technology proxy T, were found to have an insignificant effect upon those of the banks in developing countries. Regarding the firm-specific factors included in the cost inefficiency function (4), ROA was found important for all the countries in the sample. A significant RDE may imply that the commercial banks in the developing economies are not able to adopt financial instruments to reduce the risk coming from their fragile financial structures.

The Tobit regression analysis helps determine the variables that contribute positively or negatively to the cost efficiency. The technology proxy T plays a key role to explain why the commercial banks in developing countries are less cost efficient, due possible to the misalignment of the management of technologies by the banks in developing countries. For the commercial banks in the subsample of developing countries, both the SCOPE and SCALE were found insignificant. Furthermore, because the TRIM variable is positively and significantly related to the cost efficiencies of the commercial banks keeping a large amount of foreign exchange reserves helps commercial banks benefit from higher cost efficiencies and prevent them from stepping into financial crises as well.

Our measure of cost efficiencies based on the generalized two-equation stochastic cost frontier model incorporating T in a dynamic perspective offers an angle of analysis rather different from previous studies. Figure 2 and 3 capture the dynamic behavior of cost efficiencies over time in international dimensions.

Finally, we are able to offer an implicit cause of the Asian financial crisis. Our empirical results indicate that the cost efficiencies of the banks for the emerging countries had continuously deteriorated after 1993 and were devastated drastically after the crisis. Such differing dynamic patterns of the cost efficiencies strongly suggest that the decoupling of the cost efficiencies explains the occurrence of the Asian financial crisis (c.f. Figure 4). Understanding the cause can lead to comparable consensus on how to prevent crises from taking place or on how to best handle them once they do erupt.

In summary, the distinctive contributions of this research add a number of informative and significant findings to the literature. The methodologies used in this paper also represent a big plus; they allow for a joint discussion of cost efficiencies, scope and scale economies, time-varying patterns of cost (in)efficiencies, the impacts of technological progresses and scope and scale economies upon cost efficiencies in the banking industries from a global perspective, and a new way to justify the occurrence of the Asian financial crisis.

Table 1. The Estimated Cost Function of the One-Equation Stochastic Cost Frontier

Country	KO		SG		TW		HK		AU		MA		IN	
Variable	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Constant	27.2490**	2.87	6.9211	0.22	35.6370	1.13	22.4130	1.01	-9.9319	-0.57	6.2288	1.00	15.8720*	2.18
LNW	-0.8881	-1.34	-0.1743	-0.04	0.5954	0.55	-4.4338	-1.41	-0.7799	-0.30	0.3663	0.48	-0.3952	-0.44
LNR	-12.9190**	-4.48	-0.2672	-0.07	4.7034	0.60	-2.9421	-1.07	2.7537	0.96	-6.1339*	-2.20	-6.6055**	-4.57
LNLN	-0.6529	-0.37	-4.5893	-1.42	-5.8952	-1.15	1.7537	0.55	-7.8960	-1.11	4.3439*	2.13	-2.2489	-1.71
LNTD	-2.7898	-1.33	9.0975	1.09	-0.0631	-0.01	-1.8222	-0.41	9.6765	1.31	-1.7420	-0.97	1.3025	1.03
LNFI	3.4780**	2.84	-5.2015	-0.79	1.4720	0.71	1.5315	0.87	0.3116	1.25	-2.5884	-1.50	1.1741	1.91
W*R	0.3077	0.99	-0.2504	-0.45	-0.0430	-0.21	-0.3184	-0.64	-0.2866	-0.65	-0.0495	-0.14	0.2502	1.48
WSQ	-0.0088	-0.59	-0.1041	-0.39	-0.0511	-1.60	0.6972	1.40	0.4693*	2.26	-0.1075	-0.74	0.0164	0.58
RSQ	5.8034**	6.06	1.3324	1.70	-4.8918	-1.38	3.1927**	3.84	-0.1913	-0.82	5.9335**	4.83	1.7719**	5.70
LN*TD	0.2109	1.10	-0.6318	-1.20	0.1929	0.19	-0.3123	-0.43	2.2742	1.86	-0.9002	-1.59	-0.1608	-0.78
LN*FI	-0.1463	-1.06	-0.7171	-1.15	0.2270	1.32	-0.0093	-0.06	0.2503	1.03	0.2948	1.36	-0.0609	-0.68
TD*FI	-0.0666	-0.34	2.9235	1.61	-0.2781	-1.11	-0.0425	-0.17	-0.2223	-0.87	-0.0329	-0.10	-0.0035	-0.05
LNSQ	-0.0523	-0.20	1.5135**	3.00	-0.2773	-0.30	0.4067	0.50	-2.4427	-1.94	0.6925	1.25	0.1430	0.63
FISQ	0.1560	0.99	-2.1545	-1.37	-0.0261	-0.91	0.0740	0.97	0.0172**	3.23	-0.1433	-0.45	-0.0088	-0.29
TDSQ	-0.0520	-0.50	-2.4593	-1.19	0.3289	0.24	0.3369	0.41	-2.0789	-1.64	0.8000	1.35	0.3442	1.67
LN*W	-0.0210	-0.18	0.1621	0.80	0.3223	1.75	-0.1345	-0.50	0.8018	1.36	-0.2271	-1.67	0.2450	1.52
LN*R	0.5196	1.71	-0.5160	-0.96	0.7125	1.55	-0.9350*	-2.31	-0.1597	-0.37	-1.1325*	-2.39	0.4862**	3.13
TD*W	0.0474	0.37	-0.1703	-0.43	-0.3261	-1.40	0.0927	0.27	-0.9568	-1.58	0.2435*	1.97	-0.2692*	-2.22
TD*R	0.3082	1.02	0.8767	0.72	-0.2773	-0.48	0.9841*	2.33	0.1068	0.25	0.7206	1.43	-0.3104	-1.70
FI*W	0.0109	0.38	0.1116	0.34	0.0058	0.12	-0.1471	-1.10	-0.0922*	-2.15	0.0391	0.38	0.0179	0.61
FI*R	-0.9592**	-3.05	-0.3746	-0.41	-0.2010	-1.30	-0.0452	-0.34	0.0496	0.83	0.1802	0.59	-0.0949	-0.88
R^2	0.9790		0.9963		0.9956		0.9926		0.9931		0.9766		0.9928	

* denotes significance at the 5% and ** for the 1% level.

Table 2 The Estimated Cost Functions of the Generalized Two-Equation Stochastic Cost Frontier

	Developing Countries					
	Specification (i)		Specification (ii)		Specification (iii)	
Variable	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Constant	-5.53160	-1.56	-6.22130	-1.39	-6.06570	-1.42
LNW	0.30619	1.43	0.22995	1.00	0.23484	0.87
LNR	-0.00937	-0.02	-0.20728	-0.34	0.07830	0.12
LNLN	1.17250	1.78	1.35030	1.62	1.92110*	2.36
LNTD	0.32366	0.69	0.35043	0.71	-0.17832	-0.29
LNFI	-0.36324	-1.22	-0.38989	-1.04	-0.49214	-1.22
W*R	0.01520	0.22	0.02685	0.34	0.00940	0.13
WSQ	-0.01400	-0.57	-0.00993	-0.42	-0.01390	-0.65
RSQ	0.44495**	6.74	0.40489**	5.47	0.33168**	3.76
LN*TD	-0.41935**	-8.35	-0.40131**	-7.17	-0.24852**	-3.79
LN*FI	-0.00817	-0.24	0.02033	0.43	0.11399*	1.97
TD*FI	0.01730	0.57	-0.01264	-0.38	-0.10259**	-2.42
LNSQ	0.42238**	4.74	0.34561*	2.66	0.08720	0.65
FISQ	0.01490	1.56	0.01359	1.02	0.01450	1.07
TDSQ	0.38701**	6.98	0.41570**	6.99	0.36239**	5.03
LN*W	-0.04870	-1.52	-0.03464	-0.91	-0.04360	-1.18
LN*R	-0.07650	-1.20	-0.00554	-0.09	-0.07860	-0.99
TD*W	0.01590	0.40	-0.00159	-0.03	0.00770	0.17
TD*R	0.08210	1.29	0.02547	0.34	0.09540	1.25
FI*W	0.02500*	2.33	0.02994**	2.76	0.03330**	2.97
FI*R	-0.02890	-0.78	-0.02932	-0.73	-0.03070	-0.84
T	-	-	0.02083	1.08	0.01830	0.82
T^2	-	-	-0.00223	-0.23	-0.00309	-0.27
T^3	-	-	-0.00091	-0.34	-0.00070	-0.23
T^4	-	-	0.00016	0.80	0.00014	0.67
ROA	-	-	-	-	-0.00353**	-5.64
RDE	-	-	-	-	0.00254**	3.37
θ	3.05510**	3.82	3.48000**	3.51	3.63790**	3.53
σ^2	0.02620**	17.13	0.02391**	16.15	0.02230**	15.23
R^2	0.9811		0.9822		0.9830	

Notes: * is for the 5% significant level, and ** is for the 1%, and $\theta = \sigma_u / \sigma_v$

Table 3 Results of the Tobit Regressions

Developing Countries			KO		SG		TW		HK		AU		MA		IN	
Variable	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Constant	0.82643**	9.49	2.08290**	6.93	1.11530	1.27	-1.55260**	-3.58	-2.24680**	-5.19	0.00205	0.01	-1.45930*	-2.15	-0.58658*	-2.19
T	-0.00975	-5.97	-0.01830*	-2.54	-0.02570*	-2.12	-0.07950**	-3.78	0.02380*	2.42	-0.02590**	-2.94	-0.03460**	-5.14	-0.00541	-1.32
SCOPE	-0.00591	-0.68	0.01960	1.22	-0.04920	-1.83	0.04020	1.40	0.17153**	6.65	0.00697	0.30	0.14750**	4.21	0.08720**	4.66
SCALE	0.11479	1.93	-1.23380	-4.88	-0.14988	-0.21	1.28590**	6.99	0.87341**	3.39	-0.01420	-0.20	1.52270**	2.82	1.23560**	5.24
TRIM	0.09580**	4.77	-0.08660	-1.08	0.39302	1.83	-0.08040	-0.76	-0.06450	-0.30	0.06400	0.32	-0.38088**	-3.79	-0.43911**	-7.27
PROD	-0.00083**	-2.83	-0.00032	-0.33	0.00215	0.88	0.01180**	3.49	0.01050**	3.78	0.00861*	2.17	0.00297**	3.38	-0.00042	-0.50
STK	-0.00009	-0.86	0.00027	1.00	0.00015	0.31	0.00007	0.41	0.00024	0.94	-0.00057	-1.18	0.00097**	4.06	0.00015	0.97
σ	0.08350**	33.27	0.05410**	17.15	0.05370**	9.95	0.03040**	10.00	0.04190**	10.68	0.07970**	13.71	0.06240**	12.76	0.05560**	12.25
R^2	0.1840		0.6170		0.2750		0.5510		0.6480		0.1930		0.5790		0.6890	

Figure 1 The Relationship between Scope Economy and Cost Inefficiency

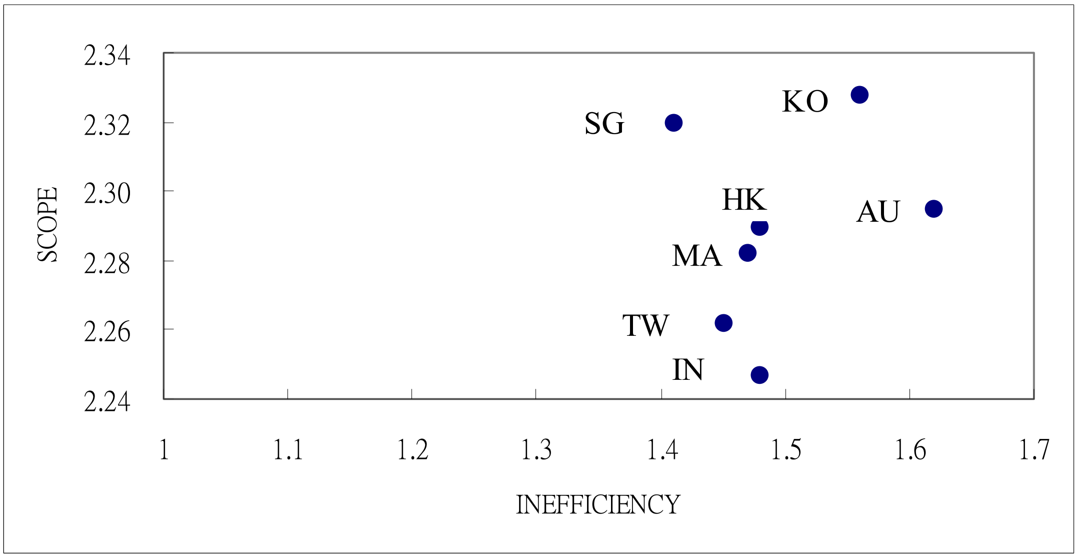
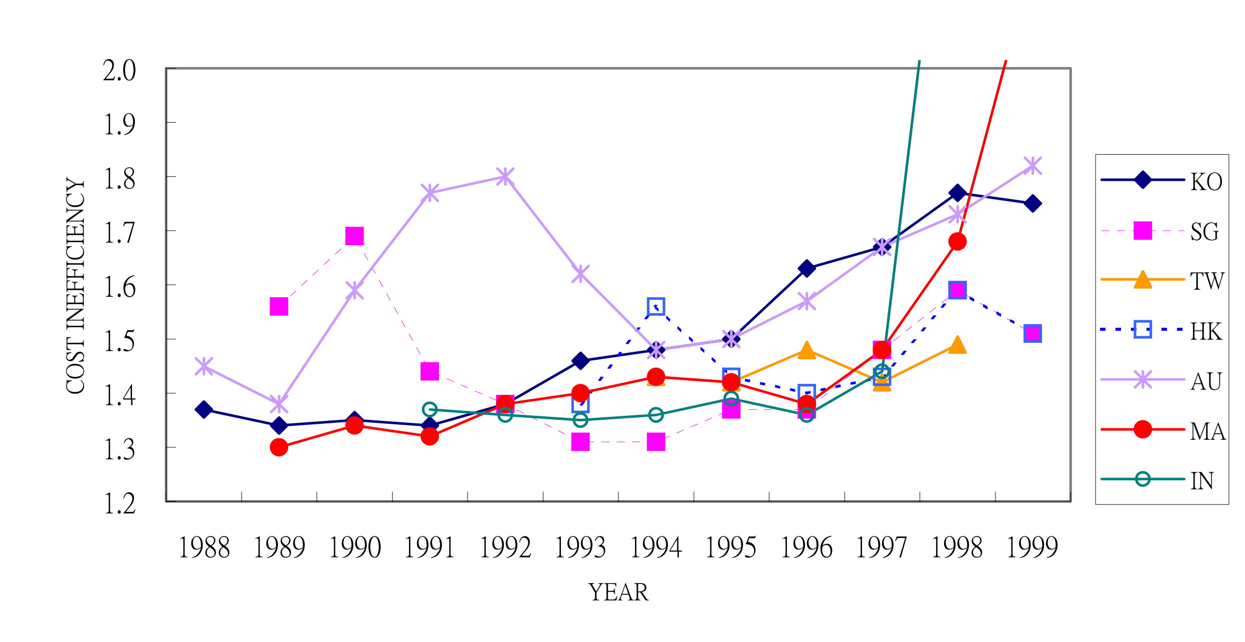


Figure2 The Dynamic Patterns of the Cost Inefficiencies for Developing Countries



ACKNOWLEDGEMENTS

The authors are grateful for the very helpful suggestions and comments from two referees and the International Conference on Comparative Management. The financial support from the National Science Council (under Grant No.NSC91-2416-H-110-030) is gratefully acknowledged.

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