**The Effects of Ownership Structure on Bank Efficiency for Taiwan: Is there a Non-Linear Relationship?**

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**Abstract**

To investigate the impact of ownership structure and concentration on bank efficiency for the case of Taiwan, I consider the non-linear relationship between ownership and efficiency, using the panel threshold model technique to test whether a non-linear relationship is significant. Empirical findings indicate that ownership structure is significantly impacted by bank efficiency; the results show that managerial ownership has a negative relation to efficiency and ownership concentration and state-ownership have no relation to bank efficiency. The results show that threshold effect is significant, which implies a significant non-linear relationship between board ownership and efficiency. This supports the form of non-linear relation as found in previous literature.

**Key words:** Ownership structure, Concentration, Panel threshold model

JEL Classification: G21, G34

1. **Introduction**

Since the original study of Jensen and Meckling (1976), the relation between ownership structure and firm performance is one of the most importance issues in corporate finance. The major focus of concern has been the potential conflict of interest between managers and shareholders; traditional agency theory illustrated that managers have higher incentive to expropriate minority shareholder rights while managers only held few shares. To limit these agency conflicts, various mechanisms have been suggested on how to work in corporate governance. Most studies illustrate various governance issues with ownership structure, executive turnover, executive compensation, and foreign investment. This study examined the relationship between bank efficiency and ownership in Taiwan, as a governance mechanism examined by ownership structure, the structure of institutional investors, ownership concentration, and to further explore whether there exists a non-linear relationship between ownership and efficiency at different ranges of ownership, in banks sampled over the period 1994 to 2010.

This study provides an interesting case study of corporate governance and efficiency for three primary reasons. First, most studies focus on how ownership affects the banks’ efficiency, e.g. Demsetz and Lehn, 1985, Ang et al., 2001 within the US, Kapopoulos and Lazaretou, 2007 within Greece, and Lemmon and Lins, 2003, within East Asian countries. They often use the accounting rate to measure the firm performance, such as return of asset, Tobins’ Q. In our known few studies that explore the relationship between ownership and efficiency score, an econometric model may provide an appropriate indicator to proxy firm performance, thus this study attempts to use two approaches to measure efficiency score: data envelopment analysis and distribution-free approach.

Second, like in most developing countries, the board members of the bank are similar family-controlled in Taiwan, and there are no outside block shareholders to monitor and prevent insider expropriate minority shareholders. The family board controls the bank and makes decisions with regard to corporate operations, business strategy, and human resource management. As a result, there is no credible supervisor, who provides incentives to the board members to make decisions that benefit their own interests and expropriate minority shareholders.[[1]](#footnote-1) Taiwan is a model for newly emerging countries and a valuable case for corporate governance; this study will test whether corporate governance is ineffective by estimating the link between ownership structure and efficiency.

Thirdly, in a classics study, Morck et al. (1988) proposed that between insider ownership and performance is a non-linear relationship by piecewise linear regression. Most papers follow this topic to further illustrate their relationship, such as Chen et al. (1993), and Kapopoulos and Lazaretou (2007). We attempt to investigate whether a linear or non-linear relationship between ownership structure and banks’ efficiency is significant, to avoid subjectively setting the boundary of ownership structure that may lead to bias; following Hansen (1999), this study provides a new technique to test it so the panel threshold model is used.

This paper is organized as follows: section one contains the introduction; section two describes the model specification, data source, and empirical design; and section three presents the empirical results and findings pertaining to ownership structures, concentration and testing for non-linear relation. The paper ends with a conclusion, which makes some suggestions for regulatory policy to improve the corporate governance of the banking industry.

**2. Methodology**

**2.1 The frontier models**

Previous studies in banking literature consider the measurement of bank efficiency to be an important problem; in an attempt to find a solution to this problem, we used parametric and non-parametric approach to measure bank efficiency. The contemporary empirical literature on efficiency of banks employs “frontier-based approaches” to measure the relative efficiency of banks, this study employ data envelopment analysis in which the best-practice production frontier for a sample of firms is constructed through a piecewise linear combination of actual input output correspondence set that envelopment the input-output correspondence of all firms in the sample (Thanassoulis, 2001). To measure the efficiency of banks, technical efficiency under constant returns to scale (CRS) is calculated, assuming the input matrix N and an output matrix M, one input x is used to produce one output y. Technical efficiency of the production plan (*y, x*)under the CRS and calculated for production plan (y, x) of production unit i as the solution to the linear programming problem as below



s.t. 

 (1)

where  is a scaling vector for the production plans,  is efficiency scale.

To estimate cost efficiency, suppose that in addition to the assumption cost efficiency is , where w is input price vector,  is efficient total cost, input vector . Input prices  are given. Thus (1) can be rewrite as



s.t. 

 (2)

Cost efficiency attains a value of less than unity if and only if at least one of its three components attains a value of less than unity. Cost efficiency is decomposed as below:

  (3)

whereis allocative efficiency, is efficiency size of scale is technical efficiency.

On the other hand, we also use the parametric approach to measure banks efficiency, cost x-efficiency measures the extent to whish a bank’s cost approximate those of the best practice or least cost bank, producing an identical output bundle under the same conditions. The measure is derived from a cost function where the dependent variable is each banks total cost, and the independent variables include the prices of inputs, the quantities of variable outputs and composite error term, a general version of this cost function for a bank may be written as

  (4)

where C is total costs, w is input prices, y is the output quantities and is error term.

We adopted the translog function to estimate the cost efficiency of a bank, inferred the translog function (see Christensen et al. 1973), applying Shepard’s Lemma to differential equation (4), we obtain three factor share equations, the sum of which equals one; the error term shows singularity of the variance matrix. The cost function in Eq. (4) and any two share equations are estimated simultaneous equations by iterative seemingly unrelated regression (ITSUR) after deleting the fund cost equation.

In general terms, the standard assumption is that the x-efficiency and random error terms can be multiplicatively separated from the remainder of the cost function, empirical function has been used to disentangle the composite error term by free distribution assumption, the banks cost equation is specified as:

 (5)

The error term is  and decomposes into two parts, which is the conventional white noise and a mean-zero random error random error incorporating the measurement error or a random shock to bank costs deemed occasional, while is a multiplicative X-inefficiency factor that may raise costs above the best-practice level. X-inefficiency  is estimated econometrically, it reflects any failure to minimize the total cost of production and the residual is calculated as . The function  is transformed into a normalised X-efficiency measure as follows:

= (6)

where  indicates the minimum in all banks and  for all *i* for that *t*. while it may be seen that this is an estimate of . Suppose that the XEFF value equals one; this would indicate that the firm is the most efficient and ranges over (0~1).

The input-output specification of this paper is based on intermediation approach as suggested by Berger (1995), most studies is follow intermediation approach definition of input-output variables such as Shen (2005), where the salary expense, capital expense, and interest expense as the input factors are use to produce earning assets, and salary, capital and interest price. The three outputs are total loans, investment, and non-interest revenues. Total loans include short-, medium- and long-term loans, overdrafts, discounts, and advances on imports. The primary data source for this study was the Taiwan Economics Journal (TEJ); the samples included 29 listed banks during the period from 1994 to 2010, total observation 453 in full sample, and 20 banks build a panel data sample observation is 340. Descriptive statistics of the empirical variables are provided in Table 1.

<Table 1 is inserted about here>

**2.2 Non-linear relationship and Panel threshold model**

Previous studies attempt to explore the non-linear relationship between ownership and firm performance. In a classics study, Morck et al. (1988) proposed that between insider ownership and performance is a non-linear relationship. Most papers follow this topic to further illustrate their relationship, such as Chen et al. (1993), and Kapopoulos and Lazaretou (2007). They often use a piecewise linear regression, which divides a different range of ownership and runs regression by statistics technique, such as Morck et al. (1988), and finds a negative relationship between performance and managerial ownership at low range of ownership (0%–5%), but a positive relation at the middle range (5%–25%). To avoid a subjective set, a threshold value identical across all observations in the study sample may cause biased results. This study used a panel threshold method to test whether a non-linear or linear relationship between ownership and efficiency is significant. Based on these arguments we propose the following hypothesis:

*: The relationship between ownership and bank efficiency is non-linear.*

To briefly describe the panel threshold model, we assume that the data are from a balance panel, where dependent variable is scalar and the repressors is a k vector,  indicates the individual and the t indicates time. The threshold function is follow as

  (7)

where is the indicator function, an alternative intuitive way of writing (7) is

  (8)

This model assumes the observations are cut into two regimes depending on whether the threshold variable is larger or smaller than the threshold, the regimes are distinguished by differing regression slopeand, and its required that the elements of are not time invariant, the analysis is asymptotic with fixed T as .. Hansen (1999) illustrates that slope coefficient can be estimated by ordinary least squares (OLS) while is known, that is

 (9)

We also expand the single threshold model that may be have multiple thresholds; in the study used, tripe threshold model takes the form

   (10)

where the thresholds are ordered so that . The equation (10) is leaner in the slope so OLS estimation is appropriate while is known. An alternative, intuitive way of writing (10) is

 (11)

**2.2 Empirical function: Ownership structure and institution investors**

A question one might ask about the agency problem might be: how does ownership structure affect the bank’s efficiency? The empirical literature shows the relationship between ownership and performance is still puzzling, the result of the relationship between ownership structure and firm efficiency is positive, such as, Lichtenberg and Pushner, 1994, Hu and Zhou, 2008. On the contrary, some studies illustrate the negatively relativity to the firm’s performance, such as Al Farooque, et al., 2007. Even though previous studies indicated that a meaningful association between ownership and performance has not been identified, Demsetz and Lehn (1985), Loderer and Martin (1997), and Demsetz and Villalonga (2001) find that no systematic relation should exist between changes in ownership and the firm’s value. There has been a diverse stream of theoretical and empirical research relation to ownership structure on a number of subjects, such as, ownership concentration, managerial ownership, non-linear relation between ownership and performance. In this paper, we further explore this last subject of analyst activity. In general, empirical literature usually adopts the return of asset, return of equity and Tobin’s Q as proxy to the bank’s performance. Is an appropriate variable to measure the banks performance by traditional account ration? Bonin et al. (2005) argue that standard financial performance measures are often higher in developing countries and less developed in the regulatory procedures. Previous studies used the econometric model to estimate banks’ efficiency to substitute for account ratio variables, e.g. Figueira et al., 2009, and Bonin et al., 2005. In light of these arguments, this study uses DFA and DEA techniques to measure banks’ efficiency prefer than financial ratio.

This study explores the effect of ownership structure with three conceptions as follows: basic ownership structure; ownership concentration; and non-linear relationship. First, basic banks’ ownership variables including board, managerial, outside block shareholders and institution investors. Institutional investors have identified corporate governance as a key factor affecting their willingness to invest in an emerging market (Gibson, 2003). We examined the effect of institutional investors to classify institutional investors into the state-owned shareholder, domestic financial institutions shareholder, domestic trust funds, domestic corporations, private domestic investors, and foreign investors. Thus, the empirical equation combined ownership variables and control variables can be written as:

 

 (12)

where BOARD indicates percentage of equity owned by board;[[2]](#footnote-2) Top\_Ten indicates percentage of equity owned by top ten shareholders; CEO indicates percentage of equity owned by CEO, B\_SIZE indicates natural log of number of directors, STATE indicates percentage of equity owned by the government; BANK indicates percentage of equity owned by domestic financial institutions shareholder, TRUST indicates percentage of equity owned by domestic trust fund; CORPOR indicates percentage of equity owned by investors of domestic corporations, PERSONAL indicates percentage of equity owned by private domestic investors; and FOREIGN indicates percentage of equity owned by foreign investors, Equity indicates total equity divided by total assets; SIZE indicates natural log of total assets; and ROA indicates return of asset ratio. R\_Growth indicates banks annual revenue growth ratio, and LODE indicates total loan divided by deposit.

According to the classical literature on agency problem, Jensen and Meckling (1976) claimed that a high level of board and managerial ownership would increase the incentive to maximize corporate value. On contrary, Morck et al. (1988) illustrate that when the ownership of the large owner exceeds a certain threshold, they gain nearly full control over the firms, and they prefer extracting private benefits that do not accrue to minority shareholders. As we already noted, it is may increased supervise the manager to maximum all shareholder wealth when the outsider shareholder is not slight. How the board and managerial ownership affect the banks efficiency, these results hasn’t a common consensus. We suggest that the ownership structure has, without a doubt, a significant impact on banks’ efficiency. Based on these arguments we propose the following hypothesis:

*: Between the ownership structure and bank efficiency is a cross-relationship.*

Previous studies on institutional investors have considered whether institutional investors improve or not on corporate performance (e.g., Pound, 1988, Agrawal and Mandelker, 1990, Duggal and Millar, 1999). Duggal and Millar (1999) found no relationship between institutional investors and firms’ performance. Bonin et al. (2005) find that foreign ownership have a significantly positive effect on banks’ efficiency and the positive impact of international institution investors. The case for believing that private ownership is superior to state ownership in creating managerial incentives to raise productive and lower cost of production is largely based on principal-agent theory (Beck et al., 2003). This suggests that more state-ownership may reduce bank efficiency. State-owned bank managers offer no incentives to pursue maximum profit strategies due to them not losing their jobs; even banks have inefficiency and less profitability. Whether the institution investor is a determinant of bank efficiency or not, it is a valuable question to further explore. Previous studies did not classify institutional investors by attribute, which may have resulted in some substantial factors being ignored. We examined the effect of institutional investors by classifying institutional investors into the state-owned shareholder, domestic financial institutions shareholder, domestic trust funds, domestic corporations, private domestic investors, and foreign investors. This model through to further discussion of these variables might result in the emergence of a new viewpoint for institution investors. In light of these arguments, we propose the following two hypotheses.

*: The state-owned shareholder is a negative relation to banks efficiency.*

*: The foreign investor is a positive relation to banks efficiency.*

**2.4 Empirical function: Ownership Concentration and Efficiency**

It is an important empirical work that intends to study how concentrated ownership affects banks’ efficiency. As shareholding concentration increases, the main bank has an increased incentive and ability to monitor management of firms (Prowse, 1995). This hypothesis states that ownership concentration is a proxy for a level of monitoring, and that profit stability should be positively related to the level of ownership concentration. Mitton, (2002) consistent with this view, explored the firm stock performance during the Asia financial crisis and found that large shareholders can prevent expropriation, and higher ownership concentration is associated with significantly better stock performance On the contrary, Demsetz and Lehn (1985) argued the Berle-Means thesis; they find no significant relationship between ownership concentration and accounting profit rates. Following previous studies adopts the Herfindahl index measure of ownership concentration (CONC), calculated by summing the squared percentage of shares controlled by each shareholder. CR\_Ten is another measure concentration indicator, using the common equity owned by the ten largest shareholders as proxy ownership concentration and follow Demsetz and Lehn (1985) who apply a logistic transformation to these percentages.[[3]](#footnote-3) In summary, most studies supported less diffused ownership positively affects firm performance. In light of these arguments, we propose the following hypothesis.

*: The concentration ownership is a positive relation to banks efficiency.*

The empirical equation on concentration ownership and ownership variables can be written as:

  (13)

The main primary data source for this study was the Taiwan Economics Journal (TEJ). The sample collected a panel data 20 banks over the period 1994 to 2010, the total observation is 340, and subsample is unbalanced data 29 banks over the period 1994–2010, total observation is 453; we excluded partial bank data that were unavailable, or for which there had been financial distress. In some cases, we were able to make up for the partial lack of data by referring to the Annual Report of Bank Business Statistics published by the Central Bank Republic of China and the annual reports of individual banks in order to conduct empirical examinations. Table 2 presents descriptive statistics for ownership structure, institution investor structures, and other control variables.

<Table 2 is inserted about here>

**3. Empirical Results**

**3.1 Results of estimate bank efficiency**

This subsection illustrates the results of banks efficiency analysis using DFA and DEA. The efficiency index includes X-efficiency (XEFF) overall technical efficiency (TE), allocative efficiency (AE), and cost efficiency (CE). DEA technique reflects what level of utilisation of input or the impact on selection of input combinations. XEFF is reflecting the management efficiency measured by DFA technique. As can be seen in Table 3, the mean X-efficiency score is 0.3864 and a decreasing tendency over the period 1994 to 2010. In this finding X-efficiency is lower than Shen (2005), a larger fall trend of X-efficiency, and this study shows that cost efficiency decreased from 2002 to 2005, reaching 0.3591, 0.334, 0.162 and 0.2983, respectively.

The mean technical efficiency, allocative efficiency and cost efficiency score is 0.7852, 0.7095 and 0.575, respectively. The finding that the mean technological efficiency is slightly higher than the allocative efficiency implies that allocative inefficiency is a major source of cost inefficiency. Thus, given an input price, the effects on cost inefficiency could be attributed to the incorrect choice of the initial input combinations. The result shows efficiency score by DEA technique is larger than efficiency score by DFA technique, which implies that the white noise may reduce efficiency score by DFA. Many uncertainly shock from macroeconomics, financial environment and industrial organization in study period. This finds the efficiency score change showing a U pattern, for instance, and the cost efficiency is decreasing over 1994–2001 and turns upward in 2002 to 2010.

**3.2 Empirical results: Ownership structure and Institutional investors**

**3.2.1 Empirical results of panel data**

This section explains how dose ownership structure and institution investors affect bank efficiency, using the X-efficiency, technical efficiency, allocative efficiency and cost efficiency as proxy efficiency score in Eq (7), the main regression results are shown in Table 1.[[4]](#footnote-4) This study adopts fixed effect model and random effect model to estimate Eq (7), and the Hausman test indicated that the random effect model is more appropriate for empirical regression. As can be seen in Table 4, this finding XEFF and TE regression have partial conflict results. Previous study literature show that effect of ownership is mixed even though used identical independent variable in various study period and countries subsample. On the other hand, XEFF is measured by parametric approach; it is considered the white noise term and exogenous effect in a single frontier, the parametric approach is more preferred than the non-parametric approach in the study period 1994 to 2010.[[5]](#footnote-5) The XEFF regression modelof 0.5384 and is stronger than for the TE result. Some sign have the same results, but our explore content mainly rely on the XEFF regression and we also attempt to illustrate a conflict sign from TE regression as to why their relationship is mixed. Using the Variance Inflation Factor (VIF) to test whether collinearity problem is significant, as can be seen in Table 4, the column 5 shows all variables of VIF less than 10, which implies there are no collinearity problems in the regression analysis.

The coefficient of BOARD is positive but it is insignificant, indicating that there is no relationship between board ownership and banks efficiency within XEFF and TE regression. This result shows beyond doubt that larger ownership by the board does not improve bank efficiency. Our result is inconsistent with Jensen and Meckling (1976) and Fama and Jensen (1983), who found that ownership does have a significant impact on performance.[[6]](#footnote-6) But this result is consistent with Himmelberg et al. (1999). McConnell and Servaes (1990) provide evidence of reverse U-shaped relationship between ownership and performance at different ranges of ownership with an inflection point between 40 percent and 50 percent. It may have a non-linear relationship between ownership and performance; thus, we used the panel threshold model to estimate regression with different level of board ownership in the next section. The coefficient of Top\_Ten is negative with XEFF regression, implying that outsider major shareholder ratios have destruction effect on banks efficiency, but the coefficient is insignificant. These results are inconsistent with Lemmon and Lins (2003), whose results showed that firm values are higher when the cash flow rights held by block shareholders are higher. Kapopoulos and Lazaratou (2007) showed that outside invest shareholdings affect firms’ performance positively. On the contrary, Demsetz and Villalonga (2001) showed no relationship between performance and managerial and Top 5 shareholder ownership. Jensen and Meckling (1976) argued that a fraction of larger insider shareholder ownership may reduce agency problem, insider shareholding ratio is lower while the outsider shareholder is at a relatively higher level, and this condition may give insider shareholders an incentive to act in a way that benefits their own interest and to expropriate outsider or minority shareholders.

The coefficient of CEO is negative and significant, implying that bank efficiency negative relation to managerial shareholder. Traditional corporate governance mechanism in emerging markets seem to fail to explain the relationship between performance and ownership structure, CEO characteristic, and risk-taking. For instance, at emerging market firms with a large domestic shareholder, CEOs of poorly performing firms are not more likely to lose their jobs (Gibson, 2003). Most banks control rights owned by family board in Taiwan, so top executive turnover is not majorly decided by their performance or profitability; the family board follow their personal druthers or politics factor to decision-making. On the other hand, Ang et al. (2001) find agency cost increases with a reduction in managerial ownership, so it is possible that large managerial ownership has a negative relation to bank efficiency. The coefficient of B\_SIZE is significantly positive with XEFF and TE regression, implying that a larger size of the board may improve banks’ efficiency. This result is inconsistent with Jensen (1993) and Eisenberg et al. (1998). Andres and Vallelado (2008) point out that the effect of board size on bank value is a trade-off between advantage (monitoring and advising) and disadvantages (coordination, control and decision-making problems), while board of directors to be larger; a larger board facilitates manager supervision and brings more human capital to advise managers. In sum, this results in no reject; a cross-relationship between ownership and banks efficiency is significant.

The coefficient of STATE is insignificant with XEFF and TE. We expect state ownership to have negative impact on bank efficiency, but the results show that between state ownership and banks efficiency is irrelevant, so this result shows  is not supported. The wave of privatization to improve efficiency and increase degree of competition started in the 1990s, decreasing the ownership percentage by state-owned to avoid the politics intervention and protecting. The privatized policy had a partial effect to increase the competitive condition toward the perfect market. The coefficient of BANK and PERSONAL is insignificant, indicating that financial institution investors and personal investors (individuals) have no impact on banks efficiency. The coefficient of PENSONAL is insignificant, implying that individual domestic investors do not effectively monitor managers, and they do not have enough power to do so.

The coefficient of CORPOR is significantly negative with TE regression, but the sign is insignificant with XEFF regression. In general, most board of directors adopt the legal person from holding their share in Taiwan. This implies that domestic corporations do not effectively monitor CEOs due to the board of directors and domestic corporate form is duality. The coefficient of TRUST is negative and significant with TE regression, implying that domestic trust fund managers are incapable of monitoring managers due to the myopic goals and conflict of interests. Fund managers approach their investments with a myopic view, guided solely by the short-term goal of out-performing earnings benchmarks in a particular quarter. Duggal and Millar (1999) illustrated that this short-term perspective leads to overreactions to information and excessive trading, and renders these investors to not strive to monitor CEOs. The results of FOREIGN is a conflict result, the coefficient is positive and significant with XEFF regression, but a contrary result with TE regression. So this result is not supported by. Previous studies do not have certain results, e.g., Bonin et al. (2005) find that the impact of foreign ownership has a significant positive effect on efficiency, and some studies show that foreign ownership is negative and significant on efficiency, such as Compbell and Keys (2002). The foreign ownership may contribute to the stability and monitor board and managerial in emerging countries. The foreign investors have a negative effect from liability of foreignness; they uncertainly having better decision-making to invest bank ownership in a host country. Figueira et al. (2009) point out that foreign investors hold minority shareholdings and domestic shareholders could overrule their views.

The coefficient of A\_SIZE is significantly negative, indicating that increasing asset size cannot improve efficiency; this result supports “too big to fail”. Previous studies on the effect of asset size on bank efficiency have given mixed results. Shen (2005) found that the optimal fixed asset size is around NT$10 billion in Taiwan banks. The coefficient of EQUIT and R\_Growth is insignificant and the coefficient of LODE is significantly positive. The EQUIT as proxy risk indicator has no impact on banks’ efficiency. The coefficient of ROA is positive and significant; this result is consistent with our expectations. This implies that more efficiency creates more banks’ profitability.

**3.2.2 Efficiency and ownership concentration**

In this subsection, how does the ownership concentration affect banks’ efficiency? The results of regression of ownership concentration measured by random effect and fixed effect mode can be seen in Table 5. The sign of CONC and CR\_Ten is negative; indicating the even though higher degree of ownership concentration cannot benefit firm efficiency, these coefficients are insignificant. This result is inconsistent with our hypothesis and previous studies. Shleifer and Vishny (1997) illustrate that large shareholders can benefit minority shareholders because they have the power and incentive to prevent expropriation. But Demsetz (1983) and Demsetz and Lehn (1985) find that the ownership concentration and firm profit rate should be unrelated. One possible reason to explore this result is that a high concentration ownership structure implies that the board of directors and managerial positions are stable or entrenched; even banks’ efficiency or profitability is worse and they would not lessen their position due to their widely held company share. Jensen and Ruback (1983) point out that high concentration of board or managerial ownership means less incentive of promoting board or managerial owners to maximize value for them. The second possible reason to explore is family-controlled firms play a particularly important role in Asian countries.[[7]](#footnote-7) In practice, the high concentration ownership firm trend is to be controlled by the board of a single family; they have less incentive to maximize firm value or shareholder wealth. Thus, the between ownership concentration and bank efficiency is an insignificant relation, and higher degree of family-controlled ownership increases the potential for expropriation of minority shareholders’ right.

**3.3 Non-linear relationship between ownership and efficiency**

**3.3.1 Results of cubic regression on board ownership**

In this subsection, we attempt to investigate whether a linear or non-linear relationship exists between ownership structure and banks efficiency, using two approaches to explore their relationship. First, following Al Farooque et al. (2007), the cubic form OLS regression model is adopted; it only considers the board ownership variable influencing on efficiency in cubic regression. Second, to avoid subjectively setting the boundary of ownership structure may lead a biased; exclude the OLS piecewise regression, panel threshold model technique is used.

As can be see Table 6, The Table 6 reported the cubic regression results with XEFF and TE, like former section the AE and CE results not listed. The results show a non-linear relationship between the board ownership and efficiency, the sign initially is initially decrease, then increase and again decrease as board shareholding is increases. This result is consistent with Hubbard and Palia (1995), Hu and Izumida (2007) and Al Farooque et al. (2007). The coefficient of BOARD is negative and insignificant the same as the former results. The square term is positive and insignificant, and cubic term is negative and significant, implying that board ownership increases further the boundary turning become negative relation to efficiency. This result supported our hypothesis; the non-linear relationship between board ownership and efficiency supports the conclusions of Morck et al. (1988). This finding is that in an approximate lateral S-shaped relation of ownership to efficiency, its relationship seems not a simple linear one, this finding suggests.

**3.3.2 Results of panel threshold model**

In this subsection, the panel threshold model technique measured the different range of ownership structure’s impact on efficiency. Following Hansen (1999), we use the F test for testing whether the threshold effect is significant or not. Table 7 presents the results of F test, the p-value less 10% shows the threshold effect is significant, and in the null hypothesis that no threshold effect can be rejected with BOARD in XEFF regression, and BOARD, Top\_Ten and PERSONAL in TE regression. For instance, the BOARD is a three threshold model; the threshold value is 0.1081, 0.2083 and 0.4046, respectively. To divide four different ranges of board ownership subsample to measure the regression of parameters by OLS, the four
subsamples are:.

In XEFF Regression, the three threshold effect is significant with board ownership, while other ownership variables are not insignificant. The coefficient of BOARD is negative and significant in all subsamples; these results are consistent with former results. It is obvious that a fall tendency of negative effect, while board ownership increases further threshold boundary, leads to the negative shock to efficiency narrowing gradually. In the first regime, where the board ownership is less than 10.81% the estimate of coefficient is -4.3, which indicates that a 1% increase in board ownership decreases bank efficiency by 430%, in the fourth regime, where the board ownership is larger than 40.46%, the estimate of coefficient is -0.37, which indicates that a 1% increase in board ownership decreases bank efficiency by 0.37%. It implies bank efficiency with higher board ownership more than bank efficiency with lower board ownership.

This finds a similar result in TE regression with BOARD.[[8]](#footnote-8) This finding again supports that the higher board ownership is more efficient. The coefficient of top ten shareholders is positive and significant, which results in the first regime, where the board ownership is less than 1.19%, the estimate of coefficient is 35.5602, and in the second regime where the board ownership is larger than 1.19%, and the estimate of the coefficient is 0.0311, which indicates that a 1% increase in board ownership decreases bank efficiency by 355.602 and 3.11%, respectively. These results show efficiency with lower block shareholder ownership more than efficiency with large block shareholder. Some studies use a measure of outside block shareholders as proxy for the degree of monitoring activity such as Singh and Davidson, 2002. A large negotiation cost with outside block shareholder for banks to interference professional managerial decision-making, and led managers not maximum banks’ resource utilized. The board or outside block shareholders usual to maxima themselves benefited for banks in Taiwan. The private domestic investor ownership variable has two thresholds in the regression relationship by F test. The two threshold values are 0.3879 and 0.6268, so three regimes of coefficient are -1.1498, -0.6889 and -0.279 in sequence, respectively. The result shows bank efficiency significantly negative relation to a large percent of minority shareholders. This is an obvious variation between Taiwan’s equity market and other developed countries; the private domestic shareholder are major investors for the equity market in Taiwan, and they are minority shareholders compared with other companies’ shareholder. On the other hand, a more dispersed ownership structure bank has a high efficiency from observe regression coefficient is a raised tendency.[[9]](#footnote-9)

In summary, the F test shows threshold effect is significant; this implies that a significant non-linear relationship between board ownership and efficiency with XEFF and TE regression. Thus, we support the form of non-line relation as found by Morck et al. (1988) again. The coefficient is various where several range of board ownership, which indicates that bank efficiency with higher board ownership is more than bank efficiency with lower board ownership.

**3.4 Robustness checks on various subsamples**

In this subsection, we check the robustness of our result by several sensitivity analyses. We have two ways to treat the various subsamples. First, are our results robust to the inclusion of unbalanced data firms? Our initial sample used a panel data covering 20 banks during the period of 1994–2010. We remove some banks sample due to these data having no balance. Major state-owned banks are excluded in panel samples and then may make the results biased. We re-estimate regression after inclusion of our obtained bank samples in equation (12), we used 29 banks from 1994 to 2010. The total observation was 453. As can be seen in Table 5, these signs obtained were qualitatively similar, the coefficient of STATE is still positive and significant, and former results show that the state ownership has a positive impact on efficiency, but it is insignificant. Previous studies illustrated that state-owned banks remain and enjoy government policy advantage because of their efficiency and profitability compared to private banks in developing countries, such as Bonin et al. (2005), and Li et al. (2004).

Second, are second financial reforms not impacting our result? Since 2001, the government carried out a series of financial reform polices to improve banks asset quality and reduce bank non-performance loans. The bank business model had a radical change after financial reform, for instance, in the Financial Holding Companies (FHC) Act, there can be FHC subsidiary and independent banks. Thus, we re-estimate regression (12) that the full sample can be divided into pre- and post- 2001 (finance reform), only to list post-2001, as the results show in Table 5. As can be seen in Table 5, the results still remain qualitatively the same with the financial reforms not influencing it.

Thirdly, previous studies often employ accounting variables to measure firm performance; these variables include return of equity, return of asset and Tobin’s Q. To further investigate the various dependent variables in our empirical equation whether to change our main results, we re-estimate regression and use the dependent variable, return of asset. As can be seen in Table 10, this study of former results shows that bank efficiency relation to foreign investors is ambiguous. The coefficient of FOREIGN is negative and significant; this implies large foreign investors had a negative association with profitability. This result is inconsistent with efficiency regression. One possibility is that the foreign investors have a negative effect from liability of foreignness, and the second possibility is that the efficiency and performance is reduced by intangible intervenes from politics in emerging countries, such as Taiwan. Thirdly, foreign bank through acquired domestic banks to expand their market share in recent years, the acquired banks almost with poor performance and bad asset quality, foreign banks would improve banks efficiency by their know-how, but cannot increase bank profit in the short-term. The results still remain qualitatively similar and imply that efficiency and performance regression is the same. <Table 9 is inserted about here>

<Table 10 is inserted about here>

**4. Conclusions**

Ownership structure is a key element of corporate governance, but literatures provide these relationships are still a puzzle, and empirical case of developed countries may be inappropriate for emerging countries’ application. To investigate the impact of ownership structure and concentration on bank efficiency for case of Taiwan, we consider the non-linear relationship between ownership and efficiency, using panel threshold model technique to test whether non-linear relationship is significant. This study attempts to build five hypotheses for testing whether cross-relationship between ownership structure and efficiency is observed.

The result shows that insignificant relationship between board ownership and banks efficiency, and shows beyond doubt that larger ownership by the board may not improve bank efficiency. The board ownership of threshold effect is significant, and it is obvious that a fall tendency of negative effect, while board ownership increases further threshold boundary, the negative shock to efficiency is narrowed gradually. This implies that bank efficiency with higher board ownership more than bank efficiency with lower board ownership. The relationship between managerial and efficiency is negative and significant, implying bank efficiency’s negative relation to managerial shareholder.

The results show that between state ownership and banks efficiency there is no relationship. The wave of privatization is to improve efficiency and increase the degree of competition that started in the 1990s, decreasing the ownership percentage by state-owned to avoid the politics intervention and protecting. The privatized policy had a partial effect to increase the competitive condition toward the perfect market. The relationship between foreign investors and efficiency is significantly negative; one possible explanation is that the foreign investors have a negative effect from liability of foreignness; the second possible explanation is that the efficiency and performance is reduced by intangible intervenes from politics in emerging countries, such as Taiwan.

Empirical findings indicate that ownership concentration has no relation to bank efficiency. One possible reason to explore this result is a high concentration ownership structure implies that the board of directors and managerial position is stabled or entrenched, and that even banks’ efficiency or profitability is worse because they would not lessen their position due to their widely held company share. The second possibility is that, in practice, the high concentration ownership firm trend is controlled by the board of a single family; they have less incentive to maximize firm value or shareholder wealth. Thus, the between ownership concentration and bank efficiency has an insignificant relation, and higher degree of family-controlled ownership increase the potential for expropriation of minority shareholders right.

The results show that threshold effect is significant, which implies that a significant non-linear relationship between board ownership and efficiency supports the form of non-line relation as found by previous literatures. Through a various degree of ownership their relation to efficiency is changeful, the insignificant relationship board ownership and efficiency on linear function estimated, but the non-linear regression estimated show the board ownership has a negative relation to efficiency, and it is obvious that a fall tendency of negative effect, while board ownership increases further threshold boundary, the negative shock to efficiency is narrowed gradually.

This study also offers some practical guidance for corporate governance in banks of Taiwan. First, traditional corporate governance mechanisms in emerging markets seem to fail to explain the relationship between performance and ownership structure, managerial characteristic, and risk-taking. Most banks control rights owned by family board in Taiwan, managerial turnover does not rely on their performance or profitability, and the family board follows their personal druthers or politics factor to decision-making. Second, the foreign investors has a slightly positive affect on banks’ efficiency, they may provide a better experience building managerial monitory mechanism and dealing with agency cost through contact with various national and cultural factors. Thirdly, poor managerial efficiency for banks due to lack of external corporate governance mechanism and bank must follow the policy-oriented business by the government. The government must establish a market-oriented external corporate governance mechanism.

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**Table 1 Descriptive statistics of Cost Function**  (**Unit: million)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Mean** | **Std.** | **Max.** | **Min.** |
| *Total cost* | 20,862.3 | 2.324.3 | 1.114E-5 | 581 |
| *Output*  |  |  |  |  |
| Investment | 94,079.14 | 1.308 | 1.092E-6 | 711 |
| Loans | 4.06E-5 | 4.217 | 2.08E-6 | 23,393 |
| Non interest revenues | 5,679.6 | 6,921 | 5,679 | 608 |
| *Input price* |  |  |  |  |
| Labor price | 917.52 | 342.2 | 4760.43 | 149.01 |
| Fund price  | 0.4272 | 0.3087 | 4.1083 | 0.006 |
| Capital price  | 0.0332 | 0.0198 | 0.076 | 0.0046 |

Note: The labor price unit measure by thousand, fund and Capital price measure by percent。

**Table 2 Descriptive statistics of regression**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Mean** | **Std.** | **Max.** | **Min.** |
| *BOARD* | 0.221 | 0.191 | 1 | 0 |
| *Top\_Ten* | 0.1256 | 0.1348 | 0.86 | 0 |
| *CEO* | 0.0023 | 0.0379 | 0.03 | 0 |
| *B\_SIZE* | 2.5348 | 0.3607 | 3.43 | 1.79 |
| *STATE* | 0.0689 | 0.1534 | 1 | 0 |
| *BANK* | 0.072 | 0.1186 | 0.59 | 0 |
| *FOREIGN* | 0.1319 | 0.1936 | 1 | 0 |
| *TRUST* | 0.0053 | 0.0796 | 0.04 | 0 |
| *CORPOR* | 0.192 | 0.1917 | 0.77 | 0 |
| *PERSONAL*  | 0.4412 | 0.2285 | 0.94 | 0 |
| *A\_SIZE* | 17.7729 | 0.9096 | 21.52 | 17.74 |
| *Equity* | 0.0724 | 0.026 | 0.21 | 0.03 |
| *ROA* | 0.0312 | 0.0227 | 0.07 | -0.06 |
| *R\_Growth* | 0.0663 | 0.2232 | 1.49 | -0.54 |
| *LODE* | 0.8166 | 0.0849 | 1.11 | 0.57 |

Note: These variables definition see in section 2.2 Definition of regression analysis.

**Table 3 Results of Banks efficiency**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **XEFF** | **TE** | **AE** | **CE** |
| 1994 | 0.6568 | 0.971 | 0.643 | 0.626 |
| 1995 | 0.4876 | 0.647 | 0.713 | 0.49 |
| 1996 | 0.7331 | 0.898 | 0.816 | 0.749 |
| 1997 | 0.2426 | 0.889 | 0.783 | 0.716 |
| 1998 | 0.5407 | 0.794 | 0.637 | 0.519 |
| 1999 | 0.528 | 0.814 | 0.742 | 0.63 |
| 2000 | 0.4077 | 0.742 | 0.659 | 0.505 |
| 2001 | 0.4441 | 0.733 | 0.604 | 0.488 |
| 2002 | 0.3591 | 0.629 | 0.686 | 0.44 |
| 2003 | 0.334 | 0.685 | 0.664 | 0.474 |
| 2004 | 0.162 | 0.777 | 0.65 | 0.538 |
| 2005 | 0.2983 | 0.716 | 0.7 | 0.524 |
| 2006 | 0.362 | 0.79 | 0.756 | 0.585 |
| 2007 | 0.2153 | 0.847 | 0.708 | 0.615 |
| 2008 | 0.1926 | 0.718 | 0.754 | 0.538 |
| 2009 | 0.2719 | 0.841 | 0.757 | 0.679 |
| 2010 | 0.3324 | 0.857 | 0.789 | 0.659 |
| mean | 0.3864 | 0.7852 | 0.7095 | 0.575 |

Note: TE is the Overall technological efficiency, PTE is the Pure technological efficiency, SE is the scale efficiency, AE is the Allocative efficiency, CE is the Cost efficiency.

**Table 4 Results of Efficiency and ownership structure**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **XEFF** | **TE** | **VIF** |
|  | **FM** | RM | **FM** | RM |  |
| *BOARD* | -0.0965(-0.7866) | -0.0244(-0.1767) | 0.0034(0.168) | 0.1263(0.8044) | 4.087 |
| *Top\_Ten* | -0.1571(-1..2505) | -0.1274(-0.9458) | -0.1133(-0.5703) | -0.0613(-0.3639) | 2.322 |
| *CEO* | -5.9712(-1.8276)\* | -7.2438(-2.049)\*\* | 6.0054(1.1513) | 5.3444(1.2478) | 1.185 |
| *B\_SIZE* | 0.072(1.6781)\* | 0.0839(1.7182)\* | 0.1083(1.5014) | 0.094(1.798)\* | 1.594 |
| *STATE* | 0.196(1.18) | 0.0682(0.3629) | -0.3602(-1.2993) | -0.1902(-0.886) | 4.876 |
| *BANK* | 0.0268(0.165) | 0.001(0.0531) | -0.2975(-1.0719) | -0.0137(-0.0647) | 2.873 |
| *FOREIGN* | 0.2523(2.033)\*\* | 0.273(1.9356)\* | -0.178(-0.855) | -0.2729(-1.7011)\* | 4.338 |
| *TRUST* | -2.6091(-1.65)\* | -0.0262(-1.2454) | 5.1275(2.1356)\*\* | 4.1707(1.8597)\* | 1.438 |
| *CORPOR* | 0.0506(0.5195) | 0.0547(0.5199) | -0.3484(-2.244)\*\* | -0.2722(-2.0896)\*\* | 2.808 |
| *PERSONAL*  | 0.0426(0.4478) | 0.1098(1.0258) | -0.3559(-2.252)\*\* | -0.1937(-1.6301) | 3.308 |
| *A\_SIZE* | -0.1533(-5.8525)\*\*\* | -0.1676(-4.1352)\*\*\* | -0.0205(-0.3431) | -0.052(-1.6499) | 3.695 |
| *Equity* | -0.5803(-0.8582) | -0.9503(-1.2281) | -0.0502(-0.0439) | 1.015(1.145) | 2.401 |
| *ROA* | 1.8425(2.6288)\*\*\* | 1.9415(2.61)\*\*\* | -0.2131(-0.194) | -0.3225(-0.3362) | 2.142 |
| *R\_Growth* | 0.0149(-0.2374) | 0.0012(0.019) | 0.1401(1.487) | 0.1081(1.18) | 1.887 |
| *LODE* | 0.5503(3.1461)\*\*\* | 0.4191(2.3436)\*\* | -0.0238(-0.0903) | 0.127(0.5799) | 1.557 |
| Hausman test |  | 19.954(0.1737) |  | 18.181(0.2532) |  |
|  | 0.4294 | 0.5384 | 0.1641 | 0.111 |  |

***Note***：the dependent variable is X-Efficiency (XEFF) and Technical efficiency (TE) , FM=Fixed effect model, RM=Random effect model, where BOARD indicates percentage of equity owned by board; Top\_Ten indicates percentage of equity owned by top ten shareholders; CEO indicates percentage of equity owned by CEO, B\_SIZE indicates natural log of number of directors, STATE indicates percentage of equity owned by the government; BANK indicates percentage of equity owned by domestic financial institutions, TRUST indicates percentage of equity owned by domestic trust fund; CORPOR indicates percentage of equity owned by investors of domestic corporations, PERSONAL indicates percentage of equity owned by private domestic investors; and FOREIGN indicates percentage of equity owned by foreign investors, Equity indicates total equity divided by total assets; SIZE indicates natural log of total assets; and ROA indicates return of asset ratio. R\_Growth indicates banks annual revenue growth ratio, LODE indicates total loan divided by deposit. .( ) is t value, \* Significant level at the α=0.1, \*\*at α=0.05 and \*\*\*at α=0.01

Hausman test: 

**Table 5 Regression on efficiency and concentration ownership**

|  |  |  |
| --- | --- | --- |
|  | **XEFF** | **TE** |
|  | **FM** | **RM** | **FM** | **RM** |
| *BOARD* | -0.027(-0.1846) | -0.1628(-1.2634) | -0.0254(-0.1177) | 0.0434(0.2529) |
| *Top\_Ten* | -0.1215(-0.6844) | -0.2616(-1.615) | -0.1743(-0.665) | -0.2136(-0.9782) |
| *CEO* | -7.2073(-2.004)\*\* | -6.5585(-1.9924)\* | 5.693(1.0728) | 5.0721(1.144) |
| *B\_SIZE* | 0.0843(1.718)\* | 0.0666(1.5635) | 0.1074(1.4828) | 0.0924(1.642) |
| *STATE* | 0.082(0.4048) | 0.2791(1.6219) | -0.3138(-1.0493) | -0.1713(-0.7483) |
| *BANK* | 0.0093(0.0493) | 0.0107(0.0659) | -0.2978(-1.07) | -0.082(-0.3763) |
| *FOREIGN* | 0.2723(1.9008)\* | 0.2885(2.286)\*\* | -0.1659(-0.785) | -0.2321(-1.372) |
| *TRUST* | -2.0345(-1.239) | -2.7878(-1.7567)\* | 5.0238(2.0747)\*\* | 4.2693(1.9529)\* |
| *CORPOR* | 0.0477(0.4437) | 0.0287(-1.756)\* | -0.3551(-2.24)\*\* | -0.3314(-2.4809)\*\* |
| *PERSONAL*  | 01015(0.9152) | 0.0151(0.1579) | -0.3695(-2.259)\*\* | -0.2596(-2.04)\*\* |
| *CONC* | -0.0173(-0.1332) | -0.1687(-1.4459) | -0.0815(-0.4249) | -0.1673(-1.059) |
| *CR\_Ten* | -0.0023(-0.3424) | -0.0639(-0.6071) | -0.0008(-0.0813) | 0.0002(0.0285) |
| *A\_SIZE* | -0.1678(-4.0916)\*\*\* | -0.1689(-6.0967)\*\*\* | -0.0236(-0.391) | 0.0322(0.888) |
| *Equity* | -0.9211(-1.1586) | -0.5012(-0.744) | 0.0574(0.0489) | 0.8417(0.9325) |
| *ROA* | 1.9363(2.5716)\*\* | 1.734(2.4706)\*\* | -0.274(-0.2465) | -0.325(-0.3406) |
| *R\_Growth* | 0.0029(0.0452) | -0.0135(-0.2122) | 0.1389(1.4629) | 0.1186(1.3441) |
| *LODE* | 0.413(2.2838)\*\* | 0.5091(3.01)\*\*\* | -0.0368(-0.1382) | 0.196(0.8563) |
| Hausman test |  | 0.2286 |  | 0.9943 |
|  | 0.5385 | 0.4429 | 0.1646 | 0.1132 |

***Note***：the dependent variable is X-Efficiency (XEFF) and Technical efficiency (TE) , FM=Fixed effect model, RM=Random effect model, some variables definition is like in Table 4, CONC indicate ownership concentration, measured by summing the squared percentage of shares controlled by each shareholder. CR\_Ten indicate the equity owned by the ten largest shareholders and a logistic transformation to this percentage. .( ) is t value, \* Significant level at the α=0.1, \*\*at α=0.05 and \*\*\*at α=0.01

Hausman test: 

**Table 6 Results of cubic regression on ownership structure**

|  |  |  |
| --- | --- | --- |
|  | **XEFF** | **TE** |
|  | **FM** | **RM** | **FM** | **RM** |
| *BOARD* | -0.5563(-1.032) | -0.469(-0.9612) | 0.2416(0.3046) | 0.4893(0.737) |
|  | 1.9095(1.3897) | 1.8412(1.4108) | 0.5081(0.2512) | 0.0598(0.0334) |
|  | -1.5249(-1.637) | -1.6838(-1.888)\* | -0.9726(-0.7098) | -0.6551(-0.5345) |
| *Top\_Ten* | -0.1487(-1.1035) | -0.1715(-1.389) | -0.1352(-0.682) | -0.0796(-0.4746) |
| *CEO* | -7.3886(-2.086)\*\* | -6.0619(-1.881)\* | 5.061(0.971) | 4.9013(1.1236) |
| *B\_SIZE* | 0.0765(1.5601) | 0.0593(1.4035) | 0.0889(1.2323) | 0.0743(1.3148) |
| *STATE* | 0.0988(0.4965) | 0.2497(1.4794) | -0.1748(-0.5965) | -0.1297(-0.5712) |
| *BANK* | -0.073(-0.3795) | -0.1279(-0.7597) | -0.3932(-1.388) | -0.2038(-0.8935) |
| *FOREIGN* | 0.2528(1.7808)\* | 0.2635(2.1074)\*\* | -0.169(-0.8091) | -0.2001(-1.1826) |
| *TRUST* | -2.085(-1.2843) | -2.6683(-1.7017)\* | 4.9017(2.0514)\*\* | 4.5037(2.0848)\*\* |
| *CORPOR* | 0.0339(0.3216) | 0.0264(0.2754) | -0.3742(-2.4122)\*\* | -0.34(-2.6036)\*\* |
| *PERSONAL*  | 0.0874(0.8065) | 0.0089(0.0953) | -0.4191(-2.6265)\*\* | -0.269(-2.1676)\*\* |
| *A\_SIZE* | -0.1524(-3.6993)\*\*\* | -0.1572(-5.9064)\*\*\* | -0.0048(-0.0791) | 0.0263(0.745) |
| *Equity* | -0.7345(-0.9412) | -0.5068(-0.7583) | 0.3392(0.2953) | 0.6196(0.684) |
| *ROA* | 1.7928(2.4028)\*\* | 1.6379(2.3436)\*\* | -0.3498(-0.318) | -0.2295(-0.24) |
| *R\_Growth* | 0.0102(0.1603) | -0.0021(-0.0335) | 0.1524(1.6219) | 0.1402(1.6085) |
| *LODE* | 0.396(2.2163)\*\* | 0.487(2.9413)\*\*\* | -0.0618(-0.235) | -0.0556(-0.2465) |
| Hausman test |  | 0.2125 |  | 0.9989 |
|  | 0.5442 | 0.4619 |  | 0.1297 |

***Note***：the dependent variable is X-Efficiency (XEFF) and Technical efficiency (TE) , FM=Fixed effect model, RM=Random effect model, some variables definition is like in Table 4, CONC indicate ownership concentration, measured by summing the squared percentage of shares controlled by each shareholder. CR\_Ten indicate the equity owned by the ten largest shareholders and a logistic transformation to this percentage. .( ) is t value, \* Significant level at the α=0.1, \*\*at α=0.05 and \*\*\*at α=0.01

Hausman test: 

Table 7 Tests for threshold effects

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | P-value | Threshold value |  |  |
| XEFF |  |  |  |  |
| BOARD | 0.01\*\*\* | 0.1081 | 0.2083 | 0.4046 |
| TE |  |  |  |  |
| BOARD | 0.1\* | 0.4046 |  |  |
| Top\_Ten | 0.08\* | 0.0119 |  |  |
| PERSONAL | 0.06\* | 0.3879 | 0.6268 |  |

Note: Using F-test to test whether threshold effect is significant, p-value result from repeating the bootstrap procedure 1000 times for each of the three bootstrap tests. \* Significant level at the α=0.1, \*\*at α=0.05 and \*\*\*at α=0.01

Table 8 Regression estimate: threshold model

|  |  |  |  |
| --- | --- | --- | --- |
|  | Coefficient | OLS SE | White SE |
| XEFF |
| BOARD |  |  |  |
|  | -4.3746 | 0.7382\*\*\* | 0.6798\*\*\* |
|  | -2.0946 | 0.4176\*\*\* | 0.365\*\*\* |
|  | -0.9831 | 0.1998\*\*\* | 0.1786\*\*\* |
|  | -0.3742 | 0.1146\*\*\* | 0.0998\*\*\* |
| TE |
| BOARD |  |  |  |
|  | -0.7544 | 0.2652\*\*\* | 0.2294\*\*\* |
|  | -0.0876 | 0.15\*\*\* | 0.1249\*\*\* |
| Top-Ten |  |  |  |
|  | 35.5602 | 11.3013\*\*\* | 6.8512\*\*\* |
|  | 0.0311 | 0.1813\*\*\* | 0.1809\*\*\* |
| PERSONAL |  |  |  |
|  | -1.1498 | 0.258\*\*\* | 0.2317\*\*\* |
|  | -0.6889 | 0.1657\*\*\* | 0.1326\*\*\* |
|  | -0.279 | 0.1225\*\*\* | 0.1022\*\*\* |

Note:. \* significant level at the α=0.1, \*\*at α=0.05 and \*\*\*at α=0.01

**Table 9 Results of Robustness test**

|  |  |  |
| --- | --- | --- |
|  | **unbalance** | **Post-2011** |
|  | **XEFF** | **TE** | **XEFF** | **TE** |
| *BOARD* | -0.137(-2.066)\*\* | 0.046(0.4822) | -0.212(-2.7426) | 0.051(0.4647) |
| *Top\_Ten* | -0.103(-0.988) | -0.0436(-0.301) | -0.1223(-0.912) | 0.0146(0.0767) |
| *CEO* | -5.712(-2.751)\*\*\* | 4.1851(1.4438) | -7.126(-3.067)\*\*\* | 4.7963(1.4524) |
| *B\_SIZE* | 0.042(1.255) | 0.724(1.5472) | 0.0272(0.5534) | 0.0459(0.6527) |
| *STATE* | 0.2735(3.39)\*\*\* | 0.0626(0.555) | 0.332(3.369)\*\*\* | 0.085(0.6067) |
| *BANK* | 0.053(0.4991) | -0.0968(-0.6873) | -0.022(-0.1555) | -0.1555(-0.7729) |
| *FOREIGN* | 0.1784(2.431)\*\* | -0.1382(-1.3476) | 0.2033(2.3135)\*\* | -0.1619(-1.2965) |
| *TRUST* | -3.181(-2.4883)\*\* | 4.326(2.421)\*\* | -4.1768(-3.0387)\*\*\* | 4.8027(2.4581)\*\* |
| *CORPOR* | -3.1807(-0.5899) | -0.2082(-2.3028)\*\* | -0.0179(-0.2192) | -0.1395(-1.1969) |
| *PERSONAL*  | -0.0038(-0.1762) | -0.0731(-1.1368) | -0.0116(-0.187) | -0.129(1.4615) |
| *A\_SIZE* | -0.1565(-10.3)\*\*\* | 0.0506(2.383)\*\* | -0.1539(-8.2582)\*\*\* | 0.0552(2.081)\*\* |
| *Equity* | -0.342(-0.6465) | 1.1998(1.6228) | 0.9075(-1.7387)\* | 0.4329(0.3478) |
| *ROA* | 1.9618(3.283)\*\*\* | -0.1442(-0.1727) | 0.9075(0.9196) | -1.0829(-0.7719) |
| *R\_Growth* | -0.089(-1.939)\* | 0.1498(2.333)\*\* | -0.0912(-1.4521) | 0.1728(1.934)\* |
| *LODE* | 0.5601(4.665)\*\*\* | -0.002(-0.1193) | 0.4939(3.398)\*\*\* | -0.0654(-0.3168) |
| Observation  | 453 | 453 | 297 | 297 |
|  | 0.4458 | 0.1165 | 0.3814 | 0.1404 |

***Note***：the dependent variable is X-Efficiency (XEFF) and Technical efficiency (TE) ,we estimate the equation by OLS. BOARD indicates percentage of equity owned by board; Top\_Ten indicates percentage of equity owned by top ten shareholders; CEO indicates percentage of equity owned by CEO, B\_SIZE indicates natural log of number of directors, STATE indicates percentage of equity owned by the government; BANK indicates percentage of equity owned by domestic financial institutions, TRUST indicates percentage of equity owned by domestic trust fund; CORPOR indicates percentage of equity owned by investors of domestic corporations, PERSONAL indicates percentage of equity owned by private domestic investors; and FOREIGN indicates percentage of equity owned by foreign investors, Equity indicates total equity divided by total assets; SIZE indicates natural log of total assets; and ROA indicates return of asset ratio. R\_Growth indicates banks annual revenue growth ratio, LODE indicates total loan divided by deposit. .( ) is t value, \* Significant level at the α=0.1, \*\*at α=0.05 and \*\*\*at α=0.01

**Table 10 Results of ROA regression**

|  |  |
| --- | --- |
|  | **ROA** |
|  | **FM** | **RM** |
| *BOARD* | 0.0124(1.179) | 0.0057(0.593) |
| *Top-Ten* | -0.3187(-1.176) | -0.2721(-1.062) |
| *CEO* | -0.0627(-6.459)\*\*\* | -0.0676(-7.433)\*\*\* |
| *B\_SIZE* | 0.098(2.64)\*\* | 0.0067(1.9932)\* |
| *STATE* | -0.016(-1.1177) | -0.0022(-0.167) |
| *BANK* | -0.0138(-0.955) | -0.0051(-0.3976) |
| *FOREIGN* | -0.0429(-4.0625)\*\*\* | -0.0412(-4.3129)\*\*\* |
| *TRUST* | 0.0002(0.0021) | -0.0581(-0.4754) |
| *CORPOR* | -0.0142(-1.773)\* | -0.0146(-1.929)\* |
| *PERSONAL*  | -0.011(-1.351) | -0.069(-1.287) |
| *A\_SIZE* | -0.0084(-2.743)\*\*\* | -0.0039(-1.814)\* |
| *Equity* | -0.026(-0.4405) | 0.359(0.6737) |
| *R\_Growth* | 0.0176(3.6745)\*\*\* | 0.195(2.0993)\*\* |
| *LODE* | 0.004(0.2904) | 0.0004(0.027) |
| Hausman test |  | 0.0125 |
|  | 0.6445 | 0.5089 |

***Note***：the dependent variable is return of asset(ROA), FM=Fixed effect model, RM=Random effect model, some variables definition is like in Table 4, CONC indicate ownership concentration, measured by summing the squared percentage of shares controlled by each shareholder. CR\_Ten indicate the equity owned by the ten largest shareholders and a logistic transformation to this percentage. .( ) is t value, \* Significant level at the α=0.1, \*\*at α=0.05 and \*\*\*at α=0.01

Hausman test: 

1. Li et al. (2004) found that mixed banks have the highest technical efficiency and that private banks have the lowest technical efficiency. They considered that bureaucratic power still plays an important role in improving efficiency and that mixed banks benefit from balancing bureaucratic power and internal incentive schemes. [↑](#footnote-ref-1)
2. Partial bank joint into financial holding companies (FHC), the banks is FHC subsidiary that ownership 100% holding by parent companies; thus, we used the parent of ownership structure substitute subsidiary bank of ownership structure. [↑](#footnote-ref-2)
3. Following Demsetz and Lehn (1985) used a logistic transformation to these shareholder percentage, using the formula as: CR\_Ten =** [↑](#footnote-ref-3)
4. For brevity, the dependent variable TE, AE and CE have similar results. We have not listed the regression result AE and CE and regression intercept in Table 4. [↑](#footnote-ref-4)
5. For this period, the banking industry undergo important financial reform, privatization, open new competitors and foreign banks entry in the 1990s, the government has advanced a series of financial reform policies to improve the quality of banks’ assets and capital adequacy ratios, NPL ratio in 2001. [↑](#footnote-ref-5)
6. Jensen and Meckling (1976) illustrate that relationship between ownership and performance is positive, which suggests that firm performance is an increasing function of the extent of board shareholding; it is so-called incentive alignment hypothesis. On the contrary, Fama and Jensen (1983) illustrate entrenchment hypothesis that its relationship is negative. [↑](#footnote-ref-6)
7. We not have to consider this factor due to the family-controlled ownership is not obtained for our database. [↑](#footnote-ref-7)
8. In the first regime, where the board ownership is less than 40.46% the estimate of coefficient is -0.7544, in the second regime, where the board ownership is larger than 40.46%, the estimate of coefficient is -0.0876, which indicates that a 1 percent increase in board ownership decreases bank efficiency by 0.0876 percent. [↑](#footnote-ref-8)
9. More than 60 percent of minority shareholder in firms’ ownership structure, which implies that ownership structure is dispersed. [↑](#footnote-ref-9)