“Nonlinear effect of female board directorship on bank financial soundness”

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NONLINEAR EFFECT OF FEMALE BOARD DIRECTORSHIP ON BANK FINANCIAL SOUNDNESS

Abstract

To verify if female directors on the bank's board play a role in managing bank stability, this paper applies a multi-threshold model to quarterly data from 26 Taiwanese commercial banks over the 2002–2018 period to find the factors that influence bank financial stability and to examine how female board directorship affects it. The empirical results suggest that women on the board do play a guarding role in a bank's financial soundness when banks reach a high debt ratio regime. The influence of female directors on the capital adequacy ratio is positive for banks with a debt ratio higher than 92.69%, and for non-performing loans it is positive within the regime of the debt ratio $90.71\% \leq \tau < 95.39\%$.

In particular, it has been found that the value of total assets is a factor that positively affects a bank's financial soundness, which supports the "too big to fail" theory for banks with high total assets and debt ratios. Revenue has the opposite effect on financial soundness when it negatively affects the capital adequacy ratio and positively affects non-performing loans. A larger board size reduces banks' financial soundness, which is contrary to the higher proportion of women on the board of directors, which generally contributes to the financial stability of the bank.

Keywords bank financial stability, board structure, gender diversity, threshold model, Taiwan

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INTRODUCTION

Maintaining financial stability is the common goal of central banks, which is regulated by many countries around the world. Generally, the stability of the banking system contributes to financial stability, and it can supplement financial stability. Monetary policy is effective only when the financial system is stable. Three core principles for the operation of banks are safety, liquidity, and profitability. Among them, managing safety is not only the most important, but also the most difficult aspect.

Article 2 of The Central Bank of Taiwan Act clearly states that promoting financial stability is one of its primary goals. Analyzing the source and the use of capital in Taiwanese commercial banks, the main sources of assets are from corporate and personal deposits, and liabilities to other deposit institutions; the assets of commercial banks are mainly used for private business loans and securities investment. Therefore, the risks of banks mainly come from their loans and securities as they comprise a large portion of the assets and contain significant risks. What banks should do for their financial soundness is to focus on their capital adequacy, non-performing loans, profitability, liquidity, and sensitivity to market risks, which are endorsed and rec-

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ommended by the IMF and are the main criteria employed in assessing banks' financial stability and soundness[1].

As a bank's main business is to absorb deposits and engage in loans, the main source of assets is deposits and long-term loans, causing the high amount of liabilities compared to the capital of the owners. There are two mismatches in the assets and liabilities of banks such as "nature" and "term structure". In terms of "nature", banks are profiting from loans to individuals or companies that cannot raise funds through the securities market. In terms of "term structure", the utilization period and maturity of a bank's asset are longer than liabilities, because most of the bank's liabilities come from depositors who can withdraw their money at any time. If the capital adequacy ratio is not maintained, banks may not be able to pay debts. Besides, the capital adequacy ratio is used to ensure if the bank's capital is sufficient for its operation. Moreover, the low debt ratio makes it easier for banks to absorb loan losses, *aka* non-performing loans, and provides a cushion to reduce future risky losses. This paper aims to find the factors that influence bank financial stability, especially the female board directorship. Although there have been many studies on the board of directors and the factors affecting the financial performance, there are relatively few studies examining the influence of the gender diversity of the board of directors. Therefore, this paper intends to contribute to filling a gap in this research field.

1. LITERATURE REVIEW

In the past few centuries, several financial crises have severely affected the international financial markets and disrupted the global economy. To avoid damage caused by financial fragility, many international organizations and central banks are actively participating in the adoption of the financial stability assessment framework, which systematically analyzes and monitors potential risks that occur inside and outside the financial system. Three main factors signaling the financial soundness of banks are the debt ratio, the capital adequacy ratio, and non-performing loans.

1.1. Debt ratio

The financial crisis has shown a recurring pattern of high leverage in financial institutions, which has promoted the rapid growth of bank loans and contributed to asset price bubbles, which exacerbated the financial crisis when the bubble burst (Reinhart & Rogoff, 2009). According to Bhattacharya et al. (1998) and Diamond and Rajan (2001), when banks want to raise capital requirements, the most direct way would be to raise equity capital as a percentage of total assets and possibly link these demands to the bank's perceivable risk. However, increasing capital demands beyond a certain point can entail transaction costs associated with issuing equity in the market. The alternative to raising capital requirements is debt, so the bank can engage in high leverage and face higher default risk. According to Diamond and Rajan (2000, 2001), higher debt ratio may reduce the bank's vulnerability, which in turn will reduce depositors' monitoring activities and hinder the ability to create liquidity. Besides, Gorton and Winton (2017) find that low leverage ratios may reduce liquidity creation by squeezing deposits, which is a critical component of liquidity creation. Banks are prone to risk-taking due to their high debt ratio and increase the riskiness of their assets, which negatively affects bank financial soundness.

1.2. Capital adequacy ratio

Ezike and Oke (2013) and Fatima (2014) propose that managing the debt ratio and the capital adequacy ratio ensures the financial stability in absorbing a reasonable loss, which is vital for bank financial soundness. Bateni et al. (2014) point out that a critical requirement for banks is sufficient and adequate capital, as well as a good balance between capital held by banks and risky assets to ensure their stability. Besides, many other studies, such as Diamond and Rajan (2000), Demirgüç-Kunt et al. (2013), Lee and Hsieh (2013), and Noreen et al. (2016), find that higher leverage may raise the probability of bank distress and risks.

1 International Monetary Fund Staff. Financial Soundness Indicators: Compilation Guide. International Monetary Fund, 2006, 2008, 2019.

It cannot be denied that a bank's capital plays a critical role in maintaining the safety of the bank and the entire banking system of one country. Alemu (2015) and Bateni et al. (2014) find that higher capital adequacy has a positive effect on a bank's financial soundness.

1.3. Non-performing loans

The link between non-performing loans and the instability of the banking system continues to receive more research attention, particularly after the global financial crisis occurred in 2008. The theory of non-performing loans relates to bank stability for three reasons such as information asymmetry, adverse selection, and moral hazard theories. Salas and Saurina (2002), Hu et al. (2004), Podpiera and Weill (2008), and Kil and Miklaszewska (2017) suggest that an increase in non-performing loans leads to higher lending risk, thus potentially weakening bank financial stability. Others studies, such as Detragiache and Gupta (2006), Martinez-Miera and Repullo (2010), and Bertay et al. (2013), show that due to differences in regulatory measures, risk management, capital sources, and market discipline, non-performing loans of different banks and their impact on bank stability may not be the same.

It has become the basic norm for banks in the world as a bank's risk-adjusted asset can be used as a tool for controlling the direction of bank operations, helps banks avoid getting involved in high-risk businesses, and can replace selective credit controls on the real estate market. For banks, participation in financial management in the form of a capital adequacy ratio does not directly intervene in market functions and yet respects banks' operational autonomy to some extent, which is in line with the principles of modern bank supervision. There is a range of papers that study the relationship between corporate board attributes and bank stability, such as Caprio et al. (2007), Cornett et al. (2009), Beck et al. (2009), Adams and Mehran (2012), Masulis et al. (2012), Liang et al. (2013), Elyasiani and Zhang (2015), Anginer et al. (2016), Chen and Lin (2016), Vallascas et al. (2017), and Battaglia and Gallo (2017). However, the literature on the board power and the role of the female board in bank financial soundness is relatively limited. Some studies such as Francoeur et al. (2008) and Nielsen and Huse (2010) have identified the reasons why the presence of women on the board of directors can affect corporate performance.

Charness and Gneezy (2012) suggest that women are always perceived as risk-averse. Palvia et al. (2015) find that US commercial banks with female CEOs assess risks more conservatively, and thereby hold lower levels of debt capital. Afterward, Palvia et al. (2020) suggest that US banks headed by female CEOs have lower non-accrual loans.

Gulamhussen and Santa (2015) find that the presence and percentage of the female boards have a negative influence on risk-taking in banks from OECD countries. While Menicucci and Paolucci (2021) suggest that Italian banks with more female boards are less risky as they manage higher capital adequacy and low debt to assets ratios. Skała and Weill (2018) find in Polish banks that women-led banks are less risky as they manage higher capital adequacy and lower debt to assets ratios.

Beck et al. (2013) support the view that the default rates of loans originated by women are lower than men. Berger et al. (2014) provide a positive link between women on the boards of banks and their portfolio risk. However, empirical evidence on the impact of gender on risk-taking is inconsistent. Berger et al. (2014) argue that banks have higher loan portfolio risk when the proportion of women on the board is higher, while Muller-Kahle and Lewellyn (2011) give the opposite result. They argued that gender-diverse banks were less likely to engage in subprime lending. In particular, Ahmed et al. (2019) find that banks with a CEO having more masculine facial features usually engage in more volatile stock returns and higher idiosyncratic risk.

This paper responds to the knowledge demand for the role of board directorship in financial soundness in the Taiwanese banking sector. Specifically, it aims to investigate not only the linear, but also the nonlinear effect of female board directorship on three keys of bank financial soundness.

2. METHODOLOGY

Many empirical studies on the relationship between the banking system and financial stabil-

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ity ignore the non-linear characteristics of these banks in terms of business coverage. Several problems in the business realm pose the bias in modeling and results due to severe non-linear behavior or regime shifts that act as additional obstacles. Thereafter, a threshold regression model is applied for the empirical model for capturing asymmetric effects of behavior over the relationship.

Relating to the threshold regression model, the first threshold auto-regression model is introduced in 1978, which is subsequently revised and applied to the nonlinear data (Tong & Lim, 1980), the regression model is adjusted by different threshold values. Then, a series of threshold regression models are used to test whether the influential direction and degree of independent variables on the dependent variables are consistent (Hansen, 1999, 2000, 2011). These threshold regression models automatically search the threshold value and divide the sample into subsamples. The specific independent variable then has a different interpretation in the corresponding thresholds. The models use the threshold variable to determine the breakpoints of the sample, which are then used to estimate the threshold values. The method fills the gap of equations that are commonly used to subjectively determine partition points. The methodology for estimating multiple breakpoints in the regression model is developed for serially correlated disturbances (Bai & Perron, 1998). Critical values for empirical applications are provided based on extensive simulation analysis of the scale and efficacy of the test (Bai & Perron, 2003). In addition to the panel regression model, this study substantiates the factors that may nonlinearly affect a bank's financial soundness by using the threshold regression model developed by Hansen, Bai and Perron to examine if there is a nonlinear effect of female directors, the independent directors, the size of the board, total assets, deposits, and loans on bank stability.

2.1. Multi-threshold model

Based on the two-stage least square model for panel data designed by Hansen (1998), the threshold value (τ) and the sum of squared errors (SSE) are obtained in the first stage, which are used to assess the estimated threshold (τ) in the second stage. Then, the threshold system uses these values to estimate the regression model in every single regime for performing the result analysis. The model is as follows:

The linear regression fitted for the observations in regime $r = 0, 1, ..., n$ is as:

$$y_t = \alpha + \theta_t^{'}\beta_r + \varepsilon_t, \tag{1}$$

where the parameters of θ variables vary across regimes. Assume that ϑ_t is a threshold variable whose threshold values are strictly increasing ($\tau_1 < \tau_2 ... < \tau_n$), these observations are in regime r if and only if $\tau_r \le \vartheta_t < \tau_{r+1,}$ the model with one threshold value and two regimes is as follows:

$$\begin{aligned} y_t &= \alpha + \theta_t^{'}\beta_1 + \varepsilon_t \qquad \text{if} \quad -\infty \le \vartheta_t < \tau_r, \\ y_t &= \alpha + \theta_t^{'}\beta_2 + \varepsilon_t \qquad \text{if} \quad \tau_r \le \vartheta_t < \infty, \end{aligned} \tag{2}$$

Assuming that the function $\aleph(.)$ is equal to 1 if the status is true and 0 otherwise, and $\aleph_r(\vartheta_t, \tau)$ is defined as $\aleph_r(\vartheta_t, \tau) = \aleph(\tau_r \le \vartheta_t < \tau_{r+1}$, all single regimes then are combined into one model with multi-threshold and n regimes:

$$y_t = \alpha + \sum_{r=1}^{n} \aleph_r\left(\vartheta_t, \tau\right) + \theta_t^{'}\delta_r + \varepsilon_t, \tag{3}$$

This multi-threshold model is used to investigate the nonlinear effect of female board directorship on stability management of Taiwanese commercial banks.

2.2. Data and variables

The data for the empirical study is from the Taiwan Economic Journal (TEJ) database that provides the financial information of the Taiwanese commercial bank listed on the market. A total of 35 listed banks are initially obtained during the studying period. Since the multi-threshold model is applied to the balanced panel data, a sample bank can be eliminated if its data is insufficient. After removing the sample banks with insufficient data, a total of 26 Taiwanese commercial banks with their 1,702 observations are selected for empirical analysis. The data includes the capital adequacy ratio, the nonperforming loans ratio, the female directors in the board, the ratio of independent directors, the size of the directorship, and the control variables such as debt ratio, the total assets, the ratio of interbank deposits to total liabilities, and the ratio of loans to total assets.

Relating to the variable of board gender diversity, the measure of equality between women and men given by Blau (1977) *aka* the Blau Index is used to empirically test whether women on the board of directors affect banks' financial soundness.

$$BI = \left[1 - \sum_{g=1}^{G} P_g^2\right] \cdot 100, \quad (4)$$

where P is the proportion of male and female directors on the bank's board and g is the gender. The maximum value for this measure is 50, when there are exactly 50% of women and 50% of men in the gender diversity indicator. The higher the BI value, the more female directors are on the board.

The debt ratio is used as the threshold variable to examine the nonlinear relationship between female directors and a bank's financial soundness. The definitions of all variables used in this study are presented in Table 1.

Table 1. Variable definition

Variable	Definition
Financial soundness (*SFM*)	
DBT_{it}	The debt ratio is calculated as the total liabilities as a percentage of total assets
CAR_{it}	Capital adequacy ratio is a measure of the amount of a bank's core capital expressed as a percentage of its risk-weighted asset
NPL_{it}	The nonperforming loans ratio measures the rate at which a bank's loans are not repaid
Board structure (*BST*)	
BI_{it}	Measure of board gender diversity. The maximum value for Blau measurement is 50
IND_{it}	Independent director is the ratio of number of independent directors to total board members
BDS_{it}	Board size is the natural log of the number of directors in the bank's board at the end of the period
Control (*CTR*)	
TA_{it}	Total assets as the natural log of total assets as at the end of the period
DTD_{it}	Deposit proportion as the ratio of interbank deposits to total liabilities
LTA_{it}	Loan proportion as the ratio of loans to total assets
REV_{it}	Revenue as the ratio of total revenues to total assets
ROA_{it}	Return on assets before interest after taxes of bank *i* at time *t*

The empirical equation for analyzing how the proportion of women on the board affects banks' financial soundness is as follows:

$$\begin{aligned} SFM_{it} &= \alpha + \beta_1 BI_{it} + \beta_2 BI_{it-1} + \beta_3 BI_{it-3} + \\ &+ \beta_4 IND_{it} + \beta_5 BDP_{it} + \delta_1 TA_{it} + \delta_2 DTD_{it} + \\ &+ \delta_3 ETA_{it} + \delta_4 LTA_{it}, \end{aligned} \quad (5)$$

Financial soundness variables (SFM) include CAR and NPL that are as explained in Table 1. These two regression models include variables of the board structure (BDS) and control (CTR). Therefore, the multi-threshold panel regression is rewritten as equation 6:

$$\begin{aligned} SFM_{it} &= \alpha + \left[\beta_r (BST)'_{it} + \delta_r \left(CTR\right)'_{it}\right] \times \\ &\times \sum_{r=1}^{n} \aleph_r \left(DBT_{it}, \tau\right) + \varepsilon_{it}. \end{aligned} \quad (6)$$

3. RESULTS

Summary statistics of variables are presented in Table 2. The values in Table 2 indicate that the mean and median Blau index (BI) during the sample period is around 16.6 percent, meaning that one out of six board members are female. The mean of board size (BDS) is 14.6 members, corresponding to two or three female directors on the bank's board. However, the maximum proportion of female members is high at 48.4 percent, while the minimum value is 0 percent. The imbalance of gender proportion on the director board across sample banks should be noted.

Table 2. Summary statistics

Variable	Mean	Median	Max	Min	Std. dev.
BAU	16.634	16.529	48.443	0.000	12.596
BI	9.988	11.350	19.840	0.000	4.883
IND	0.130	0.167	0.333	0.000	0.092
BDS	2.633	2.565	3.258	1.792	0.300
TA	20.379	20.481	22.350	17.665	0.978
DBT	92.910	93.620	99.170	50.550	3.750
NPL	1.535	0.730	16.020	0.000	2.142
DTD	0.009	0.000	0.191	0.000	0.021
NIT	0.002	0.002	0.015	–0.003	0.001
LTA	0.198	0.196	0.590	0.000	0.200
REV	0.008	0.007	0.022	0.001	0.003
ROA	0.093	0.140	1.000	–2.520	0.330

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One of the main factors affecting the overall asset quality is the quality of the loan portfolio as loans usually make up the bulk of a bank's assets and pose the greatest risk to its capital. A bank is operating healthy or not, that is, their assets are adequate and safe, which is generally examined by two asset quality indicators, such as the capital adequacy ratio (CAR) and the non-performing loan ratio (NPL), which are also the measurement of banks' financial soundness. As the capital adequacy ratio is one of the monetary policy tools, which is tracked to ensure that banks can absorb a reasonable amount of loss and complies with statutory capital requirements. The maximum and minimum values of the capital adequacy ratio (CAR) are 19.84 percent and 0.00 percent, respectively. The maximum and minimum values of the non-performing loan ratio (NPL) are 16.02 percent and 0.00 percent, respectively. It is obvious that the differences in CAR and NPL are quite large among banks. The mean and median bank size (TA) are 20.379 and 20.481, respectively, indicating that the scale of Taiwanese commercial banks is average. The debt ratio (DBT) is set as the threshold variable whose mean and median are 92.91 and 93.62, respectively, indicating that the liabilities of commercial banks are quite heavy.

Table 3 reports the results of the panel data estimation of equation 5 using different measures of bank financial soundness. The effect of BI on NPL and DBT is positive, but insignificant on CAR, which indicates the ineffectiveness of the women's board in managing bank financial soundness. The impact of TA on the three financial soundness indicators supports the hypothesis that banks that are considered "too big to fail" may engage in risky activities, exposing them to market risks, while small banks may be more cautious by adopting less risky banking operations. The diagnostics tests in Table 3 show that the model is well-fitted with high R^2 and adjusted R^2.

Table 3. The linear effect of board gender diversity on a bank's financial soundness

Variable	CAR	NPL	DBT
C	36.825***	–23.519***	11.732**
BI	–0.004	0.008***	0.014**
IND	0.050	–0.778**	–1.813**
BDS	–0.671***	0.991***	0.116
TA	–1.204***	1.136***	4.032***
LTA	–1.136***	0.589***	0.412
DTD	–3.296	–11.868***	14.431***
REV	–26.437	–74.384***	–169.366***
ROA	–0.023	–1.594***	–0.908***
Cross-section fixed	Y	Y	Y
Period fixed	Y	Y	Y
R^2	0.909	0.782	0.709
Adj. R^2	0.903	0.769	0.691

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

The nearest neighbor fit, *aka*, the non-generalizing machine learning method is applied to check for the non-linearity of BI with other variables. Figure 1 displays the nearest neighbor fit of BI vs. CAR, BI vs. NPL, and BI vs. DBT with full sample data. Each regression uses tricube robustness weights with three robustness iterations to estimate both the default nearest neighbor fit and custom fit that fits a quadratic at 50 data points. All three red fitting lines show the existence of non-linear relationships between the variables.

To investigate the non-linear effect of board gender diversity (BI) on bank financial soundness taking the capital adequacy ratio (CAR) and the non-performing loan ratio (NPL) and debt ratio into consideration, it is necessary to test for unknown thresholds effect of the debt ratio (DBT) on the relationship between bank safety indica-

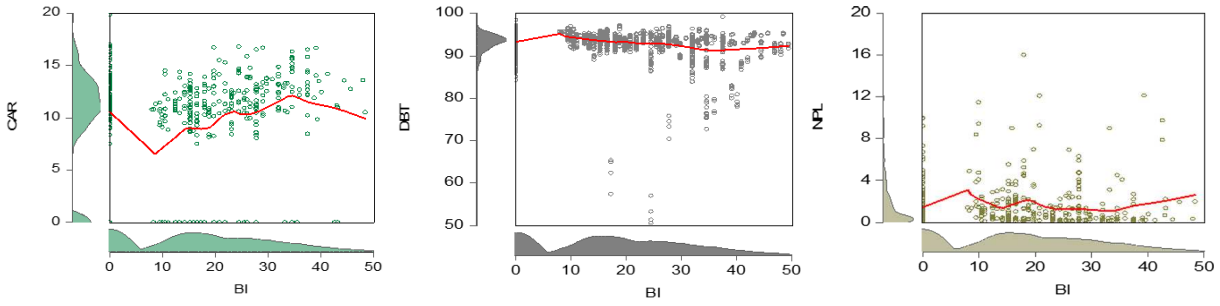

Figure 1. The nearest neighbor fit of BI vs. CAR, BI vs. NPL, and BI vs. DBT

Table 4. Test for unknown thresholds of the debt ratio (DBT)

Test for number of thresholds	Capital adequacy ratio (CAR)			Non-performing loan ratio (NPL)		
	F value	Threshold detected	Threshold value	F value	Threshold detected	Threshold value
1	32.36***	τ_1	91.22%	11.86***	τ_1	90.71%
2	12.11***	τ_2	92.69%	9.82***	τ_2	94.21%
3	11.42***	τ_3	93.36%	7.46***	τ_3	94.67%
4	6.88***	τ_4	94.61%	6.14***	τ_4	95.39%
5	6.89***	τ_5	95.38%	2.79	–	–

Note: *** indicates significance at the 1% level. The values used for detecting the thresholds of each model are F values of the Bai-Perron method.

tors (CAR, NPL) and proportion of women holding bank board seats. The basic estimation setup for breakpoint testing and regression is based on Hansen (2001) and Perron (2006).

The multi-threshold regression can be regarded as a breakpoint least squares regression, where the data is reordered according to the breakpoints of the threshold variable. The threshold values are estimated using data from 26 commercial banks. If there is evidence of a threshold effect, the data is divided into subsamples for regression. Table 3 presents the results for sequentially determining thresholds using the Bai-Perron critical values (Bai & Perron, 2003).

The Bai-Perron critical values and the estimated breaks of debt ratio are displayed in Table 4. The repartition test results indicate that there are five breakpoints for the models of the capital adequacy ratio (CAR) and five breakpoints for one of the non-performing loan ratios (NPL). The nulls of breakpoints are significantly rejected in favor of the alternatives of debt breakpoints, except the test of the last breakpoints of NPL that does not reject the null. Table 4 reports that there are five threshold values of the debt ratio (DBT) for the model of the capital adequacy ratio (CAR) and four threshold values of debt ratio (DBT) for the model of the non-performing loan ratio (NPL).

Based on the threshold values found by the Bai-Perron (2003) method, the estimation results of the threshold regression (equation 6) are summarized and presented in Table 5 and Table 6. When examining the capital adequacy ratio (CAR) as a financial soundness variable, the linear effect of bank gender diversity (BI), as reported in Table 3, is negative and not significant within the panel regression framework. However, this effect is significantly negative within the regime $91.22\% \leq \tau < 92.69\%$, then turns into a positive sign from $92.69\% \leq \tau$, which indicates that the influence of female directors on the capital adequacy ratio (CAR) is positive for banks with debt ratio higher than 92.69%. When considering the influenc-

Table 5. Nonlinear effects on the capital adequacy ratio (CAR)

Variable	Regimes of Debt ratio					
	$\tau < 91.22$	$91.22 \leq \tau < 92.69$	$92.69 \leq \tau < 93.36$	$93.36 \leq \tau < 94.61$	$93.61 \leq \tau < 95.38$	$95.38 \leq \tau$
C	23.37**	0.83	–15.92**	1.11	–12.78***	18.17**
BI	0.01	–0.04**	0.09***	0.04***	0.05***	0.02
IND	–9.53***	–5.91*	–4.60*	2.11	8.33***	–12.98***
BDS	–2.69**	–2.05**	–4.10***	–3.82***	–7.56***	–2.66
TA	0.02	1.19***	1.98***	1.10***	2.26***	–0.06
LTA	–0.50	–1.10	–1.39	0.15	0.87	8.92***
DTD	5.54	31.02**	–55.88***	–52.86***	6.99	–8.37
REV	–297**	–896***	–340***	–529***	–777***	–457**
ROA	–2.63***	–3.75***	–7.29***	–0.62	–3.79***	–3.29***
R^2	0.51					
Adj. R^2	0.49					
F-statistic	32.16***					

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

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Table 6. Nonlinear effects on non-performing loans (NPL)

Variable	Regimes of debt ratio				
	τ < 90.71	90.71≤ τ < 94.21	94.21 ≤ τ < 94.67	94.67 ≤ τ < 95.39	95.39 ≤ τ
C	1.47	6.09***	8.52**	9.50***	–12.54***
BI	–0.02	0.01*	0.00	0.02***	–0.05***
IND	–1.22	0.62*	–0.10	–2.54***	5.16**
BDS	0.54	0.80***	4.29***	3.21***	2.59**
TA	–0.14	–0.43***	–0.92***	–0.94***	0.31
LTA	1.09	0.57***	–0.50	0.38	–0.59
DTD	–19.58*	0.84	–0.56	0.63	–21.89*
REV	119.8***	236.0***	180.7***	357.4***	330.6***
ROA	–0.44	–2.56***	–4.34***	–1.44	–1.65***
R^2			0.61		
Adj. R^2			0.60		
F-statistic			58.69***		

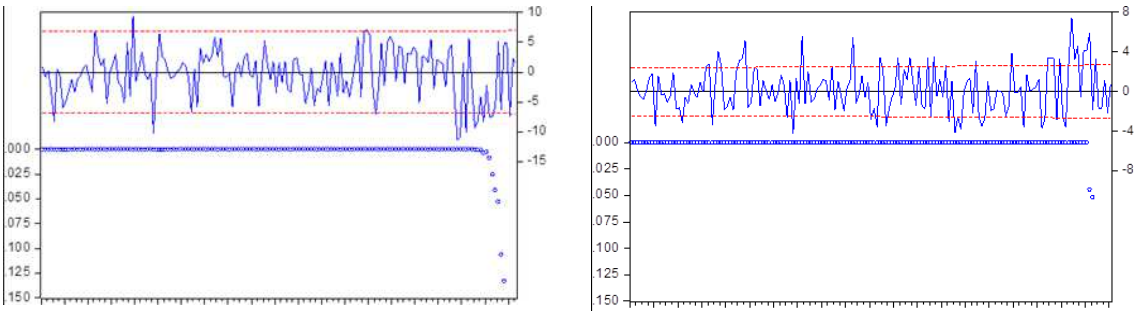
Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

ing factors, except for the influential sign of board size (BDS), revenue (REV) and return on assets (ROA) are mostly consistent in both panel model and threshold model, the sign of an independent director (IND), loan proportion (LTA), deposit proportion (DTD) within debt ratio regimes indicate the existence of nonlinearity. Specifically, the negative effect of total assets (TA) on CAR in the panel turns into a positive effect in four debt ratio regimes ranging between 91.22% and 95.38%.

Table 6 shows the effect of bank gender diversity on non-performing loans. The effect of board gender diversity (BI) is positive within three regimes: 90.71% ≤ τ < 94.21%, 94.21% ≤ τ < 94.67%, and 94.67% ≤ τ < 95.39%; then they turn to significant negative sign when 95.39% ≤ τ. This evidence proves the nonlinear effect that is different from the positive relationship between gender diversity and non-performing loans found in the panel regression. This nonlinear effect also holds with the independent director (IND), loan proportion (LTA) and deposit proportion (DTD), while board size (BDS) and return on assets (ROA) keep the same. Specifically, when taking the debt ratio into consideration, the sign of the effect completely opposites to those of total assets (TA) and revenue (REV) in panel regression.

To verify whether the nonlinear models are correctly specified, the diagnostic test for its stability is plotted in Figure 2. The n-step probability computes all feasible cases, starting with the smallest possible sample size to estimate the forecasting equation and then adding one observation at a time. Figure 2 shows that the nonlinear models fitted for the capital adequacy ratio (CAR) and non-performing loans (NPL) are rather stable.

The results of the n-step probability present the recursive residuals, standard errors, and the sample points whose probability value is at or below 15%. The right vertical axis displays the range of the recursive residuals and standard errors. The left vertical axis shows the probability values for those sample points where the hypothesis is rejected at the 5%, 10%, or 15% levels.



(CAR) (NPL)

Figure 2. Diagnostic test for model stability

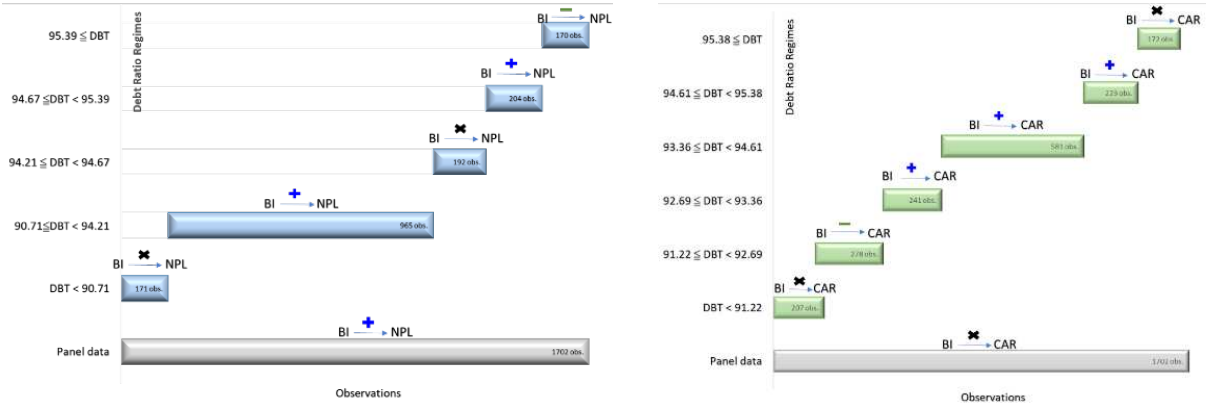


Figure 3. Nonlinear vs. linear relationship between BI and CAR, BI and NPL within debt ratio regimes

4. DISCUSSION

Figure 3 combines and illustrates the linear and nonlinear effect of board gender diversity on banks' financial soundness. The effect of board gender diversity is significant and positive, but non-linear. It is important to note that the impact of board gender diversity on the capital adequacy ratio and non-performing loans is more complicated than the simple "level" effect suggests.

The threshold effect of additional gender diversity depends on its debt level, as can be seen from the pieces of evidence within threshold regimes. For debt ratio higher than 92.69% and lower than 95.38%, the positive effect of gender diversity on the capital adequacy ratio is significant at 1%, while this effect is not evident in the linear model. For debt ratio ranging between 90.71% and 95.39%, an increase in gender diversity has a positive effect on non-performing loans. However, as the debt ratio increases, the evidence of a positive effect disappears and is replaced by a stronger significant negative one. There is a significant positive impact of the board gender diversity on the capital adequacy ratio and a significant negative impact on non-performing loans in high debt ratio banks, which is consistent with the hypothesis that women on the board can strengthen their banks' financial soundness.

When considering debt ratio as a threshold factor, the coefficient effect of board gender diversity (BI) is not consistent relative to those of panel estimation. It even completely changes the influential sign of the relationship between the board gender diversity and its financial soundness factors. In other words, as banks consider the debt ratio, the influence of female directors on financial soundness may change from positive to negative sign, and vice versa. The results show that the higher the proportion of women on the board of directors, the higher the capital adequacy ratio for banks with a debt ratio greater than 92.69%, and conversely for banks with a debt ratio of less than 92.69%. Thus, the influence of the female board on the capital adequacy ratio of the banking group with higher debt ratio is positive. For non-performing loans, the higher the proportion of women in the board of directors, the higher the non-performing loans of the banking group with a debt ratio of less than 95.39%, the opposite result appear only if the debt ratio is greater than 95.39%. This shows that the effectiveness of female boards on non-performing loans control only occurs when the debt ratio reaches the highest level.

The stable negative effect of board size on the capital adequacy ratio and positive effect on non-performing loans imply that banks with bigger board size actively explore high-risk investment, making the safety of bank operations lower due to the increase in non-performing loans. Besides, the lower performance presented by revenue and return on assets signifies the financial soundness of the capital adequacy ratio. Although, higher revenue is accompanied by higher non-performing loans, the lower return on assets may be costs that banks must pay for when selecting high capital adequacy ratio and high non-performing loans. The role of an independent board on bank financial soundness is rather mixed within regimes of debt ratio. Their action of supervising is only effective when debt ratios range between 93.61% and 95.38%.

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Although the effect of deposits and loans on bank safety is not obvious, the higher total assets lead along with the higher the capital adequacy ratio if the debt ratio is lower than 95.38%, and lower non-performing loans if the debt ratio is lower than 95.39%. In particular, the panel data results that provide shreds of evidence that the higher total asset bank leads along with the lower capital adequacy ratio, higher nonperforming loans, and debt ratio are more pronounced in the group of banks with the highest debt ratio, which still supports the "too big to fail" theory.

CONCLUSION

This paper mainly investigates not only the linear, but also the nonlinear effect of factors, especially female board directorship on three factors signaling a bank's financial soundness. The empirical results show that the women on the board act as custodians of the bank's financial soundness as banks reach their higher level of debt ratios. Unfortunately, the number of women on the board is quite low, indicating that women are not fully engaged in financial services, in terms of opportunities and outcomes, the gender gap remains significant in Taiwan. Besides, the stable negative effect of board size on the capital adequacy ratio and positive effect on non-performing loans imply that the banks with larger board size actively explore high-risk investment, making the safety of bank operations lower due to increased non-performing loans. The financial performance presented by revenue and return on assets signifies the financial soundness of banks. The sign of an independent director, loan proportion, deposit proportion within debt ratio regimes indicate the existence of nonlinearity, which proves that the linear model might not capture the full possibility of the relationship between the variables.

Women on the Board of Directors will provide a more multi-dimensional view of the company's opportunities, as well as strengthen the supervision of management, improve corporate governance, thereby leading to an increase in competitive advantage. Thus, the role of women is increasingly important, and an increase in the percentage of women on the board of directors in the banking system will contribute to the success of businesses.

AUTHOR CONTRIBUTIONS

Conceptualization: T. Thanh Binh Nguyen.
Data curation: T. Thanh Binh Nguyen.
Formal analysis: T. Thanh Binh Nguyen.
Methodology: T. Thanh Binh Nguyen.
Software: T. Thanh Binh Nguyen.
Writing – original draft: T. Thanh Binh Nguyen.
Writing – reviewing & editing: T. Thanh Binh Nguyen.

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