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Do female directors will have impact on corporate performance?

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Abstract
The purpose of this study is to explore the influence of female directors on the corporate performance of Chinese banks and Taiwanese financial holding companies. The sample consists of 14 Chinese banks and 15 Taiwanese financial holding companies in 2010–2014. The empirical results show that the proportion of non-executive female directors and independent female directors have significant positive influence on corporate performance. The result shows that the higher the proportion of female directors is, the better off the corporate performance would be. There is robust evidence in the data to conclude that female directors in specific posts can influence a firm's corporate performance.

Keywords Corporate performance · Epsilon-based measure · Female directors · Banks · Financial holding companies

Mathematics Subject Classification 90B50 · 90C30

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1 Introduction

In the recent years, gender has received attention as another main variable on corporate performance (Darmadi 2013; Khan and Vieito 2013; Lam et al. 2013). Abor and Biekpe (2007) argue that women-led businesses are less likely to use debt for a variety of reasons, including discrimination and greater risk aversion, and thus firm performs better. Additionally, Faccio et al. (2016) who agree that firms run by female leaders have lower leverage, less volatile earnings, and a higher chance of survival than firms run by male leaders. Moreover, Heminway (2007) argues that women are more trustworthy than men, and are thereby less likely to manipulate corporate financial and other disclosures.

In support of gender diversity in the workplace, the Taiwan Institute of Directors proposed the Women on Board (WOB) Initiative in May 2013 whose aim is to advocate for the roles of female directors in the board of directors. The main purpose of the initiative is to promote board structure diversity, support women's careers and development by ensuring the excellence of women in all areas. Empirical evidence from Kravitz (2003) points out that female participation has an overall positive effect on a firm's performance, while Selvaraj (2015) finds evidence that the number of females in the workplace is increasing, creating a more gender diverse work environment.

Based on a synthesis of empirical findings which show that in corporate governance, female representation on boards, audit committees and top management is associated with corporate decision, this paper, thus, explores the impact of female directors on corporate performance with updated data and improved methodologies. Specifically, this study explores the influence of female board directors on corporate performance from the point of view of female non-executive, female independent directors and female executive directors.

The sample consists of Chinese banks and Taiwanese financial holding companies for the period 2010–2014. Data will therefore be extracted from Taiwan and China.

To measure firm performance comprehensively, we employ the Epsilon-based measure (EBM) of efficiency. This method was proposed by Tone and Tsutsui (2010) and is different from the traditional data envelopment analysis (DEA) in that it has both radial and non-radial features of DEA in a unified framework. It aims to obtain the weightage on different decision making units, making every company follow standard and then make good decision to obtain higher efficiency. This study used the EBM in the DEA method to measure the operational efficiency of banks and financial holding companies, and then explored the relationship between female directors and corporate performance using OLS regression.

The remainder of this paper is organized as follows. The next section reviews prior literature and develops the hypothesis. Section 3 describes the research design, including the dynamic production process for a firm, data collection, epsilon-based measure, and regression analysis. Section 4 reports results and analyses, and Sect. 5 concludes this paper.

2 Literature review and hypotheses development

Past corporate governance literature analyses different ways to improve the monitoring of managerial activities, so that stockholders' interests can be protected. Gender diversity has become one of the most important governance issues facing managers, directors, and stockholders and it is considered part of good corporate governance. Adams and Funk (2012) raised an important question on the potential changes, what if more female were running the companies around the world? In the recent years, gender diversity in the corporations has received great attention in the media (Ben-Amar et al. 2013). This scenario has significantly affected policy debate on whether female workers, female managers and even female directors will enhance the legitimacy of firm practices (Hillman et al. 2007). Several studies have been conducted to provide insight on gender diversity in top management and its relation on company performance. The results have been mixed. Carter et al. (2003) found that gender diversity has positive effects on financial performance whereas Kochan et al. (2003) did not find significant direct effects of diversity on organizational performance.

Given that each gender contributes to management in a different and complementary way, gender balance in top management may be a source of competitive advantage. Eckel and Füllbrunn (2017) highlighted that females are stereotypically less risk taking and less competitive than males. Other studies have proved that female workers are more satisfied with their work and with their pay (Bender et al. 2005; Clark 1997).

In terms of female managerial roles in the corporation, Olson et al. (2003) reported that only 42% of female working in a family business are major decision makers and 47% received wages for their work. Moreover, the proportion of females reaching top position is still relatively low in most countries (Hoel 2008). Apart from that, only 3.09% firms have more than one female directors before 2014 in India (Chauhan and Dey 2017). However, average female directors increased to 8.55% in 2015 due to the government enforcement under the Companies Act 2013.

Although researchers are increasingly focusing to the female's involvement in the corporations, the study of female directorships is still relatively inconclusive. While many evidences confirm that males' participation in the board is associated with corporate performance, recent studies have also documented that female directorship plays an important role in corporate performance. Despite the importance of female directors in the policy debate, relatively little research discusses further on the different categories of female directors to the firm performance. Many discussions on board-related research emerged, and research suggests that board diversity can bring many benefits for the company, such as creativity and innovation (Campbell and Mínguez-Vera 2008), good communication (Niederle and Vesterlund 2007), and improved corporate governance (Adams and Ferreira 2009). Therefore, this study attempts to fill the gaps by setting different observable attributes of female directors, classified into four separate categories as follows: (1) female non-executive directors and corporate performance; (2) female independent directors and corporate performance; (3) female executive directors and corporate performance; (4) female directors and corporate performance.

2.1 Female non-executive directors and corporate performance

Chen and Jaggi (2001) suggested that the ratio of independent non-executive directors (INDs) to the total number of directors on corporate boards is positively associated with the comprehensiveness of financial disclosures, and this association appears to be weaker for family controlled firms compared to non-family controlled firms. Young (2000) found that first, the surge in demand for non-executive directors (NEDs) has been more pronounced for firms classified as having proportionately too many executive board members in the pre-Cadbury period. Second, the probability of compliance with the Cadbury Report's proposal for a minimum of three NEDs is positively related to the magnitude of the expected net benefits of adding further non-executives to the board. Besides, Heidrick and Struggles (2011) support that if women hold a few non-executive positions, it would provide an impression to the firms for having higher representation of women to tap into a wider talent pool.

Wearing and Wearing (2004) found that female non-executive directors account for just over 6% of the non-executive directors and receive about two-thirds the remuneration of their male counterparts and although female participation increases with firm size, the gender wage gap widens. Singh et al. (2008) showed that females who joined the board of directors of a company brought different thinking, reduced conflict, improved the quality of decisions that the board meetings went more smoothly. Tate and Yang (2015) proposed that an important externality to having female in leadership positions is that the companies cultivate more female-friendly cultures inside their firms. Based on the statements above, the hypothesis is developed as:

Hypothesis 1 Female non-executive directors have a positive influence on corporate performance.

2.2 Female independent directors and corporate performance

Female directors are more likely to be independent (Adams and Ferreira 2009; Dang et al. 2014). Ferreira (2015) suggested that female independent directors play a monitoring role to improve firm value. Moreover, Adams and Ferreira (2007) agreed that independent female directors could lead to a stronger governance. Kim and Starks (2016) found that capital market would react negatively when a female non-family director left the firm as public believes that the selection of female non-family director undergone a tougher process before the appointment. Mathisen et al. (2013) further explained that female outside directors who are independent bring positive impact on firm performance due to their educational level and experience. Similarly, Terjesen et al. (2016) found that female independent directors improve the board of directors' effectiveness. The finding showed that independent directors might cause greater rationality and enhanced corporate governance, thus bring better performance to the firms. Consistently, Nguyen and Nielsen (2010) found that female independent directors provide a valuable service to the shareholders. Therefore, we conjecture that female independent directors will bring a positive associate with corporate performance. The hypothesis is developed as follows:

Hypothesis 2 Female independent directors have a positive influence on corporate performance.

2.3 Female executive directors and corporate performance

Krishnan and Parsons (2008) showed that companies with more females as executive directors in senior management are found to be more profitable and have higher stock returns after initial public offerings than those with fewer female in the management ranks. Moreover, female executive directors tend to be more conservative in problem solving especially when it comes to both strategic and risk oversight (Wiersema and Bantel 1992). This would help to reduce firm risk and improve returns. Liu et al. (2014) found that female executive directors have a stronger positive effect on a firm's performance, indicating that the executive effect outweighs the monitoring effect. Based on the above, the hypothesis is developed as follows:

Hypothesis 3 Female executive directors have a positive influence on corporate performance.

2.4 Female directors and corporate performance

Perry-Richardson et al. (1990) found that females paid more attention with ethical behavior than men in the work place. A related study by Cheng (2008) reported that females are more cautious and risk-averse than men. Consistently, in decision making, females are also more reserved (De Cabo et al. 2009). Recent literature reports that females are more knowledgeable and open about cooperation compared to males, and more risk-averse relative to men (Adams et al. 2015).

In terms of corporate performance, Campbell and Mínguez-Vera (2008) and Nielsen and Huse (2010) found that when enterprises have a higher ratio of female directors, it can effectively control the board's decision-making, the company's business operations and enhance efficiency. Additionally, Carter et al. (2003) found a significant positive relationship between the proportion of women in a company's board of directors and the firm's value. In other words, female directors can clearly help to improve corporate performance. Similar findings were also found by Gavious et al. (2012) who discovered the gender of a director is influential in the eyes of analysts and investors. Hence, they confirmed that the proportion of women directors is positively correlated between the values of the company.

However, Farrell and Hersch (2005) showed that the likelihood of a firm adding a woman to its board in a given year is negatively affected by the number of women already on the board and there are studies that show no conclusive relationship at all. On the other hand, Haslam et al. (2010) indicated that there is no relationship between female presence in the board of directors and 'objective' accountancy-based measures of performance (return on assets, return on equity). Hence, we develop the hypothesis:

Hypothesis 4 Female directors have a positive influence on corporate performance.

3 Research design

3.1 Sample

The main aim of the study is to examine the association between female directors and corporate performance of Taiwanese financial holding companies and Chinese banks for the period of 2010–2014. All financial data were obtained from the Taiwan Economic Journal (TEJ) database. The initial dataset comprised all 16 Taiwanese financial holding companies and 20 Chinese banks. However, the final sample included 15 Taiwanese financial holding companies and 14 Chinese banks for the following reasons. First, this study included only Chinese banks that are with foreign direct investments by any Taiwanese companies. It is important to note that one of the requirements of the DEA approach that companies under examination should be comparably homogenous (Golany and Roll 1989). Second, for our efficiency analysis, this study eliminated those companies for which we were unable to obtain required financial data of inputs, carry-overs, and outputs from the TEJ. The DEA approach is a relative measure; thus, having a balanced panel dataset allows us to have meaningful results. Third, for our regression analysis, this study eliminated those companies with information on female directors. The total assets of the 145 firm-year observations are about 80.2% of those of their population, suggesting their representativeness for the industry.

3.2 Measures

This paper used the EBM DEA model to obtain a financial performance score. The longitudinal view of accounting shows that every firm has an accounting cycle procedure, which results in the production of financial statements such as income statements and balance sheets at the end of each operating year. In the income statement, a firm computes net income using the formula of total revenues minus total expenses, and the listings in the statement are called temporary accounts. The total net income represents the net profit/loss that the firm accrues at the end of each operating year. As a result, businesses tend to account for the accumulation of net income from zero at the start of each new operating year. On the other hand, account balances, such as assets and liabilities are accumulated at the end of each operating year on a balance sheet, and the listings in this statement are called permanent accounts. Businesses carry the account balances on the balance sheet over to the next operating year using a carry-over activity. In other words, a carry-over activity takes place between two accounting cycles. Following Lu et al. (2017), we select operating cost, liability and stockholder equity as the inputs variables in the dynamic EBM model. Operating cost are the costs which are related to the operation of a business incurred from operating activities. Liability and stockholder are the claims on assets from creditors and owners, respectively. All these amounts show the investment in firm's operation to generate the output. Meanwhile, we follow Wang et al. (2017) by using operating income and market value as the output. Moreover, this study includes intangible assets as a part of the output. This is due to the fact

Table 1 Definition of input and output variables in a dynamic EBM model

Variables	Description
Input variable	
Operating cost(Cost)	The cost owing to operating active incurred during the current period
Liability_{t-1}(LIA)	Total current liabilities, long-term debt, and other non-current liabilities, including deferred taxes and investment tax credit
$\text{Stockholder equity}_{t-1}$ (OE)	The common and preferred stockholders' equity in the company
Output variable	
Operating income (RIV)	The income owing to operating active incurred during the current period
Market value (MV)	Market value
Intangible assets (IA)	Intangible assets correspond to the following three conditions, without the physical form of non-monetary assets: (1) It can be identified (2) It can be controlled by an enterprise (3) It has a future economic benefit

that a firm's capability can be classified into tangible and intangible, to perform a task or activity to improve performance (Hafeez et al. 2006). In other words, corporate performance relies on the proper utilization of tangible and intangible assets in all potential and legal ways. Hence, this study employs intangible assets as one of the output variables in dynamic EBM model. The variables are described as follows.

For purposes of this study, corporate performance was calculated based on EBM model's score. Several variables were employed as dependent, independent and control variables. The four control variables include: company scale, measured by log of total assets (LogTA) (González et al. 2017), debt ratio (DEBT) (Ting and Lean 2011), age (López-Delgado and Diéguez-Soto 2018) and profit and loss from fair value changes (logTRA) (Penman 2007) measured by the natural logarithm of profit and loss from fair value changes. LogTRA is chosen as a control variable in fair value to reflect true economics substance. Penman (2007) highlights that fair value represents an unbiased measurement and affects the change in wealth. The measurement on each variable used is as follows (Table 1):

3.3 Methodology

The conventional DEA models ignore the problems where radial and non-radial inputs/outputs must be considered simultaneously. DEA models using EBM of efficiency are firstly proposed for a simultaneous consideration of radial and non-radial inputs/outputs (Tone and Tsutsui 2010). To overcome above problems, the advantages of Charnes-Cooper-Rhodes model and the slacks-based measure model were combined to overcome the drawbacks of a conventional model that does not include efficiency measures in non-radial measures. Additionally, the problem concerning the concurrent and unidirectional increases or decreases of the conventional model inputs and outputs was addressed. The proposed method can improve all input–output variables, depending on the situation, without the unidirectional

variable increases or decreases to conform to practical applications and provide an accurate analysis of corporate performance (EBM DEA model is presented in "Appendix I")

Due to any potential overlapping idea of proxy FD would include FIN, FNE and/or FE, the study will conduct an OLS-regression for Eq. 2 for the variables tested. The test will avoid any potential problem of multicollinearity to ensure that the assumptions underlying regression analysis are met. This paper used ordinary least squares (OLS) regression analysis and truncated regression to evaluate the relationship between female directors and corporate performance, particularly the following regression models:

$$EBM_{it} = \beta_0 + \beta_1 FNE_{it} + \beta_2 FIN_{it} + \beta_3 FE_{it} + \beta_4 LogTA_{it} + \beta_5 DEBT_{it} + \beta_6 AGE_{it} + \beta_7 LogTRA_{it} + \beta_8 COUNTRY_{it} + \varepsilon_{it} \quad (1)$$

$$EBM_{it} = \beta_0 + \beta_1 FD_{it} + \beta_2 LogTA_{it} + \beta_3 DEBT_{it} + \beta_4 AGE_{it} + \beta_5 LogTRA_{it} + \beta_6 COUNTRY_{it} + \varepsilon_{it} \quad (2)$$

where EBM is the corporate performance which is calculated from EBM model's score of firm i at time t. FNE is a dummy variable, which code as 1 if firm has female non-executive directors and 0 if otherwise of firm i at time t; FIN is a dummy variable, assigned 1 if firm has female independent directors, or otherwise, 0 of firm i at time t. FE is a dummy variable, one point if the firm has female executive directors, and zero point it there is no female Executive directors of firm i at time t. FD is the proportion of female directors = total number of female Board of Directors/total number of the Board of Directors of firm i at time t. LogTA measures the company scale, and it logs the total assets of firm i at time t. DEBT is debt ratio, which is measured as the ratio of total liabilities to total assets of firm i at time t. Age is the age of the Taiwanese financial holding company and the Chinese bank of firm i at time t. LogTRA is the natural logarithm of profit and loss from fair value changes of firm i at time t. $COUNTRY_t$ = country dummy; ε_{it} is error term (Table 2).

3.4 Descriptive statistical analysis

Panel A-Panel E in Table 3 shows the descriptive statistics of the 145 samples in the EBM model. On average, operating cost, liability, shareholders' equity, operating income, market value and Intangible assets displayed growth from 2010 to 2014.

The correlation coefficients for the inputs and outputs in the EBM process are shown in Table 4. The relationships between each input and output are all positive and significant at 0.01. These results suggest that when we increase a proportion of inputs, the proportion of outputs will also increase, thereby suggesting the existence of isotonicity for the choices of input, carry-over, intermediate, and output variables in this study (Golany and Roll 1989).

Panel A-Panel E in Table 5 show the descriptive statistics of the 145 samples in the regression analysis. On average, Non-Executive Director, Independent director, the proportion of female directors, DEBT, LogTA, Age and Profit and Loss from Fair Value Changes have smoothly gone up over the period of 2010 to 2014. The

Table 2 Dependent variable and independent variables

Variables	Measurements
Dependent variable	
EBM	The corporate performance which is calculated from EBM model's score.
Independent variables	
FNE	FNE is a dummy variable, which code as 1 if firm has female non-executive directors and 0 if otherwise
FIN	FIN is a dummy variable, assigned 1 if firm has female independent directors, or otherwise, 0
FE	FE is a dummy variable, one point if the firm has female executive directors, and zero point it there is no female Executive directors
FD	FD is the proportion of female directors = total number of female Board of Directors/total number of the Board of Directors
Control variables	
LogTA	It measures the company scale, and it logs the total assets.
DEBT	Debt ratio = Total liabilities divided by total assets
Age	Age of the Taiwanese financial holding company and the Chinese bank
LogTRA	It is the natural logarithm of profit and loss from fair value changes

findings show that corporate performance of the observed samples decrease from 0.808 in 2010 to 0.670 in 2011 and increase to 0.723, 0.740 in 2012 and 2013, respectively and finally decrease to 0.722 in 2014. The control variables (logTA, debt, age and logTRA) fluctuate over the sample period. Moreover, the results show that female directors increase smoothly over the sample period, except for 2011. There is also an observed decrease in female non-executive directors of the sample firms from 0.162 in 2010, 0.142 in 2011, 0.129 in 2012, 0.128 in 2013 to 0.084 in 2014. On the other hand, the independent female directors fluctuate over the sample period. On average, about 8.12% of the sample firms are having female independent directors over the sample period. Consistently, female executive directors of the observed firms decrease once from 0.018% in 2010 to 0.016 in 2011 and later on increase from 0.023 in 2012, to 0.024 in 2013 and 0.152 in 2014. Moreover, the findings show that the proportion of female directors decrease from 0.111 in 2010 to 0.089 in 2011 and increase to 0.091, 0.094 and 0.101 in year 2012, 2013 and 2014, respectively. On average, the proportion of female directors is about 0.097 over the sample period.

The univariate results show that female's average involvement on the board is 9.7%. The result is consistent with those Catalyst (2013) in U.S and Catalyst (2004) in U.K. With the higher likelihood for female in Taiwanese financial holding companies and Chinese banks to involve in firms' decision-making process through directorship rather than CEO position, this implies that the observed firms follow the enforcement in promoting equalities for female directors (as reported by Chou et al. (2013) that the participation of female as CEOs in Taiwanese firms is only 7.4%). This is in line with Triana et al. (2013) who suggest that board gender diversity is a double-edged since it could impede strategic changes when the firm performance is low. Furthermore, Erkut et al. (2008) reveal that boards with three or more female directors are more efficient.

Table 3 Descriptive statistics of the 145 samples in the EBM model

	Mean	SD	Center	Max
Panel A: year 2010				
(I) Cost	34.46	42.76	19.56	170.99
(I) LIA	2233.44	2441.02	1610.90	9064.34
(I) OE	139.77	138.49	93.74	559.02
(O) RIV	81.45	97.69	44.00	323.49
(O) MV	252.93	323.64	160.12	1467.38
(O) IA	5.61	7.50	1.67	26.29
Panel B: year 2011				
(I) Cost	40.93	53.15	21.44	220.99
(I) LIA	2538.31	2780.54	1780.30	10,109.41
(I) OE	168.84	177.17	116.86	700.91
(O) RIV	90.67	112.84	46.07	397.09
(O) MV	214.90	258.01	135.05	1104.90
(O) IA	6.89	8.43	2.17	27.19
Panel C: year 2012				
(I) Cost	41.48	52.98	21.93	220.99
(I) LIA	2586.76	2783.21	1849.51	10,109.41
(I) OE	171.97	176.33	124.54	700.91
(O) RIV	104.66	124.53	56.22	397.09
(O) MV	221.43	257.06	143.90	1104.90
(O) IA	7.17	8.30	3.79	27.29
Panel D: year 2013				
(I) Cost	42.21	52.80	22.69	220.99
(I) LIA	2646.58	2794.20	1939.61	10,109.41
(I) OE	179.45	177.19	132.78	700.91
(O) RIV	105.81	123.03	58.38	397.09
(O) MV	249.51	262.74	157.37	1104.90
(O) IA	7.02	8.15	3.17	25.73
Panel E: year 2014				
(I) Cost	61.06	74.58	32.22	289.91
(I) LIA	3554.76	3796.61	2420.43	14,288.88
(I) OE	255.22	264.65	192.85	1074.33
(O) RIV	141.82	155.78	73.41	570.47
(O) MV	327.81	338.14	180.97	1291.26
(O) IA	7.42	9.27	2.84	31.00

The unit for the variables is 1 billion NTD

Table 6 presents the Pearson coefficients for female directors and corporate performance. The relationship between most of the variables is positive and significant. Generally, there is a significantly negative correlation between EBM and female directors, in term of FNE ($P < 0.10$) and FE ($P < 0.05$). In addition, the findings also show that FNE is significantly and positively correlated with FIN ($P < 0.10$) and FD ($P < 0.01$). However, FIN is found that having significantly and positively correlated

Table 4 Pearson coefficients for inputs and outputs

	Cost	LIA	OE	RIV	MV	IA
(I) Cost	1.000					
(I) LIA	0.954***	1.000				
(I) OE	0.924***	0.968***	1.000			
(O) RIV	0.876***	0.911***	0.880***	1.000		
(O) MV	0.930***	0.939***	0.929***	0.907***	1.000	
(O) IA	0.598***	0.549***	0.574***	0.606***	0.599***	1.000

*, **, ***Denotes significance at < 10%, < 5%, and < 1% levels, respectively

with FD ($P < 0.01$). Other than that, the correlation results also indicate that FE is significantly positive correlated with FD ($P < 0.01$). In summary, from the above analysis, it can be deduced that the degree of associations is weak as the coefficients are less than 0.70. In other words, the correlation coefficients are not sufficiently large to cause collinearity problem in the regression.

Furthermore, multicollinearity test is conducted to check for correlation among the regressors. We find that the variance inflation factors values (VIF for FNE = 1.780; VIF for FIN = 1.313; VIF for FE = 3.540;VIF for FD = 2.454; VIF for LogTA = 2.715; VIF for DEBT = 1.757; VIF for Age = 1.903; LogTRA = 2.298; COUNTRY = 2.319) are less than five O'brien (2007) which infer no multicollinearity problem for the following regression analyses. Even the VIF shows no multicollinearity problem among all explanatory variables, the study still develops a separate model for FD to avoid any potential biasness.

4 Empirical results

4.1 Descriptive statistics and regression analysis

This paper uses the EBM model to get companies' efficiency value and we perform regression analyses to assess the impact of female directors on the corporate performance. The regression model is written as follows:

$$EBM_{it} = \beta_0 + \beta_1 FNE_{it} + \beta_2 FIN_{it} + \beta_3 FE_{it} + \beta_4 LogTA_{it} + \beta_5 DEBT_{it} + \beta_6 AGE_{it} + \beta_7 LogTRA_{it} + \beta_8 COUNTRY_{it} + \varepsilon_{it} \quad (3)$$

$$EBM_{it} = \beta_0 + \beta_1 FD_{it} + \beta_2 LogTA_{it} + \beta_3 DEBT_{it} + \beta_4 AGE_{it} + \beta_5 LogTRA_{it} + \beta_6 COUNTRY_{it} + \varepsilon_{it} \quad (4)$$

Table 7 presents the results of two regression approaches: Ordinary least squares (OLS) and Truncated regression. Following Banker and Natarajan (2008), the study first conducts OLS. The results show that FNE is significantly positive in affecting corporate performance. This could explain the increase in corporate performance when the firm has female non-executive directors. The findings are

Table 5 Descriptive statistics of the 145 samples in the regression analysis

	Unit	Mean	SD	Center	Max
Panel A: year 2010					
EBM	Ratio	0.808	0.169	0.790	1.000
FNE	Dummy	0.162	0.161	0.125	0.625
FIN	Dummy	0.081	0.147	0.000	0.500
FE	Dummy	0.018	0.071	0.000	0.333
FD	Ratio	0.111	0.093	0.091	0.375
LogTA	Thousand	9.207	0.479	9.274	10.034
DEBT	Percent	92.033	6.648	94.020	96.590
Age	–	19.207	23.517	9.000	102.000
LogTRA	Billion	142.29	125.36	102.09	575.59
Panel B: year 2011					
EBM	Ratio	0.670	0.167	0.664	1.000
FNE	Dummy	0.142	0.136	0.125	0.400
FIN	Dummy	0.066	0.133	0.000	0.500
FE	Dummy	0.016	0.058	0.000	0.250
FD	Ratio	0.089	0.078	0.067	0.250
LogTA	Thousand	9.259	0.484	9.330	10.089
DEBT	Percent	91.849	6.245	93.640	96.140
Age	–	20.207	23.517	10.000	103.000
TRA	Billion	142.89	141.86	84.70	597.49
Panel C: year 2012					
EBM	Ratio	0.723	0.183	0.718	1.000
FNE	Dummy	0.129	0.128	0.111	0.400
FIN	Dummy	0.093	0.160	0.000	0.667
FE	Dummy	0.023	0.070	0.000	0.250
FD	Ratio	0.091	0.080	0.071	0.250
LogTA	Thousand	9.316	0.479	9.364	10.145
DEBT	Percent	91.822	5.991	93.560	95.960
Age	–	21.207	23.517	11.000	104.000
LogTRA	Billion	203.45	243.09	102.69	997.88
Panel D: year 2013					
EBM	Ratio	0.740	0.177	0.747	1.000
FNE	Dummy	0.128	0.128	0.111	0.400
FIN	Dummy	0.082	0.128	0.000	0.400
FE	Dummy	0.024	0.073	0.000	0.250
FD	Ratio	0.094	0.081	0.077	0.250
LogTA	Thousand	9.365	0.474	9.404	10.186
DEBT	Percent	92.014	4.650	93.660	95.470
Age	–	22.207	23.517	12.000	105.000
LogTRA	Billion	257.21	262.85	167.50	1059.93
Panel E: year 2014					
EBM	Ratio	0.722	0.187	0.702	1.000
FNE	Dummy	0.120	0.141	0.100	0.667

Table 5 (continued)

	Unit	Mean	SD	Center	Max
FIN	Dummy	0.084	0.118	0.000	0.333
FE	Dummy	0.152	0.316	0.000	1.000
FD	Ratio	0.101	0.082	0.125	0.235
LogTA	Thousand	9.413	0.470	9.447	10.224
DEBT	Percent	92.161	3.351	93.450	95.520
Age	–	23.207	23.517	13.000	106.000
TRA	Billion	243.52	227.58	181.37	924.08

FNE is a dummy variable, which code as 1 if firm has female non-executive directors and 0 if otherwise; FIN is a dummy variable, assigned 1 if firm has female independent directors, or otherwise, 0; FE is a dummy variable, one point if the firm has female executive directors, and zero point it there is no female Executive directors; FD is the proportion of female directors = total number of female Board of Directors/total number of the Board of Directors; LogTA measures the company scale, and it logs the total assets; DEBT is debt ratio = Total liabilities divided by total assets; Age is that age of the Taiwanese financial holding company and the Chinese bank; LogTRA is the natural logarithm of profit and loss from fair value changes

Table 6 Pearson coefficients for female directors and performance

	EBM	FNE	FIN	FE	FD	LogTA	DEBT	Age	LogTRA
FNE	−0.147	1.000							
	0.077	–							
FIN	−0.115	0.138	1.000						
	0.168	0.098	–						
FE	−0.186	0.064	−0.034	1.000					
	0.025	0.444	0.681	–					
FD	−0.096	0.664	0.511	0.247	1.000				
	0.252	0.000	0.000	0.003	–				
LogTA	−0.109	0.103	0.201	−0.079	0.172	1.000			
	0.194	0.218	0.015	0.342	0.039	–			
DEBT	−0.303	−0.165	0.182	0.152	0.000	0.473	1.000		
	0.000	0.048	0.028	0.067	0.996	0.000	–		
Age	−0.155	0.241	0.200	0.095	0.390	0.461	0.135	1.000	
	0.063	0.004	0.016	0.256	0.000	0.000	0.106	–	
LogTRA	0.055	0.223	0.189	−0.096	0.143	0.614	0.215	0.366	1.000
	0.511	0.007	0.023	0.252	0.087	0.000	0.010	0.000	–
Country	0.059	−0.309	−0.277	−0.207	−0.319	−0.270	−0.347	−0.510	−0.497
	0.479	0.000	0.001	0.013	0.000	0.001	0.000	0.000	0.000

Table 7 The result of regression model (N = 145)

Variable	Ordinary least square		Ordinary least square		Truncated regression	
	Coefficient	*P* value	Coefficient	*P* value	Coefficient	*P* value
Intercept	− 1.633**	0.022	− 1.247*	0.055	− 7.664**	0.015
FNE	0.230***	0.001				
FIN	0.026	0.345				
FE	0.258**	0.023				
FD			0.711*	0.075	2.063**	0.017
LogTA	− 0.006	0.477	− 0.024	0.404	− 0.073	0.759
DEBT	2.505***	0.000	2.551***	0.000	9.034***	0.008
Age	0.003**	0.022	0.003**	0.045	0.003	0.412
LogTRA	− 0.030	0.239	− 0.034	0.195	− 0.008	0.932
COUNTRY	0.260***	0.004	0.168**	0.031	0.335*	0.076
Adj R-squared	0.180		0.092			
F-statistic	4.955***		3.433***			
Log-likelihood					− 27.253	

*, **, ***Denotes significance at < 10%, < 5%, and < 1% levels, respectively

consistent with those of Erhardt et al. (2003) who prove that firms with a higher number of female executives have higher profitability relative to their average sector profitability. Khan and Vieito (2013) found that when firms with female CEOs have smaller risk level compared firms with male CEOs. Moreover, female non-executive directors are able to bring new ideas, provide different thinking, reduce conflict, improve the quality of board meetings' decisions (Singh et al. 2008). In other words, firms with female non-executive directors outperform firms without female non-executive firms. The results support our Hypothesis 1 that female non-executive directors have a positive influence on corporate performance.

The results of the OLS regression analysis also find that firms with female executive directors have a positive and significant relationship with corporate performance. This is consistent with Liu et al. (2014) indicating that the executive effect outweighs the monitoring effect. This is mainly attributed to the females bringing with them diverse thinking for enterprises which can help companies reduce risk and enhance competitiveness. These findings also shed light on why firms with female executive directors have better corporate performance than firms without female executive directors. The results support our Hypothesis 3 that firms with female executive directors have a positive and significant relationship with corporate performance.

However, we find no statistical evidence that female independent directors play a role in affecting corporate performance. Since it is insignificant, the study rejects Hypothesis 2 and concludes that female independent directors do not have an impact on corporate performance.

For another robustness check, we conduct another OLS to test the proportion of female directors to the number of board of directors (FD) separately to avoid any potential multicollnearity issue. The regression results indicate that the higher

the proportion of female directors in the boardroom, the better the corporate performance. These findings are consistent with Kravitz et al. (2003) who agrees that female participation in the company's operation has a positive effect on overall performance. In other words, when there is a greater number of female executives in a company, corporate performance will be higher. In addition, the same findings in FD and corporate performance confirm that our results are robust with a different proxy for female directors.

Besides checking different proxy, next, we use a different approach to ensure consistency. Following Simar and Wilson (2011), we conduct Truncated regression to examine the influence of female directors to corporate performance. The estimation results with truncated regression in Table 7 remain qualitatively the same.

4.2 Findings discussion

Based on the results, we find that female directors play a crucial role in corporate performance. The findings show that when the board members consist of female non-executive directors, they will provide different viewpoints and quality deliberations (Liu et al. 2014; Zelechowski and Bilimoria 2004), thus, improve corporate performance. Firms with a higher representation of female non-executive directors demonstrate a wider talent pool and it is critical to strategic and financial decision-making in firms (Heidrick and Struggles 2011). Moreover, board composition is pertinent as the gender diversity, directors' profession, experience and skills can affect the competence of managing, monitoring, advising and external collaborations which would contribute to the corporate performance.

Findings from the study also support the hypothesized relationship between female executive directors and corporate performance. According to the OLS regression result, firms with female executive directors around will have better corporate performance. The ability of establishing the competitive advantages makes female executive directors an invaluable asset for a firm (Chauhan and Dey 2017). This means that among the board executive members, a female might have significantly different values from other females due to her expertise and talented skills. Several distinctive behavioral features of female directors such as valuable advice to top managers (Anderson et al. 2011), problem-solving skills (Daily and Dalton 2003), creativity and innovation (Robinson and Dechant 1997) and risk taker Ting et al. (2016) are the potential advantages of female directorship. Hence, the study believes that females who obtained their executive director positions would bring potential impact to the corporate performance.

In addition, the results also confirm the hypothesized relationship between the proportion of female directors and corporate performance. The findings present that firms with higher proportion of female directors in the boardroom will tend to have better corporate performance. Again, increase the number of female directors in the boardrooms may bring benefits in few ways: (a) enhance dissimilar networks and collaborations for the sake of finance sectors with other business areas (Gulamhussen and Santa 2015); (b) provide more rational decisions as females are often less

aggressive than males (De Cabo et al. 2009); (c) capable in their monitoring skills (Adams and Ferreira 2009). (d) Female are more trustworthy than males, and are thereby less likely to manipulate corporate financial and other disclosures (Heminway 2007). With that, firms with higher proportion of female directors in the boardroom may increase corporate performance.

5 Conclusion

In an extension of previous studies, this study has examined the impact of female directors on corporate performance by applying the EBM DEA model, ordinary least squares (OLS) regression analysis and truncated regression. In comparison to other studies, its scope is wider in the context of female directorship by setting different observable attributes classified into four separate categories: (1) female non-executive directors, (2) female independent directors, (3) female executive directors and (4) female directors.

The findings are as follows. First, the more the female non-executive directors, the better the corporate performance. Second, firms with female executive directors outperform than firms without female executive directors. Third, the higher the proportion of female director in the boardroom, the better the corporate performance. The results are robust using truncated regression. In conjunction with other studies that show female directors have a positive impact on corporate performance; our results imply that firms with female directors are more likely perform better. The findings are consistent with Heidrick and Struggles (2011), Wiersema and Bantel (1992), Campbell and Mínguez-Vera (2008), Nielsen and Huse (2010) and Gavious et al. (2012). However, the study concludes that female independent director is not the determinants to the corporate performance.

Nevertheless, this study has contributed to the finance literature from gender diversity dimension. These findings have policy implications with regard to female directors of companies in transitional economies in general, and in China and Taiwan finance sectors in particular. In conjunction with other studies that show female directors improve the corporate performance, our results imply that a female director is likely to improve corporate performance. It is therefore recommended that China and Taiwanese finance sectors increase gender diversity in their boardrooms. In addition, policymakers should seek to foster a competitive landscape by encouraging more female non-executive directors and female executive directors to enhance firm performance. Based on our findings that firms with female directors outperform firms without female directors, in regards to investors, this study suggests that investors will buy shares from those China banks and Taiwanese financial holding companies.

Drawing from the sample of the finance sector in Taiwanese financial holding companies and China banks, the study contributes to a better understanding of board and top management gender diversity in emerging countries in the finance sector. This means that the study has a unique focus to one business entity and can only be generalized along that scope. For considerations of future studies, we suggest a bigger sample.

Appendix I

Epsilon-based measure of efficiency in DEA model approach

Epsilon-based measure of efficiency in DEA model is illustrated as follow.

Step 1 We used SBM model for finding slacks and projected DMUs to efficient frontiers. They are all projected to the unique efficient DMU. Throughout this paper, we deal with n DMUs ($j = 1, \ldots, n$) having m inputs ($i = 1, \ldots, m$) and s outputs ($r = 1, \ldots, s$). The input and output matrices are denoted by $X = \left\{x_{ij}\right\} \in R^{mxn}$ and $Y = \left\{y_{ij}\right\} \in R^{sxn}$ respectively. We assume X > 0 and Y > 0.SBM

$$\min \frac{1 - \frac{1}{m}\sum_{i=1}^{m} \frac{s_i^-}{x_{io}}}{1 - \frac{1}{s}\sum_{r=1}^{m} \frac{s_r^+}{y_{ro}}}$$

$$\begin{aligned} &\textit{Subject to} \\ &x_{io} = \textstyle\sum_{j=1}^{n} x_{ij}\lambda_j + s_j^- = 0 \qquad i = 1, \ldots, m. \\ &y_{ro} = \textstyle\sum_{j=1}^{n} y_{rj}\lambda_j - s_r^+ = 0 \qquad i = 1, \ldots, s. \\ &\textstyle\sum_{j=1}^{n} \lambda_j = 1 \\ &\lambda_j(\forall j), s_i^- \geq 0(\forall i), s_r^+ \geq (\forall r). \end{aligned} \tag{5}$$

Using the optimal slacks s^{-*} and s^{+*} we define the projected input and output for DMUo by

$$\begin{aligned} \overline{X_{io}} &= x_{io} - s_i^{-*}(i = 1, \ldots, m) \\ \overline{Y_{ro}} &= y_{ro} + s_r^{+*}(r = 1, \ldots, s) \end{aligned} \tag{6}$$

We notice that SBM model may produce different projections but they are on the efficient frontiers of the production possibility set. Thus, we have n VRS-efficient DMUs denoted by

$$\begin{bmatrix} \overline{X} \\ \overline{Y} \end{bmatrix} = \begin{bmatrix} \bar{X}_{11} & \cdots & \bar{X}_1 \\ & \cdots & \\ \bar{X}_{m1} & \cdots & \bar{X}_{mn} \\ \bar{Y}_{11} & \cdots & \bar{Y}_{1n} \\ & \cdots & \\ \bar{Y}_{s1} & \cdots & \bar{Y}_{sn} \end{bmatrix} = \begin{bmatrix} \bar{X}_1 \\ \cdots \\ \bar{X}_m \\ \bar{Y}_1 \\ \cdots \\ \bar{Y}_s \end{bmatrix} \tag{7}$$

All CRS (constant-returns-to-scale) efficient DMUs are included in this set along with VRS-efficient DMUs.

Step 2 We calculated the diversity matrix by the formula (8)

Definition 1 (*Diversity index*). We define the "diversity index" of vectors **a** and **b** as the deviation of $\{c_j\}$ from the average $\bar{c}$ in the following way:

$$\begin{aligned} D(a,b) &= \frac{\sum_{j=1}^{n} \left| c_j - \bar{c} \right|}{n\left(c_{max} - c_{min}\right)}, \ (if \ c_{max} > c_{min}) \\ &= 0 \, (if c_{\max} > c_{\min}) \end{aligned} \tag{8}$$

Step 3 The affinity matrix is calculated by the formula (9).

In the input-oriented case, we calculate the affinity matrix $s = \left[s_{ij}\right] \in R^{m*n}$ with the elements

$$s_{ij} = s\left(\overline{x_i}, \overline{x_j}\right)(i, j = 1, \ldots, m) \tag{9}$$

All elements of the matrix S satisfy the bounds: $1 \geq s_{ij} \geq 0(\forall(ij))$

Step 4 The largest eigenvalue and eigenvector of the affinity matrix are calculated.

We define ε_x and w^- in the EBM as follows:

$$\begin{aligned} \varepsilon_x &= \frac{m - \rho_x}{m - 1} \ (if \ m > 1) \\ &= 0 (if \ m = 1) \\ w^- &= \frac{w_x}{\sum_{i=1}^{m} w_{xi}} \end{aligned} \tag{10}$$

The thus defined ε_x and w^- satisfy the relationship $0 \leq \varepsilon_x \leq 1$ and $ew^- = 1$

Step 5 Use of ε_x and w^- in the EBM of efficiency.

[EBM-I–V]

$$r^* = \min_{\theta, \lambda, s} \theta - \varepsilon_x \sum_{i=1}^{m} \frac{w_i^- s_i^-}{x_{io}} \tag{11}$$

$$\begin{aligned} &\textit{Subject to} \\ &\theta x_{io} - \sum_{j=1}^{n} x_{ij} \lambda_j - s_i^- = 0 \ \ i = 1, \ldots, m. \\ &\sum_{j=1}^{n} y_{rj} \lambda_j \geq y_{r0} \qquad\qquad r = 1, \ldots, s. \\ &\sum_{j=1}^{n} \lambda_j = 1 \\ &\lambda_j \geq 0 \\ &s_i^- \geq 0 \end{aligned} \tag{12}$$

where w_i^- is the weight (relative importance) of input i and satisfies $\sum_{i=1}^{m} w_i^- = 1 (w_i^- \geq 0 \forall i)$ and ε_x is a key parameter which combines the radial θ from BCC model and the non-radial slacks term. Parameters ε_x and $w^- = (w_1^-, \ldots, w_m^-)$ must be supplied prior to the efficiency measurements. As can be seen from the term $\frac{w_i^- s_i^-}{x_{io}}$ in the objective function (5) of, $\frac{s_i}{x_{io}}$ is units-invariant and so w_i^- should be a units-invariant value reflecting the relative importance of resource "*i*".

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