5. PREDICTING BANKS' SUBORDINATED BOND ISSUANCES

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Abstract

This study investigates the predictive determinants of banks' subordinated bond issuances. We employ macroeconomic indices, market-specific factors, individual bank financial ratios, and bank performance indices to predict banks' subordinated debt management decision-making processes. We use logistic and panel data regression approaches to identify the variables that significantly affect banks' decision to issue subordinated bonds. The logistic analysis indicates that economic expansion and insolvency risk increase the probability of banks' subordinated bond issuances, whereas profitability has no significant influence. Consistent with this result, the panel data analysis reveals that the economic growth and insolvency risk in the previous period positively forecast the growth rate of subordinated bonds in the next period. Considering bank-specific financial ratios, we find that banks with higher capital adequacy ratios and operating costs tend to increase the size of their subordinated bond holdings.

Keyword: Business cycle, Fixed effects, Logit model, Prediction, Random effects, Subordinated bond

JEL Classification: E32, G17, G21

1. Introduction

Subordinated bonds are debts that are recognized as capital for financial institutions, particularly in the case of banks. Some studies refer to the effects of subordinated bond issuances or holdings on banks. Van Der Weide and Kini (1999) suggest the effectiveness of issuing subordinated bonds regarding their disciplinary role and support mandatory subordinated bond programs for banks. They find that having creditors influences banks' risk-taking decisions, specifically to take up more risks. Further, purchases and sales of bonds issued in the secondary market convey significant information about or signal the market's perspective on the corresponding banks to supervisory institutions. DeYoung, Flannery, Lang, and Sorescu (2001) similarly propose that subordinated bond issuances have a signaling effect via the bond market and support the mandatory program. They claim

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that the prices of subordinated bonds traded in the bond market convey information of which the government and supervisory authorities may not be aware. Evanoff, Jagtiani, and Nakata (2011) empirically examine the effectiveness of subordinated bond issuances for enhancing market discipline and bank resilience. They claim that mandatory subordinated bond programs for banks significantly improve the market's perspective and information transparency in the secondary bond market, eventually improving the risk-spread relationship around additional subordinated bond issuances. Similary, Chen and Hasan (2011) argue that, with some regulatory supplements including restrictive interest rate ceilings and regulations preventing collusion, mandatory subordinated bond issuances can effectively enhance market discipline and reduce moral hazard problems by preventing managers from taking on excessive risks for their own benefits. Furthermore, Yu and Ryu (forthcoming) investigate the effect of subordinated bond issuances on bank performance and stability in the Korean banking sector and find that the issuances of the debt impacts both the profitability and insolvency risk of commercial banks. However, these previous studies mostly focus on the ex-post effects of subordinated bonds, implying that they play a disciplinary role for or negatively impact the performances of banks after the bonds are issued; few works consider the motivation for banks' decisions to issue subordinated bonds and predict such issuances.

Despite the limited number of studies that determine and predict subordinated bond issuances, some provide insights regarding overall debt issuance conducted for the purpose of raising capital. Lang, Poulson, and Stulz (1993) suggest that a firm financing capital by selling assets signals to investors that the firm is currently in need to meet its financial obligations or standards, implying that its financial status is rather weak. Jensen, Crutchley, and Hudson (1994) claim that the same concept of signaling effect applies when firms finance capital via other sales, such as equity sales. Howton, Howton, and Perfect (1998) investigate straight debt issuances from 1983 to 1993 and find that the market is negatively affected around debt issuance announcements. They also discover that the market reaction to such announcements is more negative when firms have higher cash levels. Ma, Chang, and Lee (2016) show that changes in reserve ratio requirements significantly affect the bond holding structures of banks in China. A recent study by Kim, Batten, and Ryu (2020) reveals that the degree of bank diversification significantly affects banks' financial stability, and this relationship is influenced by the economic status, specifically the global financial crisis. Overall, the literature suggests that banks' bond holding decisions depend on the economic environment, the market structure, and banks' financial statuses. This finding implies that a thorough examination of the internal and external factors affecting banks' subordinated bond holding decisions using predictive models is necessary.

Following this line of inquiry, our study investigates the Korean banking sector and examines the potential predictors or determinants of banks' subordinated bond issuances using a logit model and a panel data regression approach. The logistic regression results suggest that insolvency risk and the business cycle—whether it is in an economic expansion or recession—have significant predictive power for banks' subordinated debt issuance decisions in the next period, whereas profitability, proxied by the return on assets, does not significantly affect bond issuance. For the panel data regressions, we consider both fixed and random effects across individual banks and find that the gross domestic product (GDP) growth rate; insolvency risk; and some financial ratios, including the capital adequacy and operating costs, significantly affect the subordinated bond holding decisions of banks in the next year. We robustly confirm our results after controlling for both bank and time effects as well. These results suggest that banks' subordinated bond issuances are motivated by external factors, such as economic growth, and internal factors, such as the capital adequacy ratios, operating costs, and insolvency risks of individual banks. Further, the results suggest that banks' decisions regarding the management of subordinated bonds can be predicted using economic and financial data from the previous period.

The remainder of this paper is organized as follows. Section 2 introduces and explains the Basel III accord capital regulations and the characteristic features of subordinated bonds. Section 3 describes the sample data and the methodology used for the analyses. Section 4 addresses and interprets the results of the empirical analysis, and section 5 concludes.

2. Subordinated Bonds and the Basel III Accord

The Basel Committee on Banking Supervision (BCBS), a board affiliated with the Bank for International Settlements (BIS), introduced an enhanced and reinforced regulation, namely, the Basel III accord, for the risk management of financial institutions, specifically banks (BCBS, 2010; Eubanks, 2010). The accord, a consequent response to the preceding 2008 global financial crisis, strengthens the standards for the behavior in the banking sectors with the aim of ensuring banks' financial soundness, the integrity of the capital structure, and the overall stability of bank performance. Particularly, the capital framework of the new accord enforces more rigorous regulations for minimum capital requirements. Abiding by this framework, banks are now required to maintain total capital ratios to be 8.0% at the minimum; common equity ratios to be 4.5%, which is an increase from the 3.5% required ratio prior to the framework; the Tier 1 capital ratios to be 6.0%, which is an increase from the 4.5% required ratio before the framework; and capital conservative buffer ratios to be 2.5% at the minimum, which is increased from the previous requirement of 0.0% (BCBS, 2010). In short, the Basel III capital framework raises all standards for the capital structure with an intention to enhance the stability of the banking sector and, furthermore, the economy (BCBS, 2013).

Subordinated bonds are debts that are recognized as the Tier 2 capital and are treated as a capital component in the total capital ratio. Such bonds are distinguishable from other types of capital-recognized hybrid bonds in that they are not perpetual debentures but rather have maturity dates. Further, while bonds with more than five years until maturity are fully recognized as Tier 2 capital, the proportion of subordinated bonds recognized as capital is gradually withdrawn from Tier 2 capital once the remaining time to maturity becomes less than five years. Specifically, this proportion decreases by 20% per year for the last five years before a bond matures. Owing to their unique structure, such bonds are issued by financial institutions, especially banks, with aims of both financing and satisfying the requirements or standards for banks' capital structures. Further, these bonds have been widely adopted by banks since its issuance can be conducted directly by debtors—in this case, banks—and the issuance procedure is relatively simple.

3. Sample Data and Methodology

This study employs annually collected financial data from commercial (or general) banks in the banking sector of the Korean economy, which has a leading and emerging financial market.[2] This specific set of sample data is representative of the entire national banking industry because commercial banks comprise approximately 89% of the whole market in terms of the size of the total assets, according to the first-quarter financial announcement in 2019. The sample period extends from 2001 to 2018.

Our sample consists of macroeconomic indices, industry and market-specific factors, bank-specific financial ratios, and indices for individual bank performance (Athanasoglou, Brissimis, and Delis, 2008; Molyneux and Thornton, 1992). The macroeconomic variables include the price inflation rate (*Inflation*), which is measured as the growth rate of the consumer price index, and the economic growth rate (*GDP_G*), which is measured as the demeaned growth rate of the GDP index. The market-specific variables include the ownership structure (*OwnSt*), represented by a dummy variable that takes a value of one when the banks are privately owned and a value of zero when publicly listed, and the market concentration index (*MktConc*) measured as the Herfindahl-Hirschman index scaled by 1/1000. The financial ratio variables include banks' size (*Ln_Size*), measured as the logarithm of total assets; the capital adequacy ratio (*CapAdeq*), measured as suggested by the BIS capital adequacy standards; the operating costs to total assets (*OpCost*); the credit risk (*CR*), measured as the loan loss provision to total loans ratio; and productivity (*Ln_Prod*), measured as the revenue to the total number of employees ratio. The bank performance indices include profitability (*ROA*), measured as the return on assets (net profits to total assets), and insolvency risk (*Ln_Zscore*), measured as the logarithm of the distance-to-insolvency Z-score (Boyd and Graham, 1986; Hannan and Hanweck, 1988). We use the logarithm of the distance-to-insolvency Z-score variable owing to the structurally high skewness of its distribution. We confirm that the logarithm measures have the same implications as the standard Z-score following previous studies (Laeven and Levine, 2009; Lepetit and Strobel, 2015). In this study, we construct the Z-score measure using the current equity-to-assets ratio, the current values of the return on assets, and the sample standard deviation of the return on assets (Beck and Laeven, 2006; Hesse and Cihak, 2007; Houston, Lin, Lin, and Ma, 2010). The *Ln_Zscore* variable is calculated as follows.

$$Ln\_Zscore_{i,t} = ln(\frac{Equity-to-Assets_{i,t}+ROA_{i,t}}{S.D.(ROA)_i}), \quad (1)$$

where $Equity\text{-}to\text{-}Assets_{i,t}$ denotes the total equity to total assets ratio for bank *i* at time *t*. $ROA_{i,t}$ denotes the return on assets value of bank *i* at time *t*, and $S.D.(ROA)_i$ denotes the sample standard deviation of *ROA* for bank *i*.

Table 1 shows the summary statistics for the variables used in this study.

Table 1

Summary Statistics

Panel A: Descriptive Statistics

Variables	Mean	S.D.	Q1	Med.	Q3	Skew.	Kurt.
SubBond, growth rate	-0.003	0.343	-0.107	0.000	0.121	0.430	5.231
Inflation	0.022	0.011	0.013	0.019	0.028	0.652	-0.415
GDP_G, demeaned	-0.001	0.013	-0.006	-0.005	0.003	0.806	0.968
MktConc	2.027	0.161	1.920	1.946	2.221	0.486	-1.289

2 The importance and characteristics of the Korean market are well documented in the recent studies including Chung, Cho, Ryu, and Ryu (2019), Kim, Ryu, and Yang (2019), Lee, Lee, and Ryu (2019), Lee and Ryu (2019a, 2019b), Park, Kutan, and Ryu (2019), Ryu, Kim, and Ryu (2019), Seo, Kim, and Ryu (2019), Seok, Cho, and Ryu (2019a, 2019b), and Yang, Kutan, and Ryu (2019).

Variables	Mean	S.D.	Q1	Med.	Q3	Skew.	Kurt.
Ln_Size	20.556	1.227	19.977	21.192	21.477	-1.483	1.612
CapAdeq	0.078	0.023	0.067	0.076	0.082	1.192	2.668
OpCost	0.104	0.103	0.055	0.072	0.098	3.465	13.790
CR	0.013	0.006	0.008	0.013	0.016	1.576	5.180
Ln_Prod	6.105	0.250	5.944	6.055	6.180	1.174	1.610
ROA (%)	0.482	0.380	0.363	0.523	0.659	-2.486	12.161
Ln_Zscore	3.026	0.532	2.736	2.945	3.322	0.133	0.753

Panel B: Correlation Matrix for Bank-Specific Variables

Indicators	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) *Ln_Size*	1.00						
(2) *CapAdeq*	-0.63***	1.00					
(3) *CR*	0.08	-0.45***	1.00				
(4) *Ln_Prod*	-0.02	-0.20*	0.18	1.00			
(5) *OpCost*	-0.12	-0.20*	0.26**	0.84***	1.00		
(6) *ROA*	0.02	0.14	-0.45***	0.22*	0.06	1.00	
(7) *Ln_Zscore*	-0.73***	0.70***	-0.33***	-0.01	0.07	0.31***	1.00

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

Panel A displays the descriptive statistics for all variables, and Panel B displays the correlation matrix for the bank-specific variables and performance indices. *SubBond* denotes the growth rate of subordinated bonds held by banks. The market-specific and macroeconomic data are collected from the KOSIS (Korean Statistical Information Service), and the data for financial ratios are publicly provided by the FSS (Financial Supervisory Service) and the KDIC (Korea Deposit Insurance Corporation). The distance-to-insolvency Z-score and subordinated bond data are hand-collected from the financial statements and audit reports of individual banks. In Panel A, the columns Mean and S.D. denote the mean and standard deviation of each variable, respectively. Q1, Med. and Q3 indicate the first quartile, median, and third quartile values, respectively. The column Skew. denotes the skewness, and Kurt. denotes the kurtosis.

In Panel B, *CapAdeq* is negatively correlated with bank size, which is logical considering that the denominator portion of the capital adequacy ratio is positively affected by total assets values. *CR* is negatively correlated with *CapAdeq*, indicating that banks with lower capital adequacy ratios have greater credit risk values. *OpCost* is positively correlated with *Ln_Prod*, indicating that a bank's per employee productivity is higher when its operating cost is higher. The relationship is natural considering that, given the level of employment, the operating cost is likely to be higher when the production is greater. *ROA* is significantly and negatively correlated with *CR*, implying that banks with higher credit risk are less profitable. *Ln_Zscore* is the distance-to-insolvency measure; it is negatively correlated with *Ln_Size* and *CR*, indicating that banks with greater total assets and credit risk have higher insolvency risk; and it is positively correlated with *CapAdeq* and *ROA*, indicating that banks with greater capital adequacy ratios and the return on assets values exhibit lower insolvency risk.

One of the most common approaches to investigating the predictive determinants of a response variable is the logit model approach. In regards to bank performance prediction, there are some previous studies predicting banks' default probabilities using logistic regression methods. Specifically, Ohlson (1980) divides banks into two subgroups: bankrupt and nonbankrupt subgroups and investigates the financial ratios that significantly affect banks' probability of bankruptcy. Similarly, Charitou, Neophytou, and Charalambous (2004) predict bank bankruptcies using a logit model with such variables as cash flows and financial leverage; and Fu, Lin, and Molyneux (2014) find that market concentration and macroeconomic variables, such as GDP, significantly affect and predict the probability of bankruptcy. Following this approach, we employ a logit model with bank performance indices and business cycle dummy variables to predict and investigate the factors that affect banks' probabilities of issuing subordinated bonds. The specific logit model for estimation is as follows.

$$logit(\tilde{\pi}_t) = ln(\frac{\tilde{\pi}_t}{1-\tilde{\pi}_t}) = \alpha + \beta_1 ROA_{t-1} + \beta_2 Ln\_Zscore_{t-1} + \beta_3 D\_GDP_{t-1}, \quad (2)$$

where $\tilde{\pi}_t = P(D\_SubBond_t = 1 | ROA_{t-1}, Ln\_Zscore_{t-1}, D\_GDP_{t-1})$.

In equation (2), $D\_SubBond_t$ is a binary variable that takes a value of one when the subordinated bond growth rate is positive and a value of zero when it is negative. A positive value of subordinated bond growth rate indicates that banks are choosing to raise the overall amount of subordinated bonds issued. $ROA_{t-1}$and Ln_Zscore_{t-1}indicate the return on assets and logarithm of the distance-to-insolvency z-score in period *t*-1, respectively. $D_GDP_{t-1}$is a dummy variable that takes a value of one when the value of demeaned GDP growth rate is positive at time *t*-1 (i.e., during an economic expansion) and a value of zero otherwise (i.e., during an economic recession). $\tilde{\pi}_t$ is the conditional probability of banks making an issuance decision at time t ($D\_SubBond_t$=1) given the information about the values of ROA_{t-1}, Ln_Zscore_{t-1}, and D_GDP_{t-1}.

To further examine the dynamic and predictive relationship between subordinated bond issuances and other predictive variables, we employ panel data regression models that consider individual panel effects between commercial banks. Owing to the length of time (*T*) of our sample data structure relative to the number of panels (*N*), we assume that this setting is relatively free from the endogeneity problem and that the bias from the dynamic structure is negligible (Hsiao, 2014; Nickell, 1981). The estimation model for the panel data regression is given as follows.

$$\begin{aligned} SubBond_{i,t} = \alpha &+ \left(\beta_0 SubBond_{i,t-1}\right) + \beta_1 Inflation_{i,t-1} + \beta_2 GDP\_G_{i,t-1} + \beta_3 OwnSt_{i,t-1} \\ &+ \beta_4 MktConc_{i,t-1} + \beta_5 Ln\_Size_{i,t-1} + \beta_6 CapAdeq_{i,t-1} + \beta_7 OpCost_{i,t-1} \\ &+ \beta_8 CR_{i,t-1} + \beta_9 Ln\_Prod_{i,t-1} + \beta_{10} ROA_{i,t-1} + \beta_{11} Ln\_Zscore_{i,t-1} + e_{i,t}, \quad (3) \end{aligned}$$

where $e_{i,t} = \varepsilon_{i,t} + ind_i$.

In Equation (3), α is a constant, and ind_i is individual panel effects for bank *i*, which we consider either fixed or random in our analysis. As mentioned, we assume that the endogeneity issue is negligible owing to the data structure; nevertheless, we still analyze models both with and without a lagged dependent variable term. Then, to examine the robustness and consistency of the results, we analyze the predictive variables for subordinated bond issuances considering both individual panel effects and time effects. The estimation model is shown in Equation (4).

$$\begin{aligned} SubBond_{i,t} = \alpha &+ \beta_1 Inflation_{i,t-1} + \beta_2 GDP_{G_{i,t-1}} + \beta_3 OwnSt_{i,t-1} + \beta_4 MktConc_{i,t-1} \\ &+ \beta_5 Ln_{Si}ze_{i,t-1} + \beta_6 CapAdeq_{i,t-1} + \beta_7 OpCost_{i,t-1} + \beta_8 CR_{i,t-1} \\ &+ \beta_9 Ln\_Prod_{i,t-1} + \beta_{10} ROA_{i,t-1} + \beta_{11} Ln\_Zscore_{i,t-1} + u_{i,t}, \quad (4) \end{aligned}$$

where $u_{i,t} = \varepsilon_{i,t} + ind_i + time_t$.

In Equation (4), ind_i denotes individual random panel effects, and $time_t$ denotes time effects. The lagged dependent variable term is excluded since the model by itself controls for time effects.

4. Empirical Results

Table 2 shows the results of the analysis using the logit model approach. Panel A displays the results of the group statistics analysis, which roughly illustrates the relationship between the response variable (i.e., subordinated bond issuances, represented by *D_SubBond*) and the explanatory variables (i.e., *ROA*, *Ln_Zscore*, and *D_GDP*). The columns Reductions and Issuances denote the statistic results when the *D_SubBond* dummy variable equals zero and one, respectively. Mean Diff. indicates the difference of means, and T-stat. for Diff. indicates the *t*-statistics. We identify the means of each key variable when the subordinated bond growth rate is positive and when it is not, and we verify whether the distributions are significantly different in terms of mean values. The mean of *Ln_Zscore* when the subordinated bond is issued is 2.7782, which is significantly different from the mean when the subordinated bond growth rate is not positive. The significantly negative difference in the mean of *Ln_Zscore* (-0.3975) indicates that the insolvency risk is greater when the size of subordinated bonds held by banks increases (i.e., when the growth rate of the subordinated bond is positive). *GDP_G*, in contrast, has a significantly positive mean difference of 0.0121. Thus, the GDP growth rate is higher when the size of subordinated bonds increases.

Table 2

Logit Model Approach

Panel A: Group Statistics

	Reductions *D_SubBond*=0		Issuances *D_SubBond* =1		Mean Diff.	T-stat. for Diff.
	Mean	S.D.	Mean	S.D.		
ROA	0.0047	0.0036	0.0049	0.0053	0.0002	-0.87
Ln_Zscore	3.1757	0.5297	2.7782	0.4472	-0.3975***	-3.37
GDP_G	-0.0048	0.0110	0.0073	0.0133	0.0121***	3.65

Panel B: Logistic Regression Results

	Coef.	Std. Error	Wald χ^2 Stat.	Odds Ratio
Intercept	5.242***	1.941	7.30	
ROA_{t-1}	25.750	83.498	0.10	
Ln_Zscore_{t-1}	-2.021***	0.683	8.76	0.133
D_GDP_{t-1}	1.213*	0.641	3.58	3.363
R^2	0.209			
LR Test	16.67***			
Score Test	14.58***			
Wald Test	11.45***			

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

Panel B presents the logistic regression results. D_GDP_{t-1} is a dummy variable that takes a value of one in case of an economic expansion at time *t*-1 and zero in case of an economic recession. The rows labeled LR Test, Score Test, and Wald Test give test results for the global null hypothesis that all of the estimated coefficients are zero, and the figures shown in these rows are chi-square (χ^2) statistics. The test results all confirm that at least one estimate is significantly different from zero and that the model is significantly different from the null model at the 1% level. As indicated by the results in Panel A, we discover that *Ln_Zscore* and *D_GDP* in the previous period (t-1) significantly affect the probability of subordinated bond issuances in the current period (t) (or, the increase the amount of issued subordinated bond holdings). The estimated coefficient of Ln_Zscore_{t-1} is negative and significant at the 1% level, indicating that banks with greater insolvency risk are more likely to issue subordinated bonds in the future. More specifically, in terms of the odds ratio (0.133), banks with greater insolvency risk bu one unit are 7.519 times more likely to increase subordinated bonds in the next period. This result supports the previous convention that financially distressed banks are more likely to issue subordinated bonds, which are simple means of financing. The estimated coefficient of D_GDP_{t-1} is positive and marginally significant, indicating that banks tend to issue subordinated bonds when they experience an economic expansion in the previous year (t-1). In terms of the odds ratio (3.363), banks are 3.363 times more likely to increase their subordinated bonds when they experienced an economic expansion in the previous year. In terms of odds ratio (3.363), banks are 3.363 times more likely to increase their subordinated bonds when they experienced an economic expansion in the previous year, compared to when they experienced a recession. This result is consistent with those in Panel A.

Table 3 presents the results of the panel data analysis. Models M1 and M2 consider fixed effects across individual banks, models M3 and M4 consider random effects, and model M5 is the two-way random effects model which considers both bank and time effects. The figures in parentheses are the t-statistics for each estimated coefficient. Models M1 and M3 include a lagged term for the dependent variable ($SubBond_{t-1}$) assuming that the endogeneity issue is negligible owing to the structure of the sample dataset; models M2 and M4 present the estimation results for the models without a lagged term. The row labeled F-test denotes the test results for fixed effects across banks, and the row Hausman denotes the Hausman test results for random effects. The LR test is the log-likelihood test for the model fitness. The rows Bank Effects and Time Effects address whether the model considers panel and time effects, respectively, and Yes indicates that it considers the given effects.

Table 3

Panel Data Regression

	Fixed Effects (M1)	Fixed Effects (M2)	Random Effects (M3)	Random Effects (M4)	Two-way Random Effects (M5)
Intercept	5.599 (1.43)	5.442 (1.34)	5.434 (1.60)	1.833 (0.65)	-1.256 (-0.37)
$SubBond_{t-1}$	-0.304** (-2.25)		-0.261* (-1.99)		
$Inflation_{t-1}$	5.530 (1.04)	2.563 (0.48)	6.568 (1.28)	4.037 (0.79)	1.407 (0.12)
GDP_G_{t-1}	6.298** (2.15)	7.249** (2.41)	6.917** (2.44)	7.345** (2.47)	13.292** (2.17)
$OwnSt_{t-1}$	0.246 (1.54)	0.236 (1.43)	0.167 (1.15)	0.032 (0.26)	-0.039 (-0.35)

	Fixed Effects (M1)	Fixed Effects (M2)	Random Effects (M3)	Random Effects (M4)	Two-way Random Effects (M5)
$MktConc_{t-1}$	-0.271 (-0.67)	-0.225 (-0.54)	-0.155 (-0.40)	0.047 (0.12)	-0.507 (-0.59)
Ln_Size_{t-1}	-0.001 (-0.01)	-0.040 (-0.30)	-0.029 (-0.28)	0.008 (0.11)	0.140^{*} (1.86)
$CapAdeq_{t-1}$	13.555^{**} (2.06)	11.158 (1.66)	6.768^{*} (1.76)	5.454^{*} (1.72)	11.574^{***} (3.22)
$OpCost_{t-1}$	1.669^{**} (2.08)	1.589^{*} (1.91)	1.733^{**} (2.35)	1.233^{*} (1.72)	1.978^{**} (2.59)
CR_{t-1}	-10.681 (-0.83)	-8.907 (-0.67)	-7.391 (-0.60)	0.969 (0.08)	-9.329 (-0.73)
Ln_Prod_{t-1}	-0.516 (-1.39)	-0.426 (-1.11)	-0.526 (-1.58)	-0.253 (-0.84)	-0.105 (-0.34)
ROA_{t-1}	25.556 (1.21)	26.285 (1.20)	6.558 (0.41)	5.860 (0.39)	-14.587 (-0.90)
Ln_Zscore_{t-1}	-1.403^{***} (-2.75)	-1.171^{**} (-2.26)	-0.757^{***} (-2.72)	-0.428^{**} (-2.39)	-0.297^{*} (-1.86)
F-test	2.57^{**}	1.82			
Hausman			3.32	7.65	8.52
LR Test	26.26^{***}	19.77^{**}	26.08^{***}	16.89^{*}	29.76^{***}
Bank Effects	Yes	Yes	Yes	Yes	Yes
Time Effects	No	No	No	No	Yes
R^2	0.467	0.416	0.340	0.290	0.305

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

For the fixed and random effects models with a lagged dependent term (M1 and M3), we find that *GDP_G_{t-1}*, *$CapAdeq_{t-1}$*, *$OpCost_{t-1}$* and *Ln_Zscore_{t-1}* variables significantly predict banks' subordinated bond issuances. Consistent with the logistic regression results in Table 2, the coefficient of *GDP_G_{t-1}* is positive and significant for both models (6.298 for M1; 6.917 for M3), indicating that a higher economic growth rate in the previous period (*t*-1) leads to a greater increase in subordinated bonds issued by banks in the current year (*t*). The coefficient of *Ln_Zscore_{t-1}* is negative and significant (-1.403 for M1; -0.757 for M3), indicating that a lower (higher) Z-score (insolvency risk) at time *t*-1 leads to greater subordinated bond growth at time *t*. In other words, banks with higher insolvency risk tend to increase their subordinated bond holdings the following year. This result is in an agreement with the previous studies suggesting that banks with poor financial statuses are more likely to issue subordinated bonds for the purpose of capital financing or meeting capital requirements. The financial ratios *$CapAdeq_{t-1}$* and *$OpCost_{t-1}$* are found to positively affect the subordinated bond growth rate. The positive coefficients of *$CapAdeq_{t-1}$* (13.555 for M1; 6.76 for M3) and *$OpCost_{t-1}$* (1.669 for M1; 1.733 for M3) indicate that banks with higher capital adequacy ratios or higher operating costs tend to increase their subordinated bond holdings in the next period.

To verify the validity of the dynamic structure of the models and eliminate concerns about the endogeneity problem, we analyze models M2 and M4, which are panel data regressions without a lagged dependent term, considering fixed and random effects, respectively. We observe that analysis results remain the same when the lagged dependent variable term is excluded with the exception of $CapAdeq_{t-1}$ in M2. The consistency of the results suggests that the bias arising from the endogeneity issue is negligible and that the approach used in this study is valid (Hsiao, 2014).

Finally, model M5 is the estimation result of the two-way random effects panel data regression. When we consider both individual bank effects and time effects, we find that the coefficient of GDP_G_{t-1} is still positive (13.292) and significant, indicating that we can expect subordinated bond holdings to increase in the next period if an economic expansion occurs in the current period. The Ln_Zscore_{t-1} estimate (-0.297) is marginally significant and still negatively predicts the growth rate of subordinated bonds, supporting the hypothesis that financially distressed banks are likely to issue subordinated bonds. The coefficients of $CapAdeq_{t-1}$ and $OpCost_{t-1}$ (11.574 and 1.978, respectively) are both positive, which is consistent with previous results. Ln_Size_{t-1}, is found to have a positive and marginally significant effect (0.140) after controlling for time effects, implying that banks with greater total assets are more likely to issue subordinated bonds. The general results of model M5 are consistent with the results of M1 and M3, indicating the robustness of the analyses.

5. Concluding Remarks

This study identifies and investigates the determinants that predict banks' subordinated bond issuances. Using annual time-series data of macroeconomic indices, market factors, bank-specific financial ratios, and bank performance indices, we conduct logistic and panel data regressions assuming both fixed and random effects across banks. The logit model approach finds that insolvency risk—represented by Ln_Zscore_{t-1}—and the business cycle—represented by D_GDP_{t-1}, a dummy variable for economic expansions and recessions—significantly affect the probability of bond issuance of banks in the next period. The panel data model approach consistently shows that the business cycle and insolvency risk increase the size of banks' subordinated bond holdings, supporting previous findings that banks issue subordinated bonds to raise capital when they are financially distressed. Further, we find that bank-specific financial ratios, the capital adequacy ratio and operating costs predict subordinated bond issuances as well. The results are robust to controlling for bank and time effects.

This study makes an academic contribution in that it analyzes the predictive factors for banks' subordinated bond issuance decisions before the bonds are issued. Most studies focus on the ex-post roles of subordinated bonds after they are issued by banks, and the motivation or rationale for the banks' decisions to issue these specific bonds are rarely considered. This is the first study to examine the ex-ante dynamics of subordinated bond issuances. It also makes practical contributions regarding the prediction methods in that it provides useful information to investors, creditors, and supervisory government authorities for future investment or regulatory decisions. The intertemporal relationship between variables and subordinated bond issuances provides insights into the prediction of banks' decisions regarding the management of these bonds. Our results suggest that banks' management of subordinated bonds in the next period can be predicted using information about the economic growth rate, insolvency risk, and the financial ratios of individual banks in the previous period.

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