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The determinants of interest margins and their effect on bank diversification: Evidence from Asian banks

Jane-Raung Lin[a], Huimin Chung[a], Ming-Hsiang Hsieh[a,*], Soushan Wu[b]

[a] Graduate Institute of Finance, National Chiao Tung University, 1001 Ta-Hsueh Road, Hsinchu 30050, Taiwan
[b] National Taiwan Normal University and at the Securities and Futures Institute, Taiwan

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ABSTRACT

An endogenous switching regression model is employed for this study, categorizing the banks into regimes of high and low degrees of diversification, with our results indicating that net interest margins can be less sensitive to fluctuations in bank risk factors for functionally diversified banks as compared to more specialized banks. In turn, this implies that by diversifying their income sources, these banks can reduce the shocks to net interest margins arising from idiosyncratic risk. Our results show that prior findings can hold when the banks are located in a regime with a low degree of diversification.

1. Introduction

The issue of net interest margins on the overall business activities of banks has already been addressed in the considerable body of banking research literature. The net interest margins that are set by banks, essentially to cover the cost of intermediation, reflect both the volume and mix of assets and liabilities; Angbazo (1997) specifically suggests that the net interest margins of banks should actually represent a summary measure of their net interest rate of return.[1] In addition, with an increase in exposure to risk, adequate net interest margins should produce sufficient earnings to enhance the capital base. Since net interest margins are clearly of significant importance to the banking industry, the issues pertaining to how they are optimally determined and how they adjust to changes in the banking environment merit closer scrutiny.

In our attempt to model bank net interest margins within the current study, we consider the 'dealer' model—an approach that views banks as risk-averse dealers in the loan and deposit markets under the condition where loan requests and deposit funds are both found to occur non-synchronously at random time arrivals. This approach was initially developed by Ho and Saunders (1981), and has been extended within a number of subsequent studies,[2] as well as applied under several different settings.[3]

Important regulatory steps have been taken to expand the functional scope of banking institutions[4], both in the US (the Gramm–Leach–Bliley Act, 1999) and in the European Union (the Second Banking Directive, 1989). Furthermore, as a result of the 1997 Asian financial crisis, the structures of the various financial systems in many Asian countries changed from controlled systems to more liberalized forms (Gochoco-Bautista et al., 2000). However, even though diversification activity has become an important trend in banking management, the existing literature on the determination of bank net interest margins does not adequately account for the effects of such diversification. Therefore, the primary aim of the present study is to explore how diversification of business by

* Corresponding author. Tel.: +886 3 5712121x57075; fax: +886 3 5733260.
E-mail addresses: jrlin@faculty.nctu.edu.tw (J.-R. Lin), felixhsieh@mail.tbb.com.tw (M.-H. Hsieh).

[1] Net interest margins (commonly referred to as bank interest margins) are usually defined as the difference between interest revenue and interest expenses, expressed as a percentage of average earning assets (Angbazo, 1997).

[2] Examples include McShane and Sharpe (1985), Allen (1988), Angbazo (1997), Saunders and Schumacher (2000) and Drakos (2003).

[3] See Maudos and Fernandez de Guevara (2004), Carbo and Rodriguez (2007) and Maudos and Solís (2009).

[4] Financial stabilization and deregulation have had important implications on the income statements of banks: there has been a shift from net interest income to non-interest income not dependent on traditional financial intermediation (Albertazzi and Gambacorta, 2009).

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banks affects the determinants of net interest margins for a sample of commercial banks that operate within Asia.

The banking systems throughout Asia was previously characterized by the existence of large, dominant corporate and family-owned corporations with their own financial subsidiaries; this served to create internal markets within these firms, thereby enabling them to circumvent many legal restrictions, most notably on offshore financing. The governments of the various countries also played important roles, both in terms of bank ownership and through subsidizing banks, particularly for lending directed towards national growth strategies (Williams and Nguyen, 2005). Within the context of financial deregulation, many of the banking systems in Asian countries have recognized the need for major changes most often associated with increased competition, reorganization and concentration. The various banks have responded to this new environment by adopting a proactive strategy within which the range of products offered to their clients has been extended considerably. A potential benefit for the financial conglomerates is their cross-selling ability, whereby multiple financial products are sold to similar customers (Baele et al., 2007).

In practice, bank revenues from lending activities tend to be cyclical—they are largely dependent on both the needs and strengths of loan customers and the stage of the economic cycle. Given that fee-based services and financial advice constitute a more stable revenue stream, banks may place greater emphasis on these types of revenue lines in an attempt to smooth out their financial performance; as such, they are also likely to pursue functional diversification through activities such as commercial banking, investment banking, insurance and other financial services potentially capable of generating revenue in a variety of different ways, including interest, transaction fees and commissions. Further, we consider the diversification activities of banks that occur either as a result of shifts between interest income and non-interest income activities, or diversification across these two types of income generating activities. While banks are able to diversify into non-interest income services and products that are directly linked to an existing interest income generating activity, they can also diversify within either interest income activities or non-interest income activities (Mercieca et al., 2007). We therefore expect to find that such functional diversification enables the banks to realize comparative advantages by increasing their income sources, and that these banks may reduce the shocks to net interest margins arising from idiosyncratic risk.

Using a two-regime endogenous switching regression model, this study extends Angbazo's (1997) model by including bank diversification to explore how diversification of business by banks affects the determinants of net interest margins.[5] We assume that a bank may operate in one of two regimes, with either a low or a high degree of diversification. The probability of operating within each regime is determined by the Hu and Schiantarelli (1998) switching model associated with the following features. First, we can directly test the effects of different factors on the likelihood of a bank being faced with a high degree of diversification by estimating the switching function. Second, as the switching function is defined as a function of the financial variables of the bank, as well as other characteristics that proxy for the severity of bank diversification information, the determination of whether the bank is located in a regime with a high degree of diversification is undertaken endogenously in each period; the model can thereby effectively capture the dynamic effects of bank-specific variables on bank diversification.

The results of the present study demonstrate that the signs on the coefficient of risk factors as predicted by Angbazo (1997) can hold only when the banks are located in a regime with a low degree of diversification, although these conclusions cannot be confirmed when the banks are located in a regime with a high degree of diversification. In addition, prior studies provide somewhat inconclusive results regarding the effects of bank revenue diversification on risk; for example, Baele et al. (2007) find that most banks can reduce their idiosyncratic risk by engaging in revenue diversification, while Lepetit et al. (2007) demonstrate that higher reliance on non-interest generating activities is also associated with higher risk.[6] In this study, we find that for functionally diversified banks, the margins can be less sensitive to fluctuations in bank risk factors than those of specialized banks. This implies that by diversifying their income sources and placing more emphasis on these revenue lines to smooth their financial performance, these banks can reduce the shocks to net interest margins arising from idiosyncratic risk. Since these prior studies focused on European banks, the present study fills an important gap within the literature on the effects of revenue diversification on Asian banks by providing some indirect support for Baele et al. (2007).

The remainder of this paper is organized as follows. A review of the prior literature is presented in Section 2, followed in Section 3 by a description of the dataset and an explanation of the methodology adopted for this study. Our empirical results are presented in Section 4. Finally, the conclusions drawn from this study are presented in Section 5.

2. Literature review

The first study undertaking an analysis of the determinants of interest margins was provided by Ho and Saunders (1981), who approached the issue from the perspective of banking firms acting as mere intermediaries between lenders and borrowers; they reported that interest margins are comprised of two basic components: the degree of competition within the associated markets and the interest rate risk to which the banks were exposed. Allen (1988) extended the single product model of Ho and Saunders (1981) to include heterogeneous loans and deposits, and posited that product diversification may result in a reduction in pure interest spreads.

McShane and Sharpe (1985) re-conceptualized the source of interest rate risk, regarding it as the uncertainty existing within money markets, as opposed to the interest rates on credits and

[5] Hu and Schiantarelli (1998) indicate that firms are partitioned into groups on the basis of a single indicator that may or may not be a good proxy for the imperfect substitutability of functional diversification. The use of a single indicator is thought to prevent researchers from controlling for the multiplicity of factors that have some influence on the functional diversification of a bank. In addition, the issue of whether a bank belongs to the specialized or functionally diversified group is determined exogenously, and is fixed over the entire sample period, despite the fact that a bank may move from one regime to another. This problem can be overcome when bank-specific control variables interact with possible time-varying bank characteristics that switch the bank between low and high degrees of diversification. However, if a single characteristic is used in these interactions, it may be inadequate to capture the severity of bank diversification information; if more than one characteristic is used, the number of parameters to be estimated increases rapidly and may lead to imprecise inferences. Thus, this study attempts to deal with both static and dynamic misclassification problems by employing an endogenous switching regression model (with unknown sample separation) to investigate the impacts of functional diversification on the net interest margins of banks.

[6] Using stock market data to analyze the long-term performance and riskiness of banks for different degrees of functional diversification, Baele et al. (2007) showed that for some banks, diversification can actually reduce idiosyncratic risk, thereby making them safer. On the other hand, from their investigation into the relationship between bank risk and product diversification within the changing structure of the European banking industry, Lepetit et al. (2007) concluded that banks expanding into non-interest income activities will invariably find themselves exposed to higher risk and a greater risk of insolvency than those banks that are mainly engaged in the supply of loans.

deposits. Based on the development of an empirical model that incorporated credit risk into the existing model, Angbazo (1997) noted that the net interest margins of commercial banks reflect both the default and interest-rate risk premiums, and also that banks of different sizes are sensitive to different types of risk.

Hasan and Sarkar's (2002) separate examinations of the effects of interest rate changes on existing loans (loans-in-place) and potential loans (loans-in-process) led to the finding that 'low-slack' banks are indeed exposed to significantly greater interest rate risk than 'high-slack' banks. Maudos and Fernandez de Guevara (2004) subsequently went on to include average operating costs as a determinant of the intermediation margin, using the Lerner index of market power as a direct measure of the degree of competition. Carbo and Rodriguez (2007) further extended the model by incorporating the importance of non-traditional activities, proposing a multi-output model with the overall aim of determining the nature of the relationship between bank margins and specialization. Chen (2007) demonstrated the effect of banking deregulation on credit risk, and revealed that competition intensified following the completion of the Second Banking Directive, while loan quality improved in most markets. The evidence showed that the loan quality improvement is associated with lower interest margin.

Maudos and Solís (2009) recently modeled net interest margins with the simultaneous inclusion of operating costs, diversification and specialization as the determinants of the margins; their results indicated that high margins are largely explained by average operating costs and market power. Furthermore, based on their exploration of the sources of risk as important determinants of the corporate structure of different banks when expanding into new markets, Dell'Ariccia and Marquez (2010) found that corporate structure has direct effects on risk taking and affiliate size.

Other studies have found that diversification has a significantly positive impact on the volatility of earnings. DeYoung and Roland (2001), for example, concluded that fee-based activities, which represent a growing share of banking activities, raise the overall level of volatility in bank revenue. A similar result was obtained by Stiroh (2004), who demonstrated a growing correlation between net interest income and non-interest income. When employing a portfolio framework to assess the impact of increased non-interest income on equity market measures of return and risk within US financial holding companies, Stiroh (2006) could find no link between non-interest income exposure and average returns across banks, although a significantly positive link between non-interest income and the volatility of market returns was discernible.

Lepetit et al. (2008) subsequently investigated the ways in which the expansion by banks into fee-based services affected their interest margins and loan pricing, and found that: (i) greater reliance on fee-based activities was associated with lower lending rates; and (ii) borrower default risk was underpriced in the lending rates charged by those banks with greater proportions of fee income. Hence, their findings suggest that banks may tend to use loans as a loss leader, which in turn raises the issue of how cross-selling strategies should be addressed by regulators in order to control for bank risk.

Berger et al. (2010) concluded that all dimensions (loans, deposits, assets, and geography) of diversification were associated with higher costs and reduced profits. These results were robust regardless of alternative measures of diversification and performance. Moreover, they observed that banks with foreign ownership and those with conglomerate affiliation were associated with fewer diseconomies of diversification, suggesting that foreign ownership and conglomerate affiliation may play important mitigating roles.

Despite the fact that extensive research on net interest margins within US commercial banks, and to a lesser extent European financial institutions, has already been undertaken, relatively little research has been carried out to determine bank net interest margins within financial institutions in Asia. By analyzing a sample of banks in Asian countries, the present study makes a two-fold contribution that complements the extant literature. First, we handle both static and dynamic misclassification problems by employing the Hu and Schiantarelli (1998) model, with unknown sample separation, to investigate the ways in which functional diversification affects bank net interest margins. Second, we show that by diversifying into new activities and placing greater emphasis on these revenue lines to smooth their financial performance, banks can reduce their idiosyncratic risk.

3. Data and methodology

This study employed data on commercial banks in nine Asian countries (China, India, Indonesia, Japan, the Philippines, Singapore, South Korea, Taiwan and Thailand) covering the years 1997–2005. As our sample covers the nine-year period following regional deregulation, it should enable us to detect long-term effects of diversification on both bank performance and risk. The time frame of our study sample also ensures that multiple business cycles were represented.

The annual balance sheet and income statements of the commercial banks obtained from Bankscope Fitch IBCA were used to construct the variables for empirical analysis in the present study. In order to enhance cross-country comparability, we excluded banks with missing data on basic accounting variables, such as assets, loans, deposits, equity, interest income and non-interest income. We also excluded all outliers by eliminating extreme bank observations for each considered variable. In addition, most of the estimates were based on a balanced sample of those banks for which the data were continuously available throughout the entire sample period. The main reason for using a balanced sample was to allow us to check whether our results were robust in terms of modeling the firm-specific effects as a function of pre-sample average values of the firm-specific explanatory variables in the net interest margin and switching function—the meaningfulness of this method increases if we take averages over a common period. Our final panel dataset was comprised of 262 banks, providing a total of 2358 bank-year observations. Table 1 reports the median values of the bank variables by country, while Table 2 depicts the Pearson correlation coefficients[7] of all of the variables used in this study.

We extended the model of Angbazo (1997) utilizing a switching model of net interest margins in an attempt to determine the importance of bank diversification; the model was based on the Hu and Schiantarelli (1998) endogenous switching regression model. Depending on the switching function, the net interest margin equation can be in either of two regimes, both of which are unobserved by the researcher, and characterized by different values of the coefficients of the bank-specific control variables.

The estimation of the switching function allows us to assess the statistical and economic significance of the characteristics of the different banks in determining the probability of being in one of two regimes: a 'high degree of diversification' (*hd*) or a 'low degree of diversification' (*ld*). The basic specification of the switching model of net interest margins is defined as follows, with the

[7] Regressions were checked for multicollinearity using the variance inflation factor (VIF). The maximum VIF of any of our explanatory variables was 3.63, indicating that multicollinearity was not a serious problem in our models.

Table 1
Summary descriptive statistics, by country.

Variables	Countries									Mean	Median	S.D.
	China	India	Indonesia	Japan	S. Korea	Philippines	Singapore	Taiwan	Thailand			
Nim	2.63	2.56	6.36	1.91	2.67	4.32	2.27	2.41	2.90	2.64	2.26	3.66
Mgmt	93.83	86.04	89.30	95.37	89.09	83.20	89.32	90.74	87.86	91.59	93.54	7.18
Lev	9.35	5.81	12.99	4.46	4.66	15.13	11.80	7.13	7.16	6.47	5.12	5.77
Opp	5.04	6.05	3.04	1.49	6.36	5.06	3.94	3.05	2.97	3.27	2.27	3.08
Imp	1.31	0.87	3.80	1.88	2.80	3.06	0.97	2.06	3.69	1.96	1.79	4.16
Liq	28.73	37.96	26.80	15.26	10.84	33.18	37.27	13.46	13.05	21.46	16.09	15.77
Int	−61.10	−50.95	−49.78	−77.16	−70.26	−51.34	−48.84	−75.45	−70.65	−67.34	−74.36	17.21
Cdt	0.15	1.55	4.10	0.98	2.09	2.45	0.90	1.34	2.38	1.47	0.84	15.07
Ni	10.33	38.49	23.31	16.86	34.08	39.68	24.98	17.93	32.04	23.11	17.78	21.48
Lta	52.75	44.55	47.06	68.20	58.84	48.36	54.76	68.33	68.85	59.98	63.29	14.96
Rd	21.01	65.53	39.72	29.59	53.93	63.15	49.96	36.07	55.90	40.37	34.72	24.62
Ad	80.65	83.94	64.21	62.50	79.86	75.05	87.71	63.13	55.87	69.05	69.63	18.32

The median values of the bank-specific control variables and the functional diversification measures; the control variables include net interest margin (*Nim*), management efficiency (*Mgmt*), capital base (*Lev*), opportunity cost of reserves (*Opp*), implicit interest payments (*Imp*), liquidity risk (*Liq*), interest rate risk (*Int*), and credit risk (*Cdt*); the functional diversification measures include the ratio of non-interest income to total operating income (*Ni*), the loans-to-assets ratio (*Lta*), revenue diversity (*Rd*) and asset diversity (*Ad*). The diversity measures are defined in this study as follows: $Diversity = 1 - |2x - 1|$, where x is either the loans-to-assets ratio or the ratio of non-interest income to total operating income. The diversity variables, which take values of between 1 and 0, increase with the degree of diversification (Baele et al., 2007; Laeven and Levine, 2007). All figures refer to percentages.

net interest margin equation for bank i, operating in a low degree of diversification regime, at time t, being:

$$Nim_{i,t} = X_{it}\beta^{ld} + \varepsilon_{1,it} \quad (1)$$

$$\text{if} \quad Z_{it}\gamma + u_{it} < 0 \quad (2)$$

Conversely, the net interest margin equation for bank i, operating in a high degree of diversification regime at time t, is defined as:

$$Nim_{i,t} = X_{it}\beta^{hd} + \varepsilon_{2,it} \quad (3)$$

$$\text{if} \quad Z_{it}\gamma + u_{it} \geq 0 \quad (4)$$

where $X_{it} = (1, Mgmt_{it}, Lev_{it}, Opp_{it}, Imp_{it}, Liq_{it}, Int_{it}, Cdt_{it}, Int_{it} \times Cdt_{it}, CD, YD)$; $Z_{it} = (1, Ni_{it}, Lta_{it}, Rd_{it}, Ad_{it}, CD, YD)$; and $Nim_{i,t}$ is the ratio of net interest income (before provisions for loan losses) to average earnings assets.

In the net interest margin function, $X_{it} = (1, Mgmt_{it}, Lev_{it}, Opp_{it}, Imp_{it}, Liq_{it}, Int_{it}, Cdt_{it}, Int_{it} \times Cdt_{it}, CD, YD)$, where $Mgmt_{it}$ is management efficiency; Lev_{it} is the capital base; Opp_{it} refers to the opportunity cost of reserves; Imp_{it} denotes the implicit interest payments; Liq_{it} refers to the liquidity risk; Int_{it} is the interest rate risk; and Cdt_{it} refers to the credit risk. The empirical model variables, their proxies and the predicted coefficient signs, which are all based on the same assumptions made in Angbazo (1997), are summarized in Table 3. The Z_{it} vector in each of the specifications of the switching function represents a set of diversification variables, comprised of the ratio of non-interest income to total operating income (Ni_{it}), the loans-to-assets ratio (Lta_{it}), revenue diversity (Rd_{it}) and asset diversity (Ad_{it}). In addition, country dummies (CD), and year dummies (YD) are included to capture unobserved time and country heterogeneity.

We followed Baele et al. (2007) to adopt a pragmatic definition of the degree of functional diversification for our empirical analysis, relying on one asset-based measure and one broad measure of relative diversification, both of which are publicly available and widely used by analysts and investors to assess the long-term potential and risk of banks.[8] Any bank with a lower loans-to-assets ratio or a higher proportion of non-interest revenue was regarded as being more oriented towards non-traditional banking activities. An alternative approach is to follow Baele et al. (2007) and Laeven and Levine (2007) to construct measures of asset and revenue diversity; asset diversity is based on the stock variables, while revenue diversity is based on the flow variables, with these diversity measures defined as follows: $Diversity = 1 - |2x - 1|$, where x is either the loans-to-assets ratio or the ratio of non-interest income to total operating income. The diversity variables, which take values between 1 and 0, increase with the degree of diversification.[9]

Existing theoretical arguments suggest that a bank is more likely to operate in a regime with a high degree of diversification when asset diversity, revenue diversity and the ratio of non-interest income to total operating income are high, and when the loans-to-assets ratio is low. In our formulation, this implies that the coefficients on the ratio of non-interest income to total operating income, revenue diversity and asset diversity should be positive, while the coefficient on the loans-to-assets ratio should be negative. Furthermore, in the more general specification, we allowed the switching function to be dependent on the cost-to-income ratio, as well as the natural logarithm of bank size.[10] We expected to find a greater likelihood of a bank operating in the high degree of diversification regime when the cost-to-income ratio is low and when the natural logarithm of bank size is high.

Following Hu and Schiantarelli (1998), we assumed that in the bank net interest margin and switching functions, the vector of the error terms $(\varepsilon_{1,it}, \varepsilon_{2,it}, u_{it})'$ is jointly normally indepen-

[8] The asset-based measure is the loans-to-assets ratio, which captures the proportion of loans relative to total assets. The revenue measure is the ratio of non-interest income to total operating income, where the higher the ratio, the more a bank focuses on non-traditional bank activities (see Baele et al., 2007).

[9] Asset and revenue diversity are similar in spirit to the Hirschmann–Herfindahl index of concentration of asset activities or revenue streams. The use of the latter measure of activity concentration is found in several studies, such as Stiroh and Rumble (2006), Baele et al. (2007) and Laeven and Levine (2007).

[10] The cost-to-income ratio (ratio of operating expenses as a proportion of the sum of net interest and non-interest revenue) measures the operational efficiency of each bank, with efficient banks being expected to have a higher franchise value (Baele et al., 2007). Bank size is highly correlated with the measures of functional diversification; indeed, Mercieca et al. (2007) showed that small banks do not gain by diversifying outside their traditional lines of business, thereby suggesting that it may be difficult for such institutions to achieve a strong foothold in non-interest activities. Moreover, Lepetit et al. (2008) found that small banks (with total assets of less than €1 billion) significantly increase their risk exposure when engaging in commission and fee activities.

Table 2
Correlation matrix.

	Nim	*Mgmt*	*Lev*	*Opp*	*Imp*	*Liq*	*Int*	*Cdt*	*Ni*	*Lta*	*Rd*
Mgmt	0.3321 (<0.0001)										
Lev	0.1743 (<0.0001)	−0.1718 (<0.0001)									
Opp	0.0325 (0.1150)	−0.3592 (<0.0001)	0.1113 (<0.0001)								
Imp	0.7616 (<0.0001)	0.3914 (<0.0001)	−0.1467 (<0.0001)	−0.0722 (0.0004)							
Liq	0.1783 (<0.0001)	−0.1708 (<0.0001)	0.3456 (<0.0001)	0.3692 (<0.0001)	−0.0013 (0.9486)						
Int	0.2153 (<0.0001)	−0.2634 (<0.0001)	0.4797 (<0.0001)	0.5305 (<0.0001)	−0.0213 (0.3004)	0.8344 (<0.0001)					
Cdt	0.0467 (0.0233)	−0.0440 (0.0328)	−0.0023 (0.9097)	0.0090 (0.6615)	0.1125 (<0.0001)	−0.0254 (0.2181)	0.0243 (0.2387)				
Ni	0.4694 (<0.0001)	−0.5587 (<0.0001)	0.1098 (<0.0001)	0.3072 (<0.0001)	−0.4823 (<0.0001)	0.1714 (<0.0001)	0.3223 (<0.0001)	0.0412 (0.0452)			
Lta	−0.0267 (0.1958)	0.4917 (<0.0001)	−0.2830 (<0.0001)	−0.4308 (<0.0001)	0.1817 (<0.0001)	−0.6651 (<0.0001)	−0.6770 (<0.0001)	−0.0184 (0.3710)	−0.4255 (<0.0001)		
Rd	0.1151 (<0.0001)	−0.2156 (<0.0001)	0.0593 (0.0040)	0.3553 (<0.0001)	0.0471 (0.0221)	0.3023 (<0.0001)	0.3900 (<0.0001)	0.0361 (0.0799)	0.5340 (<0.0001)	−0.3630 (<0.0001)	
Ad	0.1409 (<0.0001)	−0.0556 (0.0070)	−0.0102 (0.6195)	0.2911 (<0.0001)	0.0858 (<0.0001)	0.2705 (<0.0001)	0.3012 (<0.0001)	0.0039 (0.8511)	0.1493 (<0.0001)	−0.3780 (<0.0001)	0.3980 (<0.0001)

The Pearson correlation coefficients between all of the variables used in this study, with *p*-values shown in parentheses.

dently distributed with mean zero and covariance matrix Σ,

$$\text{where } (\varepsilon_{1,it}, \varepsilon_{2,it}, u_{it})' \sim N(0, \Sigma), \quad \Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{1u} \\ \sigma_{21} & \sigma_2^2 & \sigma_{2u} \\ \sigma_{u1} & \sigma_{u2} & \sigma_u^2 \end{bmatrix}.$$

The non-zero covariance between $\varepsilon_{1,it}$, $\varepsilon_{2,it}$ and u_{it} allows the shocks to net interest margins to be correlated with the shocks to the financial characteristics and other characteristics of the banks; thus, the model used in the present study is an endogenous switching regression model (Maddala, 1986).

Although we cannot directly observe the regime within which the bank is located, we can specify and calculate the probability of the occurrence of each regime as follows:

$$\begin{aligned} \text{Prob}(Nim_{i,t} = Nim_{i,t}^{ld}) &= \text{Prob}(Z_{it}\gamma + u_{it} < 0) \\ &= \text{Prob}(u_{it} < -Z_{it}\gamma) \\ &= \Phi(-Z_{it}\gamma) \end{aligned}$$

$$\begin{aligned} \text{Prob}(Nim_{i,t} = Nim_{i,t}^{hd}) &= \text{Prob}(Z_{it}\gamma + u_{it} \geq 0) \\ &= \text{Prob}(u_{it} \geq -Z_{it}\gamma) \\ &= 1 - \Phi(-Z_{it}\gamma) \end{aligned}$$

The likelihood density function for each observation f_{it} is a weighted conditional density function of $\varepsilon_{1,it}$ and $\varepsilon_{2,it}$, with weights of $\text{Prob}(u_{it} < -Z_{it}\gamma)$ and $\text{Prob}(u_{it} \geq -Z_{it}\gamma)$,

$$\begin{aligned} f(Nim_{i,t}) &= \phi(\varepsilon_{1,it} \,|\, Z_{it}\gamma + u_{it} < 0)\Phi(-Z_{it}\gamma) \\ &\quad + \phi(\varepsilon_{2,it} \,|\, Z_{it}\gamma + u_{it} \geq 0)[1 - \Phi(-Z_{it}\gamma)] \\ &= \phi(\varepsilon_{1,it}, \sigma_1)\Phi\left[\frac{-Z_{it}\gamma - (\sigma_{1u}/\sigma_1^2)\varepsilon_{1,it}}{\sqrt{1 - (\sigma_{1u}^2/\sigma_1^2)}}\right] \\ &\quad + \phi(\varepsilon_{2,it}, \sigma_2)\left\{1 - \Phi\left[\frac{-Z_{it}\gamma - (\sigma_{1u}/\sigma_2^2)\varepsilon_{2,it}}{\sqrt{1 - (\sigma_{2u}^2/\sigma_2^2)}}\right]\right\} \end{aligned} \tag{5}$$

where $\phi(\cdot)$ is the normal density function and $\Phi(\cdot)$ is the cumulative distribution function; thus, $\phi(\varepsilon_{Jit}|\cdot)$ and $J = 1, 2$ denote the conditional density, and $\phi(\varepsilon_{Jit}, \sigma_J)$ denotes the marginal density.

The second equality sign uses the fact that the joint density is equal to the product of the conditional density multiplied by the marginal density and the properties of the bivariate normal. As in the probit model, we can only estimate γ/σ_u in Eqs. (1)–(4), as opposed to the separate estimations of γ and σ_u, with σ_u being normalized as equal to 1. Furthermore, σ_{12} is inestimable, since it does not appear in Eq. (5). For a panel of N firms, with T_i observations for firm i, the log-likelihood function for all the observations is given by $F = \sum_{i=1}^{N}\sum_{t=1}^{T_i} \log(f_{it})$. The β^{hd}, β^{ld} and γ parameters can be estimated by maximizing the log-likelihood function.

4. Empirical results

4.1. Cross-sectional model regression results

The empirical determinants of bank interest margins can be found in Model (9) of Table 4. Management efficiency (*Mgmt*) and Capital base (*Lev*, a proxy for solvency risk) are positively related to bank margins. The positive relationship between the capital base and net interest margins is consistent with the increased average cost of capital, since equity capital is increased by substituting equity for debt.[11] The coefficient on the opportunity cost of reserves

[11] This in turn leads to a requirement for higher net interest margins (as noted by Berger, 1995).

Table 3
Empirical model variables and descriptions.

Variables	Description	Predicted sign	Rationale
Panel A: bank-specific control variables			
Mgmt	Management efficiency: Earning assets/total assets	+	This ratio is included to estimate the component of the interest margins attributable to management efficiency. Since management decisions affect the composition of assets that earn (high) interest, these changes will be reflected in higher net interest margins
Lev	Capital base: Book value equity/total assets	+	Since equity is a more costly funding source, an increase in equity capital may increase the average cost of capital; banks will therefore require a higher net interest margin in order to compensate for the higher cost of capital
Opp	Opportunity cost of reserves: Non-interest bearing reserves/total assets	+	The opportunity cost of reserves is the average return on earning assets foregone by holding deposits in cash, which increases the cost of funds beyond the observed rate. Banks will raise their net interest margins in order to compensate for this
Imp	Implicit interest payments: (non-interest expenditure – non-interest revenue)/earning assets	+	Implicit interest payments reflect extra payments to depositors through service charge remission arising from competition in the market for deposits. These extra interest payments should be reflected in higher interest margins
Liq	Liquidity risk: Liquid assets/total liabilities	–	With an increase in the proportion of funds invested in cash or cash equivalents, there is a decline in liquidity risk, leading to a lower liquidity premium in the net interest margin
Int	Interest rate risk: Net short term assets/book value equity	–	The maturity-mismatch hypothesis suggests that interest rate risk exposure has a negative correlation with the average maturity of assets (Flannery and James, 1984); thus, the higher the level of short-term assets, the lower the sensitivity to near-term interest rate changes, which should result in a lower interest rate risk premium
Cdt	Credit risk: Loan loss provisions/total loans	+	Banks with more risky loans will require a higher net interest margin to compensate for the greater risk of default
Panel B: functional diversification measures			
Ni	Ratio of non-interest income to total operating income: Non-interest income/total operating income	+	This measure effectively captures all of the sources of the non-interest income generated by diversified banks. The higher the ratio, the greater the focus on non-traditional banking activities
Lta	Loans-to-assets ratio: Total loans/total assets	–	The loans-to-assets ratio captures the proportion of loans relative to total assets, with a very high value indicating that the bank specializes in loan making
Rd	Revenue diversity: $Diversity = 1 - \|2x - 1\|$, where x is the ratio of non-interest income to total operating income	+	The revenue diversity variables, which take values between 0 and 1, increase with the degree of diversification
Ad	Asset diversity: $Diversity = 1 - \|2x - 1\|$, where x is the loans-to-assets ratio	+	The asset diversity variables, which take values between 0 and 1, increase with the degree of diversification

The empirical model variables and descriptions for bank interest margins, along with their predicted coefficient signs and the economic rationale following Angbazo (1997), Baele et al. (2007) and Laeven and Levine (2007).

(*Opp*) is found to be positive and significant at the 5% level, which leads to a requirement for higher net interest margins to compensate the banks for the interest foregone on earnings assets. The coefficient on the implicit interest payments (*Imp*) reveals that the increasing reliance on implicit interest leads to a corresponding increase in the net interest margins of the banks. Firms with a greater proportion of funds in liquid assets (*Liq*) have lower margins to reflect their reduced liquidity risk premiums. Further, the coefficient on the credit risk (*Cdt*) is positive, indicating that banks with more risky loans will tend to select higher net interest margins.

However, when the interest rate risk (*Int*) is also included with the bank-specific control variables, the coefficient is found to be both positive and significant. This finding differs markedly from the negative sign reported in Angbazo (1997), where it was suggested that any increase in the net short-term assets—which implies lower interest rate risk exposure—will lead to a requirement for lower interest rate risk premiums. Given that we use a similar measure of interest rate risk in the present study, the most probable explanation for the difference is the net short-term assets. This may be due to the fact that Asia's financial institutions often excessively rely on short-term funding, particularly when interest costs and margins are low (Arner and Park, 2010); therefore, the average net short-term assets may be less than zero, which may explain the finding that banks with lower interest-rate risk exposure have a requirement for lower interest rate risk premiums. The interaction term is found to be positive and significant in the full sample regression; with the exception of (*Int*), all of these findings are broadly consistent with those of Angbazo (1997).

4.2. Endogenous switching model regression results

The results for the basic model are reported in Panel A of Table 5, where we find that the sensitivity of net interest margins to bank risk factors varies with the degree of bank diversification. The coefficients on capital base, opportunity cost of reserves, implicit interest payments, liquidity risk, interest rate risk (*Int*), credit risk (*Cdt*) and the interaction between the two ($Int \times Cdt$) are all found to be significant and higher in the low diversification regime, as compared to the high diversification regime. This indicates that banks in the high diversification regime seem to be less sensitive to these bank-specific variables; it also implies that by diversifying into new activities and place greater emphasis on these revenue lines as a means of smoothing out their financial performance, banks can reduce the shock of idiosyncratic risk on net interest margins, which is consistent with our hypothesis.

Since banks are allowed to diversify functionally, many Asian banks have integrated mutual fund distribution or insurance activities into their retail networks. These actions may have increased the acceptance of one-stop shopping by customers, and may also have helped banks to extract reputational rents from such activi-

Table 4
Cross-sectional regression estimates.

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)	Model (9)
Constant	−0.1288 (−14.14)***	0.0192 (17.23)***	0.0251 (22.84)***	0.0132 (24.56)***	0.0175 (13.96)***	0.0572 (19.23)***	0.0262 (34.62)***	0.0263 (34.79)***	−0.0375 (−4.49)***
$Mgmt_{it}$	0.1694 (17.09)***								0.0642 (9.20)***
Lev_{it}		0.1106 (8.59)***							0.1533 (17.44)***
Opp_{it}			0.0386 (1.58)						0.0420 (2.40)**
Imp_{it}				0.6699 (57.03)***					0.6626 (57.70)***
Liq_{it}					0.0414 (8.79)***				−0.0007 (−0.14)
Int_{it}						0.0458 (10.70)***			0.0281 (4.90)***
Cdt_{it}							0.0114 (2.27)**		0.0225 (1.51)
$(Int^{*}Cdt)_{it}$								−0.0065 (−0.99)	0.0418 (2.16)**
R^2	0.11	0.03	0.11	0.58	0.03	0.05	0.01	0.01	0.69
F-stat.	291.97	73.82	2.49	3252.97	77.32	114.48	0.02	0.32	648.01

The ordinary least squares estimates of the net interest margin regressions on management efficiency (*Mgmt*), capital base (*Lev*), opportunity cost of reserves (*Opp*), implicit interest payments (*Imp*), liquidity risk (*Liq*), interest rate risk (*Int*), credit risk (*Cdt*) and the interaction between the latter two ($Int \times Cdt$) based on the following model:

$Nim_{i,t} = X_{it}\beta + \varepsilon_{it} \quad Xit = (1, Mgmt_{it}, Lev_{it}, Opp_{it}, Imp_{it}, Liq_{it}, Int_{it}, Cdt_{it}, Int_{it} \times Cdt_{it})$.

The dependent variable is bank net interest margins (*Nim*), which is the ratio of net interest income (before provisions for loan losses) to average earning assets; figures in parentheses are *t*-ratios, and the total number of observations is 2358.

** Statistical significance at the 5% level.

*** Statistical significance at the 1% level.

ties, thereby enabling them to realize comparative advantages by diversifying their income sources and widening their range of products. Banks also glean information from their lending relationships that may facilitate the efficient provision of other financial services. Moreover, information acquired via other financial services can also improve loan origination and credit risk management. As such, if integration were to lead to operational synergies, then relative to specialized banks, the operating costs of financial conglomerates would be lower (as a result of economies of scope).

Within a regime characterized by a low degree of diversification, the coefficients on capital base, opportunity cost of reserves, implicit interest payments and credit risk are all significantly positive, while the coefficient on interest rate risk is significantly negative. These results are broadly consistent with those reported in Angbazo (1997); nevertheless, they cannot be confirmed for a high degree of diversification regime, essentially because such bank-specific control variables as management efficiency, opportunity cost of reserves, liquidity risk and credit do not yield significant coefficients for the net interest margin. We therefore suggest that the signs on the coefficient of risk factors as predicted by Angbazo (1997) can hold only when the banks are located in a low degree of diversification regime.

In the present study, the coefficients on the ratio of non-interest income to total operating income, revenue diversity and asset diversity are all found to be significant and positive, indicating that with an increase in these ratios, a bank is more likely to be faced with a high degree of diversification. The negative coefficient on the loans-to-assets ratio indicates that the higher this ratio, the greater the likelihood of the bank being faced with a low degree of diversification. These findings are consistent with those of Baele et al. (2007) and Laeven and Levine (2007).[12]

We now attempt to explain whether the data are better characterized by a model that allows for two regimes as opposed to a single regime. Following Hu and Schiantarelli (1998) and Goldfeld and Quandt (1976), we find that the likelihood ratio test result is 7.70, with significance at the 5% level, leading to a decisive rejection of the single regime hypothesis.[13] Hence, in accordance with the theoretical model presented by Angbazo (1997), we employ the endogenous switching regression model, dividing the bank sample into regimes of high and low degrees of diversification.

We also carry out a regression estimation of the basic model on an unbalanced sample of banks with at least six successive years of observations over the period from 1997 to 2005, the results of which are reported in Panel B of Table 5. As depicted in the table, the coefficients on management efficiency, capital base, implicit interest payments, liquidity risk and interest rate risk are all found to be significant and higher in the low degree of diversification regime than in the high degree of diversification regime. In addition, the signs of the coefficients on the diversification variables in the switching function are found to be the same as in the balanced sample, despite their coefficients having been determined less precisely.

12 Baele et al. (2007) and Laeven and Levine (2007) both concluded that a bank that is more oriented towards non-traditional banking activities has a lower loans-to-assets ratio or a higher non-interest revenue share. Furthermore, lower values of these diversity indices imply greater specialization, whereas higher values signify that the bank engages in a mixture of lending and non-lending activities.

13 Hu and Schiantarelli (1998) indicated that the testing is complicated by the fact that the parameters of the switching function are not identified under the restriction that the coefficients in the two degrees of diversification equations are equal. Goldfeld and Quandt (1976) showed that using a Chi-squared distribution for the likelihood ratio test with degrees of freedom equal to the number of constraints plus the number of unidentified parameters yields a test that favors non-rejection of the restrictions.

Table 5
Estimation results of the basic version of the balanced and unbalanced panel switching regression model, 1997–2005.

Variables	Net interest margin function				Switching function	
	Low degree of diversification		High degree of diversification		Coeff.	*t*-statistic
	Coeff.	*t*-statistic	Coeff.	*t*-statistic		
Panel A: balanced panel: $Z_{it}=(1, Ni_{it}, Lta_{it}, Rd_{it}, Ad_{it}, CD, YD)$						
Constant	−0.0514	−3.77***	0.0293	2.76***	−2.0937	−6.19***
$Mgmt_{it}$	0.0077	0.66	−0.0032	−0.34	–	–
Lev_{it}	0.2168	18.40***	0.0790	7.05***	–	–
Opp_{it}	0.1188	3.56***	0.0208	1.26	–	–
Imp_{it}	0.8233	51.99***	0.2000	9.11***	–	–
Liq_{it}	0.0302	3.42***	−0.0041	−0.73	–	–
Int_{it}	−0.0573	−5.85***	0.0003	0.06	–	–
Cdt_{it}	0.4456	10.34***	0.0171	1.39	–	–
$(Int \times Cdt)_{it}$	1.2158	15.17***	0.0196	1.24	–	–
Ni_{it}	–	–	–	–	1.4354	7.36***
Lta_{it}	–	–	–	–	−3.1398	−8.51***
Rd_{it}	–	–	–	–	6.2193	20.95***
Ad_{it}	–	–	–	–	1.4469	5.87***
Log likelihood: 5825.957						
Total no. of observations: 2358						
Panel B: unbalanced panel: $Z_{it}=(1, Ni_{it}, Lta_{it}, Rd_{it}, Ad_{it}, CD, YD)$						
Constant	−0.2577	−18.93***	−0.0063	−0.51	−12.4693	−14.20***
$Mgmt_{it}$	0.2417	21.83***	0.0336	3.04***	–	–
Lev_{it}	0.3123	26.73***	0.1227	9.90***	–	–
Opp_{it}	−0.0552	−1.76*	0.0294	1.92*	–	–
Imp_{it}	0.2718	20.18***	−0.0414	−1.03	–	–
Liq_{it}	0.0595	6.56***	0.0061	0.86	–	–
Int_{it}	−0.0632	−6.54***	0.0063	1.06	–	–
Cdt_{it}	0.0068	1.11	0.0928	6.59***	–	–
$(Int \times Cdt)_{it}$	0.0382	4.52***	0.0237	0.81	–	–
Ni_{it}	–	–	–	–	10.9601	16.66***
Lta_{it}	–	–	–	–	−1.5009	−3.15***
Rd_{it}	–	–	–	–	5.4965	16.52***
Ad_{it}	–	–	–	–	8.1062	12.60***
Log likelihood: 6113.2852						
Total no. of observations: 2760						
Panel C: balanced panel: $Z_{it}=(1, Ni_{it-1}, Lta_{it-1}, Rd_{it-1}, Ad_{it-1}, CD, YD)$						
Constant	−0.0851	−5.78***	−0.1007	−5.72***	−5.5897	−14.12***
Mgmtit	0.0888	8.49***	0.1429	10.10***	–	–
Lev_{it}	0.1802	15.00***	0.1606	7.25***	–	–
Opp_{it}	0.0478	1.75*	0.0235	0.76	–	–
Imp_{it}	0.6653	43.19***	0.5556	26.42***	–	–
Liq_{it}	0.0138	1.44	0.0075	0.66	–	–
Int_{it}	−0.0260	−2.33**	0.0274	2.33**	–	–
Cdt_{it}	0.0308	1.79*	−0.1050	−1.21	–	–
$(Int \times Cdt)_{it}$	0.0803	3.26***	−0.1316	−1.23	–	–
Ni_{it-1}	–	–	–	–	3.2194	16.06***
Lta_{it-1}	–	–	–	–	−0.8650	−1.88**
Rd_{it-1}	–	–	–	–	4.5946	16.60***
Ad_{it-1}	–	–	–	–	1.4345	4.64***
Log likelihood: 4849.42						
Total no. of observations: 2096						

The results of the basic version of the switching regression model on management efficiency (*Mgmt*), capital base (*Lev*), opportunity cost of reserves (*Opp*), implicit interest payments (*Implicit*), liquidity risk (*Liq*), interest rate risk (*Int*), credit risk (*Cdt*) and the interaction between the latter two ($Int \times Cdt$) in the net interest margin equation, as well as the diversification variables in the switching function, including the ratio of non-interest income to total operating income (*Ni*), the loans-to-assets ratio (*Lta*), revenue diversity (*Rd*) and asset diversity (*Ad*). Although not reported here, country dummy (*CD*) and year dummy (*YD*) variables are included in all specifications. The dependent variable is the bank net interest margin (*Nim*), which is the ratio of net interest income (before provisions for loan losses) to average earning assets. The model is defined as follows:

$$Nim_{i,t} = X_{it}\beta^{ld} + \varepsilon_{1,it} \quad \text{if} \quad Z_{it}\gamma + u_{it} < 0, \quad Nim_{i,t} = X_{it}\beta^{hd} + \varepsilon_{2,it} \quad \text{if} \quad Z_{it}\gamma + u_{it} \geq 0$$

$$X_{it} = (1, Mgmt_{it}, Lev_{it}, Opp_{it}, Imp_{it}, Liq_{it}, Int_{it}, Cdt_{it}, Int_{it} \times Cdt_{it}, CD, YD)$$

* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

The results reported above provide general support for the argument that functional diversification is important to bank interest margins; however, the model estimated thus far includes contemporaneous diversification variables as the regressor, which can give rise to the potential problem of endogeneity. In order to account for this possibility, we re-estimate the model with the contemporaneous diversification variables replaced by their lagged values. The estimates for the balanced sample are reported in Panel C of Table 5, where we find that the results confirm those obtained previously.

An additional potential problem with the estimation model under discussion here is that there is insufficient consideration of the firm-specific effects within the estimations. We assume that we can model the firm-specific time-invariant effects in the net interest margin and switching functions as a linear function of the

Table 6
Estimation results of the basic version of the switching regression model with firm-specific effects, 2001–2005.

Variables	Net interest margin function				Switching function	
	Low degree of diversification		High degree of diversification		Coeff.	*t*-statistic
	Coeff.	*t*-statistic	Coeff.	*t*-statistic		
Panel A: with firm-specific effects: $\xi_i^{ld} = \bar{X}_i\delta^{ld}$, $\xi_i^{hd} = \bar{X}_i\delta^{hd}$, $\eta_i = \bar{Z}_i\delta^{s}$						
Constant	0.0954	6.32***	−0.0159	−0.78	−5.7805	−9.25***
$Mgmt_{it}$	−0.0368	−2.81***	−0.0632	−4.44***	–	–
Lev_{it}	0.1188	7.20***	0.0443	2.53**	–	–
Opp_{it}	0.1014	3.35***	−0.0190	−0.72	–	–
Imp_{it}	0.9454	62.59***	0.2977	4.29***	–	–
Liq_{it}	0.0389	3.06***	0.0002	0.01	–	–
Int_{it}	−0.0390	−2.51**	0.0053	0.30	–	–
Cdt_{it}	0.0081	0.50	−0.1225	−1.16	–	–
$(Int \times Cdt)_{it}$	0.0159	0.76	−0.2131	−1.00	–	–
Ni_{it}	–	–	–	–	0.9784	1.91*
Lta_{it}	–	–	–	–	−1.3695	−1.77*
Rd_{it}	–	–	–	–	6.1913	13.28***
Ad_{it}	–	–	–	–	3.0258	5.92***
Log likelihood: 3747.284						
Total no. of observations: 1310						
Panel B: without firm-specific effects (ξ_i^{ld}, ξ_i^{hd} and η_i excluded)						
Constant	0.0722	4.97***	0.0386	2.43**	−5.4671	−9.44***
$Mgmt_{it}$	−0.0701	−7.82***	−0.0199	−1.59	–	–
Lev_{it}	0.1344	9.26***	0.0773	5.21***	–	–
Opp_{it}	0.0934	3.21***	0.0232	1.13	–	–
Imp_{it}	0.9267	64.75***	0.4478	6.82***	–	–
Liq_{it}	−0.0033	−0.31	−0.0102	−0.98	–	–
Int_{it}	0.0096	0.76	−0.0062	−0.53	–	–
Cdt_{it}	−0.0148	−0.99	−0.0478	−0.44	–	–
$(Int \times Cdt)_{it}$	−0.0139	−0.73	0.0356	0.17	–	–
Ni_{it}	–	–	–	–	1.8163	5.40***
Lta_{it}	–	–	–	–	−2.2635	−3.74***
Rd_{it}	–	–	–	–	5.7779	14.73***
Ad_{it}	–	–	–	–	2.7544	6.26***
Log likelihood: 3704.5416						
Total no. of observations: 1310						

The results of the basic version of the switching regression model with firm-specific effects. Following Hu and Schiantarelli (1998), we estimate the model over the 2001–2005 period while using the 1997–2000 period to calculate the averages for the firm-specific variables, $\bar{X}_i$ and $\bar{Z}_i$, which are the means of the firm-specific components, X_{it} and Z_{it}, and δ^{ld}, δ^{hd} and δ^{s}, which are the (column) vectors of the parameters. The model is defined as follows:

$$Nim_{i,t} = X_{it}\beta^{ld} + \xi_i^{ld} + \varepsilon_{1,it} \quad \text{if} \quad Z_{it}\gamma + u_{it} + \eta_i < 0, \qquad Nim_{i,t} = X_{it}\beta^{hd} + \xi_i^{hd} + \varepsilon_{2,it} \quad \text{if} \quad Z_{it}\gamma + u_{it} + \eta_i \geq 0$$

$$X_{it} = (1, Mgmt_{it}, Lev_{it}, Opp_{it}, Imp_{it}, Liq_{it}, Int_{it}, Cdt_{it}, Int_{it} \times Cdt_{it}, CD, YD)$$

$$Z_{it} = (1, Ni_{it}, Lta_{it}, Rd_{it}, Ad_{it}, CD, YD)$$

* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

average values of the firm-specific variables included within each of them. As such, we must minimize the potential for endogeneity arising from the correlation between the error terms in the net interest margin equations and the switching function, as well as in the proxies for the firm-specific effects. We therefore follow Hu and Schiantarelli (1998)[14] to estimate the model over the 2001–2005 period, while using the 1997–2000 period to compute the averages for the firm-specific variables.

The estimation results of the model with contemporaneous control variables and time-invariant firm-specific effects over the 2001–2005 period are presented in Panel A of Table 6, with the results showing that in the low degree of diversification regime, the coefficients on capital base, opportunity cost of reserves and implicit interest payments are all positive and significant; however, interest rate risk is found to have a significant and inverse relationship with net interest margins. These results are broadly consistent with the findings reported by Angbazo (1997) for the US banking market.

The same estimation period is used in Panel B of Table 6, although the firm-specific effects are set as equal to zero. Examining the control variables, we find that the coefficients on capital base, opportunity cost of reserves and implicit interest payments all remain significant and higher in the low degree of diversification regime, as compared to the high degree of diversification regime. However, the coefficients on liquidity risk, interest rate risk and credit risk are not significant. Consistent with the findings of Baele et al. (2007), our results also show that the coefficients on the ratio of non-interest income to total operating income, loans-to-assets ratio, revenue diversity and asset diversity are statistically and economically significant, which reveals that a bank with a greater likelihood of being in a high degree of diversification will have a lower loans-to-assets ratio or a higher proportion of non-interest revenue.

Further, we carry out a number of robustness checks, all of which are specification related. As we can see from Panel A of Table 7, when the cost-to-income ratio is added to the diversification variables, its coefficient has the predicted negative sign. An important result is the finding that banks with greater cost inefficiency, as

[14] Hu and Schiantarelli (1998) indicated that while this approach is unsatisfactory, because it imposes restrictions on the nature of the firm-specific effects and requires estimations the model on a reduced sample period, it does allows users to check on the robustness of the results reached thus far.

Table 7
Estimation results of a general version of the switching regression model, 1997–2005.

Variables	Net interest margin function				Switching function	
	Low degree of diversification		High degree of diversification		Coeff.	*t*-statistic
	Coeff.	*t*-statistic	Coeff.	*t*-statistic		
Panel A: Z_{it} = (1, $Lnsize_{it}$, Cir_{it}, Lev_{t-1}, Cdt_{t-1}, ROE_{t-1}, *CD*, *YD*)						
Constant	−0.0640	−4.40***	0.0357	3.16***	−2.9398	−5.12***
Mgmtit	0.0556	4.83***	−0.0197	−1.98**	–	–
Levit	0.2377	16.78***	0.0534	5.69***	–	–
Oppit	0.1138	2.80***	0.0246	1.76*	–	–
Impit	0.7438	44.24***	0.1680	6.79***	–	–
Liqit	0.0052	0.55	0.0083	1.30	–	–
Intit	−0.0110	−1.05	−0.0101	−1.48	–	–
Cdtit	0.1916	4.80***	0.0134	1.31	–	–
(*Int* × *Cdt*)*it*	0.5898	8.74***	0.0163	1.24	–	–
Lnsizeit	–	–	–	–	0.2866	8.99***
Cirit	–	–	–	–	−0.7225	−3.15***
Lev_{it-1}	–	–	–	–	2.7297	3.66***
Cdt_{it-1}	–	–	–	–	0.6405	1.84*
ROE_{it-1}	–	–	–	–	0.2196	2.50**
Log likelihood: 4862.969						
Total no. of observations: 2096						
Panel B: Z_{it} = (1, Ni_{it}, Lta_{it}, Rd_{it}, Ad_{it}, $Lnsize_{it}$, Cir_{it}, Lev_{t-1}, Cdt_{t-1}, ROE_{t-1}, *CD*, *YD*)						
Constant	−0.0969	−8.46***	0.1602	7.79***	−5.0561	−7.2***
$Mgmt_{it}$	0.0987	10.56***	−0.1452	−9.69***	–	–
Lev_{it}	0.1809	17.38***	0.0306	1.43	–	–
Opp_{it}	0.1703	3.82***	−0.0291	−0.89	–	–
Imp_{it}	0.7134	50.83***	0.1724	4.13***	–	–
Liq_{it}	0.0041	0.59	0.0061	0.42	–	–
Int_{it}	−0.0208	−2.81***	−0.0061	−0.37	–	–
Cdt_{it}	0.3066	10.97***	−0.0110	−0.56	–	–
$(Int \times Cdt)_{it}$	0.8787	16.64**	−0.0161	−0.64	–	–
Ni_{it}	–	–	–	–	43.1017	17.07***
Lta_{it}	–	–	–	–	−1.2787	−2.96***
Rd_{it}	–	–	–	–	0.4640	1.95*
Ad_{it}	–	–	–	–	1.1756	3.76***
$Lnsize_{it}$	–	–	–	–	0.1307	3.38***
Cir_{it}	–	–	–	–	−0.3562	−1.95*
Lev_{it-1}	–	–	–	–	2.0224	2.22**
Cdt_{it-1}	–	–	–	–	2.8910	3.80***
ROE_{it-1}	–	–	–	–	0.2193	2.24**
Log likelihood: 5118.609						
Total no. of observations: 2096						

The results of a more general version of the switching regression model within which the following variables are included in the net interest margin equation: management efficiency (*Mgmt*), capital base (*Lev*), opportunity cost of reserves (*Opp*), implicit interest payments (*Imp*), liquidity risk (*Liq*), interest rate risk (*Int*), credit risk (*Cdt*), and the interaction between the latter two (*Int* × *Cdt*). The following diversification variables are included in the switching function: non-interest income to total operating income ratio (*Ni*), loans-to-assets ratio (*Lta*), revenue diversity (*Rd*), asset diversity (*Ad*), the natural logarithm of bank size (*Lnsize*), cost-to-income ratio (*Cir*), capital base (*Lev*), credit risk (*Cdt*) and return on equity (*ROE*). The model is defined as follows:

$$Nim_{i,t} = X_{it}\beta^{ld} + \varepsilon_{1,it} \quad \text{if} \quad Z_{it}\gamma + u_{it} < 0, \quad Nim_{i,t} = X_{it}\beta^{hd} + e_{2,it} \quad \text{if} \quad Z_{it}\gamma + u_{it} \geq 0$$

$$X_{it} = (1, Mgmt_{it}, Lev_{it}, Opp_{it}, Imp_{it}, Liq_{it}, Int_{it}, Cdt_{it}, Int_{it} \times Cdt_{it}, CD, YD)$$

* Statistical significance at the 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

measured by the cost-to-income ratio, are less likely to be in the high degree of diversification regime. This implies that banks with superior management skills or better technologies are also perceived as having appropriate functional diversification.

The coefficient on the natural logarithm of bank size is found to be positive and significant, which indicates that as this ratio increases, the likelihood of the bank being faced with a high degree of diversification also increases.[15] When a bank applies to engage in some new form of business, the relevant authorities will consider the bank's financial situation as a critical reference for approval; hence, the capital base (*Lev*), credit risk (*Cdt*) and return on equity (*ROE*) are all included as additional regressors within the switching function. The coefficients on the capital base, credit risk and return on equity are found to be significant and positive, indicating that with an increase in any of these ratios, the bank is more likely to be faced with a high degree of diversification.

Panel B of Table 7 provides the results for the case where the ratio of non-interest income to total operating income, loans-to-assets ratio, revenue diversity, asset diversity, natural logarithm of bank size, cost-to-income ratio, capital base, credit risk and return on equity are all treated as diversification variables within the switching function.

The coefficients on the ratio of non-interest income to total operating income, revenue diversity, asset diversity, natural logarithm of bank size, capital base, credit risk and return on equity are all significantly positive, while the negative coefficients on the loans-to-assets ratio and cost-to-income ratio indicate that the

[15] This suggests that it may be difficult for small banks to achieve a strong foothold in non-interest activities, which may be due to the fact that traditional interest income activities are those lines of business where small banks have the most expertise, whereas small banks may have less experience in non-interest activities; see also Laeven and Levine (2007).

higher the ratio, the greater the likelihood of the bank being in a low degree of diversification regime. The coefficients on all of the diversification variables maintain the same sign under the more restricted specification.

5. Conclusions

In the present study, we extend the Angbazo (1997) model to include bank diversification as part of our investigation into how diversification of business by banks affects the determinants of net interest margins for a sample of commercial banks operating in Asia; we use a two-regime endogenous switching model to categorize banks into regimes of high and low degrees of diversification. We find that for functionally diversified banks, net interest margins can be less sensitive to fluctuations in bank risk factors than the net interest margins of specialized banks. This is consistent with our hypothesis, and implies that by diversifying their income sources and placing emphasis on these revenue lines to smooth their financial performance, the banks can reduce the impact of idiosyncratic risk on their net interest margins. We also show that the signs on the coefficient of risk factors as predicted by Angbazo (1997) can hold only when the banks are located in a low degree of diversification regime; however, the conclusions of Angbazo (1997) cannot be confirmed when the banks are located in a high degree of diversification regime.

In addition, we find that the coefficients on the ratio of non-interest income to total operating income, revenue diversity and asset diversity are significantly positive, indicating that with an increase in these ratios, the bank will be more likely to face a high degree of diversification. The negative coefficient on the loans-to-assets ratio indicates that the higher this ratio, the greater the likelihood that the bank will face a low degree of diversification. As such, we confirm the findings of both Baele et al. (2007) and Laeven and Levine (2007): banks that are oriented towards non-traditional banking activities have a lower loans-to-assets ratio or a higher proportion of non-interest revenue.

However, within the context of the current financial crisis on a global scale, too much reliance on non-interest types of revenue may raise the level of risk for these banks. It would therefore appear that the security of such banks will be largely dependent upon the ways in which they interact with economy-wide shocks, as well as the types of diversifying activities that they choose to undertake, although these issues are beyond the scope of the present study. Further research in this area should aim to investigate whether the observed shift towards non-interest income activities will continue to benefit these financial conglomerates once the current global financial crisis has subsided.

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