Factors Determining Net Interest Margins in Australia: Domestic and Foreign Banks

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This study tests the application of the Ho and Saunders (1981) model of bank net interest margins (NIMs), and its subsequent developments, using Australian data. The core elements of this model apply in Australia. Bank market power is found to increase NIMs, consistent with McShane and Sharpe (1985), with evidence of bank buying market share and mispricing for risk. Operating costs also have an important role in determining NIMs, together with implied payments and management quality. Bank NIMs are found to have fallen over the study period.

I. INTRODUCTION

The study of bank net interest margins is still a relatively under-researched area of banking. Given the importance of interest income as a component of bank revenue this is an important gap in the contemporary literature. In the Australian case interest income contributes over 80% of bank total income, thus understanding the factors that determine bank net interest income is of importance to those wishing to understand the banking system. This is particularly important when bank net interest income is considered to be the price of the intermediation services provided by banks. Banks are a key component of economic growth, with the flow of funds between lenders and borrowers being important to economic development. Thus, understanding the factors that determine net interest margins is important to all those concerned with the well-being of the financial system.

The seminal work provided by Ho and Saunders (1981) forms the basis for many of the contemporary studies of net interest margins, with this work being developed and extended by authors such as McShane and Sharpe (1985), Allen (1988), Angbazo (1997) and more recently Maudos and Guevara (2004). This paper will provide a test of these developments to determine which of these changes are most appropriate to the determination of net interest margins in Australia. Further, this paper provides a post-deregulation update to the single previous Australian study provided by McShane and Sharpe (1985), which considered Australian banking prior to its deregulation in the early 1980s, by considering 1989 to 2001. The differences between domestic and foreign bank net interest margins will also be considered.

This study finds that the core elements of the Ho and Saunders (1981) model remain relevant to the Australian banking market, with bank net interest margins

being a positive function of bank managerial risk aversion (as measured by capital ratios) and interest rate risk. The extension provided by McShane and Sharpe (1985) is also confirmed, with bank market power, as measured by dominant (Big Four) bank status, increasing net interest margins. Evidence was also found to support banks buying market share via reduced net interest margins and a consequent increase in credit risk, reflecting banks not fully pricing for credit risk during the study period, similar to a recent Italian study of Guiso*, et al*. (2006). These results are different to those proposed by Angbazo (1997), suggesting that this modification was not entirely appropriate in the Australian context. In a critique by Lerner (1981), it was suggested that operating costs should be an explicit component of any model of net interest margins and this was implemented by Maudos and Guevara (2004). This study finds that bank operating costs are an important component of any net interest margin model, together with the cost of implied payments and management quality. It is also found that net interest margins have experienced a significant downward trend over the study period. Foreign banks were found to have significantly lower net interest margins than domestic banks.

The rest of this paper is structured as follows. The next section will develop the model that will be tested in this paper while also providing an integrated review of the relevant literature. The third section will detail the empirical variables that will be used to test the model. The fourth section will outline the sample details and methodology, while the fifth section discusses the results of the empirical tests. The final section provides a conclusion and proposes possible directions for further research.

II. MODEL DEVELOPMENT

The Ho and Saunders (1981) model of bank net interest margins provides a frequently used starting point for empirical studies of net interest margins. This model considers the bank to be a risk-averse dealer in the markets for homogenous deposits and homogenous loans. A key role of the bank is to provide immediacy of service to both depositors and borrowers. The major source of risk for this bank is interest rate risk (volatility). The bank operates in a single period in which it maximises end of period wealth by setting deposit and loan rates at the start of the period while facing asymmetry between the arrival timing of deposits and demand for loans. The prices of both deposits and loans are set to minimise the mismatch of the asymmetry between loan demand and deposit arrival. Any mismatches between deposits and loans are satisfied by the bank dealing in the money market. In the case of deposits exceeding loans the surplus funds are invested at the risk-free rate r, and the bank faces reinvestment risk at the time when the money market deposit matures. In the case of demand for loans exceeding deposits the shortfall is funded in the money market, at the risk-free rate r, and the bank faces refinancing risk when the short-term borrowing in the money market matures before the loan.

Thus the rates set by the bank are:

$$R_L = (r + b) \tag{1}$$

$$R_D = (r - a) \tag{2}$$

The banks resulting margin is:

$$R_L - R_B = (a + b) \tag{3}$$

where:

R_L = the rate set on loans.
R_D = the rate set on deposits.
r is the expected risk-free interest rate.
a is the fee charged by the bank to provide immediacy in the deposit market and bearing reinvestment risk.
b is the risk premium charged by the bank to bear refinancing risk.

The optimal spread s is shown by Ho and Saunders (1981) to be:

$$s = (a + b) = \alpha/\beta + 1/2R\sigma_I^2 Q \tag{4}$$

In the Ho and Saunders (1981) framework the term α/β represents the net interest margin required by a risk-neutral bank (this was termed the pure spread). R represents the bank's managerial risk aversion, σ^2 is the variance of the interest rate on deposits and loans, and Q is the bank average transaction size. In the original Ho and Saunders (1981) framework the size of the net interest margin is independent of the size of the credit inventory.

The Ho and Saunders (1981) model, however, has some restrictive assumptions. Lerner (1981) criticised the model on the basis that it did not include production costs. McShane and Sharpe (1985) argue that some elements of the Ho and Saunders model were not applicable to the Australian situation. The McShane and Sharpe (1985) modification found that under the alternative assumption of interest rate risk attaching to the short-term money market rate rather than the risk-free rate, the same result as equation (4) is derived, but the equation has the slightly different interpretation in that α/β represents the bank's degree of market power and thus bank market power increases bank net interest margins. Allen (1988) modified Ho and Saunders (1981) further, by assuming that bank products are no longer homogenous. Allen (1988) found that pure interest spreads may be reduced when cross-elasticities of demand for bank products are considered, which acts as a type of portfolio diversification effect. The original Ho and Saunders model abstracted from credit risk and this was modified by Angbazo (1997), who found that the presence of credit risk will increase bank interest margins, and further

that the interaction between credit risk and interest rate risk also determines bank interest margins.

The most recent development of the Ho and Saunders model has been provided by Maudos and Guevara (2004). This model explicitly includes the role of operating costs, as originally suggested by Lerner (1981), as well as incorporating the modifications developed by Allen (1988), McShane and Sharpe (1985) and Angbazo (1997). The Maudos and Guevara (2004) model continues to assume that the bank is a risk-averse dealer in the credit market, facing a single period decision to maximise end of period wealth. Bank loan demand and deposit arrival remain asymmetric in time and thus banks continue to face reinvestment and refinancing risk, which is represented by the variance of the money market interest rate. However, banks also face credit risk which interacts with interest rate risk. Further, Maudos and Guevara (2004) also assume that there are production costs associated with both deposits [C(D)] and loans [C(L)]. Under these assumptions it is shown that the optimal interest margin is:

$$s = a + b = \frac{1}{2}\left(\frac{\alpha_D}{\beta_D} + \frac{\alpha_L}{\beta_L}\right) + \frac{1}{2}\left(\frac{C\,(L)}{L} + \frac{C\,(D)}{D}\right) - \frac{1}{4}\frac{U''\left(\overline{W}\right)}{U'\left(\overline{W}\right)} \times \left[\left(L + 2L_0\right)\sigma_L^2 + (L + D)\sigma_M^2 + 2(M_0 - L)\sigma_{LM}\right] \tag{5}$$

Thus under this theoretical model the determinants of bank net interest margins are:

(i) The structure of the market for loans and deposits (as represented by the term $(\frac{\alpha_D}{\beta_D} + \frac{\alpha_L}{\beta_L})$).
(ii) Operating costs as measured by C(L) and C(D).
(iii) Managerial risk aversion as measured by $\frac{U''(\overline{W})}{U'(\overline{W})}$. If bank managers are risk averse then $\frac{U''(\overline{W})}{U'(\overline{W})} < 0$ and interest margins will increase accordingly.
(iv) Volatility of the market interest rate ($\sigma^2_{M;}$), representing reinvestment and refinancing risk.
(v) Risk of the loan book (credit risk, measured by σ^2_L).
(vi) The interaction between credit risk and market risk (σ_{LM}).
(vii) The average size of the bank's operations (L+D and $L + 2L_0$), with bank net interest margins an increasing function of average banking activity. Maudos and Guevara (2004) argued that increasing average size exposes the bank to greater proportional loss. This issue will be explored in more detail later in the paper.

Banks also operate within a framework that imposes additional costs upon its operations due to institutional and regulatory factors. These costs are expected to be reflected in the bank's net interest margins to reflect their overall goal of profit

maximisation. Such effects are not entirely captured in the theoretical models such as those developed by Ho and Saunders (1981) or Maudos and Guevara (2004).[1] Instead, these costs are usually accounted for by including these effects in the empirical application of the model of bank net interest margins, as failure to include these effects will result in a potentially misspecified regression. The costs of this type that are usually reflected in the empirical literature to date are:

(viii) Implied interest/implied payments; banks may pay implied interest to their depositors by, for example, offering transactions at below their marginal cost and offering a wide range of locations for banking service. Both Ho and Saunders (1981) and Saunders and Schumacher (2000) measured these implied payments as non-interest expense minus non-interest revenue divided by total assets.

(ix) The opportunity cost of reserves; costly regulations imposed upon banks include the requirement to hold funds on reserve at a return generally below the market rate of return, so imposing an opportunity cost upon the bank (Angbazo, 1997).

(x) Management quality is important in bank profitability, (Angbazo, 1997); efficient bank management results in the bank selecting profitable assets and low cost funding sources while managing bank risk. Thus, higher bank management quality would be expected to improve bank net interest margins.

(xi) Liquidity risk; within the context of models based upon Ho and Saunders (1981) banks face asymmetry between loan demand and deposit arrival. Banks can reduce their exposure to this risk by holding a proportion of their assets in highly liquid form. It would be expected that as this holding of liquid assets increases, so the liquidity risk premium in bank interest margins will decline (Angbazo, 1997).

III. EMPIRICAL VARIABLES

Market Power

The role of market power in setting bank interest margins has been demonstrated by both McShane and Sharpe (1995) and Maudos and Guevara (2004), both theoretically and empirically. This study will employ several alternative measures of bank market share to determine which aspect of competition has been most important to NIM determination over the study period.[2] The first definition will apply a narrow market definition and consider bank market share as a percent of total Australian bank assets. The second broader definition will consider bank market share as a

[1] See also Saunders and Schumacher (2000).

[2] The data available to this study did not allow a Lerner Index to be estimated as was done by Maudos and Guevara (2004).

percent of bank and non-bank financial institution[3] assets. A third definition of market share reflects the impact of growing competition from securitisation-based lending in Australia (Avkiran, 1999), and measures bank market share as a percent of bank, non-bank financial institution and securitisation vehicle assets. In each case the data was matched to the individual bank balance date. In the case of securitisation vehicles the available data was provided quarterly and where the bank balance date did not exactly match the available data, the quarter before was used. This did not affect many banks. It would be expected, as previously found by McShane and Sharpe (1985), that bank NIMs have a positive relationship with bank market share.

Operating Costs

Operating costs will be measured as non-interest expenses divided by total assets.

Managerial Risk Aversion

In this study managerial risk aversion will be measured using two measures, a simple capital ratio (shareholders funds/total assets) and the observed risk-weighted capital adequacy ratio calculated according to the Bank for International Settlements Accord. It would be expected that higher levels of capital result in higher NIMs.

Interest Rate volatility

The Ho and Saunders (1985) model has been used to determine the sensitivity of bank NIMs to changes in interest rates. Two approaches have been adopted. Studies such as Ho and Saunders (1981), Brock and Rojas-Suarez (2000) and Saunders and Schumacher (2000) have employed a two-stage methodology. In the first stage, the Ho and Saunders model has been estimated and the intercept used as an estimate of the time-period-specific pure spread, which eliminates the bank-specific factors, such as risk. This pure spread was then used as a dependent variable in a second-stage regression to determine the sensitivity of the pure spread to economy-wide variables such as inflation, interest rates and nationality. A large cross-section of observations and a long time series of data are needed for this approach in order to ensure precision of estimation in both stages. Alternatively, McShane and Sharpe (1985) included measures of short-term interest rate volatility within their estimation of the Ho and Saunders model, as did Angbazo (1997) and Maudos and Guevara (2004). Given that the degrees of freedom required to perform the two-stage approach are not available to this study, the single-stage approach will be employed.

It has generally been found that bank spreads are increased by interest rate volatility. Ho and Saunders (1981) found U.S. banks particularly sensitive to volatility of the 1-year bond rate. Saunders and Schumacher (2000) found banks to

[3] Non-bank financial institutions will encompass Building Societies, Credit Unions, Money Market Corporations and Finance Companies.

be equally sensitive to both short- and long-term interest rates. Brock and Rojas-Suarez (2000) found Latin American bank pure spreads to be increased by interest rate volatility. McShane and Sharpe (1985) used a short-term interest rate only and found that interest rate volatility increased bank NIMs in Australia pre-deregulation. Maudos and Guevara (2004) found European bank interest margins to be positively impacted upon by short-, medium- and long-term interest rate volatility.

This study will use the standard deviation of the daily 90-day bank bill rate for the 2 years prior to and including the balance date[4] to measure interest rate volatility. This measure is appropriate as the bank bill rate is a frequently used benchmark rate for bank loans and provides the basis for swap and Forward Rate Agreement pricing. As volatility of other interest rate maturities may also impact upon bank net interest margins, several alternative measures of exogenous interest rate risk will also be employed. First, the standard deviation of the daily 5-year Treasury bond rate for the 2 years prior to and including the balance date. Second, as banks borrow over the short term and lend for longer periods, a measure of yield curve effects is also pertinent. This is measured as the standard deviation of the 5-year Treasury bond rate less the 90-day bank bill rate calculated daily for the 2 years prior to and including the balance date. It would be expected that NIMs would show a positive relationship with the volatility measures employed.

Credit Risk

Credit risk will be measured using the balance of the general provision for doubtful debt account divided by loans, advances and other receivables before write-offs for bad debts and provisions. The alternative measure of default risk that will be used is the charge to profit and loss for bad debts and provisions for doubtful debts (net of recoveries) also divided by loans, advances and other receivables. These two measures replicate as closely as possible, given differences in data availability and the two credit risk measures employed by Angbazo (1997). Loans and advances are used as the denominator for these measures as it provides a direct measure of the size of the loan book. It is possible that two banks with similar levels of loan loss provisions have different levels of lending, and potentially different levels of loan quality. Specifying the loan quality measure in this manner controls for this possibility. It would be expected that increased levels of observed bank default risk would result in higher net interest margins.

Interaction between Interest Rate Risk and Credit Risk

Each of the two alternative measures of credit risk will be multiplied by the three alternative measures of interest rate risk to determine the extent of the interaction between these two risk measures.

[4] McShane and Sharpe (1985) used the authorised dealers deposit rate; however, the authorised dealer system is no longer used in Australia and the 90-day bank bill rate was employed as a consistently available alternative.

Size of bank operations

The Maudos and Guevara (2004) model indicates that the average size of banking activity impacts positively upon net interest margins. This result is derived under the assumption that the operating costs of a bank are a positive function of the average quantity of deposits and loans. This assumption is in response to the criticism of Lerner (1981) that the Ho and Saunders (1981) model failed to account for the production costs associated with intermediation. The Maudos and Guevara (2004) empirical model, lacking any superior data, operationalised this measure by assuming that these production costs are a function of bank size only, rather than average size of activity. This paper will modify this approach by considering the impact bank market choice has upon these average production costs. A bank may choose to focus upon the retail segment, with its associated distribution costs or a less costly (in terms of distribution cost) wholesale focus. Each of these strategies may yield identically sized loan portfolios but generate differences in cost structures. Given that there is some heterogeneity in the bank size and strategy in the study sample it is felt that controlling for these differences is appropriate. This retail intensiveness will be measured by the individual bank branch network. It would be expected that those banks with larger branch networks would have higher production costs per loan and that these costs would be reflected in the bank net interest margin. Two measures of this implied cost of retail activity will be used: (i) the number of branches to loans (Retail 1) and (ii) the number of branches to total assets (Retail 2). Again, it would be expected that both of these measures would have a positive relationship with NIMs.

In order to control for institutional and regulatory factors as discussed above, the following variables will also be included in the empirical model:

Implied Interest / implied payments

Banks may pay implied interest to depositors. These implied payments increase immediacy and attractiveness to depositors by, for example, offering transactions at below marginal cost and offering a wide range of locations for banking services. Both Ho and Saunders (1981) and Saunders and Schumacher (2000) measured implied payments as non-interest expense minus non-interest revenue divided by total assets, as will this study. It would be expected that banks making these implied payments would expect compensation by receiving a higher NIM. Thus a positive relationship between implied payments and NIMs would be expected.

The cost of bank reserves / implied taxes

Costly regulations imposed upon banks include requiring banks to hold funds on reserve with the central bank. These reserves typically earn a rate of return below the general market rate, and so impose an opportunity cost upon the bank. A profit-maximising bank would be expected to recoup this opportunity cost via increasing its net interest margin. Reserve requirements will be measured as the required

regulatory deposits with the Reserve Bank of Australia divided by AUD liabilities excluding shareholders' funds.[5] Given that these required deposits have evolved over the study period, it will be possible to determine the impact of this variation upon net interest margins. It would be expected that there would be a positive relationship between these regulatory costs (or implied taxes) and NIMs.

Management Quality

It would be expected that banks with higher quality management would be able to offer a profitable optimisation of the bank's portfolio while also minimising operating costs. This study will measure management quality as the cost-to-income ratio, thus measuring the operating costs borne to generate one dollar of gross income. It would be expected that this measure would have an inverse relationship with bank net interest margins.

Liquidity Risk

As bank holdings of liquid assets increase so too the liquidity risk premium in bank interest margins declines (Angbazo, 1997). Liquidity risk will be measured by two alternative measures: the first measure will be cash holdings divided by Australian dollar liabilities.[6] Alternatively, liquidity risk will be measured using the Reserve Bank of Australia definition of liquid assets divided by total AUD liabilities excluding shareholders funds.[7] This second definition is notes, coin, balances with the Reserve Bank (excluding required deposits[8]), Treasury notes, Commonwealth Government Securities and other Government Securities divided by total AUD liabilities excluding shareholder's funds.[9]

Control Variables

The four major banks dominate the Australian banking system. In 1988 these banks controlled 67.8% of bank assets, and in 1998 these banks controlled 67.5% of total bank assets.[10] In this context, these banks can be considered 'too big to

[5] From 1981 the required deposits (Statutory Reserve Deposits [SRD]) with the Reserve Bank of Australia were 7% of deposits; in 1988 this system was replaced by the non-callable deposit [NCD] requirement of 1%, with surplus deposits being returned over time. In July 1999 the NCD requirement was removed.

[6] Cash as defined in the Reserve Bank of Australia *Bulletin*: coin, Australian notes and cash with the Reserve Bank.

[7] This denominator is used to ensure consistency with the definition used by the Reserve Bank of Australia and APRA before liquidity holdings were negotiated with each bank on an individual basis.

[8] Over part of the study period statutory deposits up to 3% of deposits could count toward prime asset ratios (prime asset ratios were abolished in 1998). Statutory deposits were, in effect, not available to be withdrawn; thus, regulatory deposits are excluded from this definition of liquid assets. Statutory deposits were abolished in July 1999.

[9] Over time the required holdings of prime assets have changed; in 1986 the PAR ratio was set at 12% of Australian dollar assets; in 1988 this became 10%; in 1990, 6%; in 1997, 3%. In 1998 the bank's holdings of liquid assets were negotiated at the individual bank level by the Reserve Bank and its successor for prudential regulation, the Australian Prudential Regulation Authority (APRA).

[10] Reserve Bank of Australia *Bulletin,* various issues.

fail' and so receive implied deposit insurance (Terry and Trayler, 2004).[11] Dennis, *et al*. (1998) concluded that observed Australian bank Certificate of Deposit yields reflected the too big to fail effect. Thus, it is likely that the four major Australian banks are able to benefit from the too big to fail effect via higher interest margins. As a result dummy variables will be used to represent Big Four and Foreign banks, with the Other Domestic banks being represented by the intercept.

IV. DATA AND METHOD

The data was obtained from the bank annual reports, the Reserve Bank of Australia *Bulletin* and the Australian Prudential Regulation Authority. The study considers fully licensed banks operating in Australia between 1989 and 2001;[12] foreign bank branches are excluded due to lack of data. The sample consists of 43 banks, including 21 foreign subsidiary banks. A bank is defined as a foreign bank if it has more than 50% foreign ownership. In the majority of cases, the foreign banks are totally foreign owned. The foreign banks are mainly active in the provision of wholesale finance, with the main exception being Bank of Western Australia, which has a substantial retail focus.[13] The Domestic banks are divided into two categories, Big Four and Other Domestic. As mentioned previously, four major banks dominate the Australian banking system. The Other Domestic banks are mainly regional banks with focus upon retail banking, with the main exception of Macquarie Bank, which has a wholesale market focus. There are 18 Other Domestic banks in the sample. Table 1 details the sample used in this study.

Table 2 shows the descriptive statistics for the sample used in this study, while Table 3 shows the descriptive statistics segmented by bank type. The domestic Australian banks have higher net interest margins than the Foreign banks, while the Foreign banks have lower levels of retail activity. The Foreign banks also have higher levels of observed default risk: given this higher risk it is not surprising that the Foreign banks also have the highest levels of capital on average. The Other Domestic banks are the most active in retail banking and have correspondingly the lowest levels of observed default risk. The Big Four banks have the lowest cost-to-income ratio indicating higher management quality, but the Foreign banks have the lowest operating costs on average. The Foreign banks also hold the highest levels of liquid assets. As can be seen in panel C of Table 3, one foreign bank earned a negative net interest margin in one year. This reflected the impact of a

[11] Fitz-Gibbon and Gizycki (2001) provide a comprehensive history of lender of last resort lending in Australia. Since 1900 Australia has experienced few instances of direct central bank support of failing institutions, yet depositor loss of funds has been limited. Thus, the central bank support of the Australian banking system is more implied than explicit.

[12] Data for Capital Adequacy ratios were available from 1990 onwards only.

[13] Bank of Western Australia was formerly the R&I Bank of Western Australia and was 51% owned by the Halifax-Bank of Scotland Group (HBOS), through the sample period this bank retained (and still retains) its focus upon regional retail banking. The Bank of Western Australia is now 100% owed by HBOS.

Table 1. Sample Composition

	Big Four	Other Domestic	Foreign	Total
1989	4	9	14	**27**
1990	4	10	12	**26**
1991	4	9	12	**25**
1992	4	9	11	**24**
1993	4	11	9	**24**
1994	4	10	10	**24**
1995	4	9	8	**21**
1996	4	10	6	**20**
1997	4	8	5	**17**
1998	4	9	5	**18**
1999	4	7	6	**17**
2000	4	8	7	**19**
2001	4	8	4	**16**
Total Observations	**52**	**117**	**109**	**278**

restructure of the Australian operations prior to its sale to another foreign bank in the following year.

The model developed in the previous section will be estimated using unbalanced panel regressions. When employing unbalanced panel regressions it is possible that the assumptions of OLS will hold, particularly the assumption that there is no correlation between the ith and jth error term. Whether the assumptions of OLS have been violated can be determined by the use of a Lagrange Multiplier (LM) test. The LM test employs the residuals of an OLS regression of the same specification as the pooled regression to determine if the assumptions of OLS have been violated. In cases where the assumptions of OLS were found to be violated, the appropriate pooled regression technique was used. A Hausman test was employed to determine if a fixed effect (Least Squares Dummy Variable) or random effects estimator was appropriate.[14]

V. RESULTS

The initial regression results are shown in Table 4. The base model proposed by Ho and Saunders (1981) is supported, with net interest margins a positive function of managerial risk aversion (as measured by capital holdings) and interest rate volatility. The standard deviation of the 5-year bond rate and a yield curve measure were also tested as alternative measures of interest rate risk, with identical

[14] Further references regarding pooled regression methodology are available in Greene (2000) and Baltagi (2001). When time invariant dummy variables are included in the estimated model, the application of the LSDV model is not possible. In these cases the alternatives are OLS or a random effects estimator as determined by the results of an LM test.

Table 2. Descriptive Statistics: All Banks

Variable	Mean	Std Dev.	Minimum	Maximum	Observations
Net Interest Margin	2.275641	1.083359	−1.37E-02	7.951423	278
Market Power 1	6.273308	10.44805	5.27E-02	45.90948	278
Market Power 2	4.818304	8.060183	4.17E-02	37.03855	278
Market Power 2a	4.738777	7.917818	4.06E-02	36.02514	278
Market Power 2b	4.661303	7.7673	3.97E-02	34.43895	278
Capital Ratio (Equity /Total Assets)	7.4335	3.083026	2.817333	22.74591	278
Capital Adequacy Ratio	12.24144	4.288255	8.4	42.1	236
Operating Cost	2.972207	1.716608	0.380959	12.70943	247
Std Dev of 90-Day Bank Bill	1.330261	0.827389	0.153578	2.714091	278
Std Dev of 5-Year Bond	0.981422	0.338806	0.396836	1.728927	278
Std Dev of Yield Curve	0.878869	0.429057	0.299848	1.717709	278
Provisions /Loans	2.26214	3.512598	3.45E-02	34.01413	268
Doubtful Debts Expense / Loans	1.176679	3.04	−1.55672	29.95806	268
Implied Payments	1.016667	1.265904	−4.23294	11.80659	247
Retail Activity 1 (Branches / Loans)	1.59E-03	2.24E-03	2.35E-05	3.05E-02	265
Retail Activity 2 (Branches / Total Assets)	1.15E-03	1.92E-03	1.60E-05	2.73E-02	265
Implied Taxes	0.541796	0.341931	0	1.779359	278
Management Quality (Cost to Income Ratio)	0.869806	0.120088	0.467279	2.022079	247
Liquidity Measure 1	1.10234	2.983708	0	39.44716	278
Liquidity Measure 2	11.3833	9.138759	0.659734	65.10152	278

results.[15] As an alternative measure of managerial risk aversion, the bank's capital adequacy ratio was substituted for capital holdings, with the same results as for capital holdings. As slightly more observations are available for capital holdings, the results are shown for this variable.

The extension to the Ho and Saunders model provided by McShane and Sharpe (1985) proposes a positive relationship between bank market power and net interest margins, as shown in Table 4; the market power variable is consistently negative.[16] However, the dummy variable representing the Big Four banks, with a dominant market position, is consistently positive and significant, supporting the arguments of McShane and Sharpe (1985). Explanation for the negative sign of market power can be found by considering the results of Maudos and Guevara (2004). Maudos and

[15] These three alternative measures of interest rate risk exhibited high correlations, thus including all three (or any two) in the same regression induced multicollinearity.

[16] The results for market power 2 are shown as this reduced some multicollinearity as opposed to market power 1, the results for market power 2a and 2b are largely the same.

Table 3.

Panel A: Descriptive Statistics: Big Four Banks

Variable	Mean	Std Dev.	Minimum	Maximum	Observations
Net Interest Margin	2.749349	0.506901	1.708542	3.82115	52
Market Power 1	27.04169	6.154522	19.49129	45.90948	52
Market Power 2	20.80947	4.906327	13.67372	37.03855	52
Market Power 2a	20.4615	4.761656	13.55621	36.02514	52
Market Power 2b	20.11193	4.553134	13.55721	34.43895	52
Capital Ratio	6.619454	1.113217	4.539455	8.677647	52
Capital Adequacy Ratio	10.39583	1.186261	8.6	13.9	48
Operating Cost	2.751053	0.548366	1.565206	4.17481	52
Std Dev of 90-Day Bank Bill	1.198034	0.843817	0.153578	2.705727	52
Std Dev of 5-Year Bond	0.926051	0.338426	0.406457	1.563383	52
Std Dev of Yield Curve	0.839289	0.429184	0.349196	1.717709	52
Provisions /Loans	2.496862	1.284603	1.048242	6.125621	52
Doubtful Debts Expense / Loans	0.805535	0.838177	0.100162	4.223476	52
Implied Payments	1.146575	0.521751	0.205425	2.503523	52
Retail Activity 1 (Branches / Loans)	1.70E-03	8.47E-04	4.31E-04	3.57E-03	51
Retail Activity 2 (Branches / Total Assets)	1.04E-03	4.93E-04	2.39E-04	2.13E-03	51
Implied Taxes	0.424327	0.247228	0	0.920635	52
Management Quality (Cost to Income Ratio)	0.814752	4.77E-02	0.726678	0.898555	52
Liquidity Measure 1	0.680232	0.336297	0.413892	2.242488	52
Liquidity Measure 2	7.284182	2.269699	2.442689	11.55704	52

Panel B: Descriptive Statistics: Other Domestic Banks

Variable	Mean	Std Dev.	Minimum	Maximum	Observations
Net Interest Margin	2.661028	1.150257	0.107882	7.951423	117
Market Power 1	2.225842	2.145098	0.101297	8.445564	117
Market Power 2	1.695264	1.620576	8.25E-02	6.386008	117
Market Power 2a	1.668396	1.5918	8.03E-02	6.221842	117
Market Power 2b	1.645269	1.566223	7.70E-02	6.105013	117
Capital Ratio	6.848071	2.165314	2.817333	13.90228	117
Capital Adequacy Ratio	11.69019	1.954314	8.7	18.4	103
Operating Cost	3.295562	1.846177	0.380959	10.37141	116
Std Dev of 90-Day Bank Bill	1.251206	0.78468	0.153578	2.714091	117
Std Dev of 5-Year Bond	0.952814	0.332798	0.396836	1.728927	117
Std Dev of Yield Curve	0.838705	0.402295	0.308395	1.717709	117
Provisions /Loans	1.421084	1.776446	6.56E-02	12.60656	117
Doubtful Debts Expense / Loans	0.601515	1.250647	−1.55672	11.16184	117
Implied Payments	1.283404	0.988566	−1.78021	3.294228	116

Table 3. (Continued)

Retail Activity 1 (Branches / Loans)	2.49E-03	3.05E-03	2.35E-05	3.05E-02	112
Retail Activity 2 (Branches / Total Assets)	1.91E-03	2.70E-03	1.94E-05	2.73E-02	112
Implied Taxes	0.547075	0.378564	0	0.954696	117
Management Quality (Cost to Income Ratio)	0.873709	9.22E-02	0.467279	1.283249	116
Liquidity Measure 1	0.919404	1.148166	0	5.875077	117
Liquidity Measure 2	8.870394	3.83296	0.659734	23.68588	117

Panel C: Descriptive Statistics: Foreign Banks

Variable	Mean	Std Dev.	Minimum	Maximum	Observations
Net Interest Margin	1.635979	0.88651	−1.37E-02	4.411502	109
Market Power 1	0.709985	0.700636	5.27E-02	2.564619	109
Market Power 2	0.541747	0.539842	4.17E-02	2.056845	109
Market Power 2a	0.533759	0.53079	4.06E-02	2.001812	109
Market Power 2b	0.527754	0.523638	3.97E-02	1.92278	109
Capital Ratio	8.450249	4.126002	3.41	22.74591	109
Capital Adequacy Ratio	13.95165	6.382944	8.4	42.1	85
Operating Cost	2.642977	1.942656	0.600441	12.70943	79
Std Dev of 90-Day Bank Bill	1.478198	0.849094	0.324788	2.669074	109
Std Dev of 5-Year Bond	1.038545	0.34017	0.511156	1.655883	109
Std Dev of Yield Curve	0.940862	0.452728	0.299848	1.717709	109
Provisions /Loans	3.132826	5.232775	3.45E-02	34.01413	99
Doubtful Debts Expense / Loans	2.051362	4.660549	−1.26248	29.95806	99
Implied Payments	0.539493	1.757149	−4.23294	11.80659	79
Retail Activity 1 (Branches / Loans)	5.42E-04	6.64E-04	4.16E-05	4.91E-03	102
Retail Activity 2 (Branches / Total Assets)	3.76E-04	5.23E-04	1.60E-05	3.95E-03	102
Implied Taxes	0.592169	0.328399	0	1.779359	109
Management Quality (Cost to Income Ratio)	0.900314	0.168763	0.520814	2.022079	79
Liquidity Measure 1	1.500074	4.591542	0	39.44716	109
Liquidity Measure 2	16.03617	12.61793	1.131334	65.10152	109

Guevara (2004) argued that bank net interest is a positive function of the average size of operations, but difficulties in data availability restricted the implementation of this measure. Instead, bank size was employed by Maudos and Guevara, and it was found (Maudos and Guevara, 2004, Table 2, p. 2273) that size has a significant and negative relationship with bank net interest margins. This non-expected sign is most likely due to the restrictions of data availability resulting in Maudos and Guevara (2004) operationalising average size by using log of deposits or log of

Table 4. Dependent Variable: Net Interest Margin All Banks

Variable				
Market Power 2	−0.0251**	−0.0263**	−0.0263**	−0.0263**
Operating Cost	0.1172***	0.1165***	0.1181***	0.1185***
Capital Ratio	0.0324**	0.0340***	0.0319**	0.0319**
Std Dev of 90-day bank bill	0.1843***	0.2118***	0.1929***	0.1966***
Provisions	−0.0804*	−0.0803*	−0.0814*	−0.0793*
Provisions * SD of 90 day bank bill	0.0168	0.0146	0.0167	0.0158
Retail 1	16.8126		16.2801	
Retail 2				16.3418
Implied Payments	0.8387***	0.8594***	0.8402***	0.8427***
Implied Taxes	0.0421			
Management Quality	−8.3764***	−8.5669***	−8.4253***	−8.4469***
Liquidity 1	−0.0038			
Big Four	0.3623*	0.3655*	0.3780*	0.3789**
Foreign	−0.1917**	−0.1994**	−0.1945**	−0.1998**
Constant	8.1094***	8.2745***	8.1649***	8.1837***
N	226	237	226	226
Adjusted R^2	0.9106	0.9098	0.9112	0.9109
F Statistic	177.38***	238.96***	210.83***	210.34***
LM Test†	0.12	0.46	0.12	0.12

* = significant at 5% level; ** = significant at 1% level; *** = significant at 0.1% level.
† The LM test determines if the assumptions of OLS regression have been violated. Rejection of the null hypothesis results in OLS estimation being inappropriate. A Hausman test is then necessary to determine the appropriate pooled regression technique.

loans. Several possibilities present themselves to explain the market power results of this current study: (i) that banks are experiencing decreasing returns to scale in net interest margins (as found by Sturm and Williams (2004) for Australian banks in a different context); or (ii) that the Australian banks were willing to sacrifice net interest margins to achieve size targets and so were buying market share at the cost of lower net interest margins.

This study argues that size does not necessarily reflect the cost of loan production as it does not measure the different costs of writing syndicated loans (for example) as compared to using branch networks to distribute housing loans, and so retail network measures are used to measure the cost of delivery.[17] This argument was not supported, with the alternative measures of retail activity consistently insignificant.

The Maudos and Guevara (2004) modification to the Ho and Saunders model of including operating costs (as suggested by Lerner, 1981) was strongly supported,

[17] This approach also has the benefit of reducing the multicollinearity between the market power measure used in this study and the size measure applied by Maudos and Guevara (2004).

with this variable consistently positive (as hypothesised). Angbazo (1997) argued that management quality has an important role in determining bank net interest margins, arguing that those banks with higher quality management will charge correspondingly lower net interest margins, as was found in this study. The argument that bank liquidity holdings will increase bank net interest margins was not supported. Similarly, implied taxes, as measured by required deposits with the Reserve Bank of Australia, were found to have no relationship with bank net interest margins.

Bank payment of implied interest to bank depositors by increasing the immediacy and availability of bank services was found to increase bank net interest margins. This variable may also reflect the impact of bank delivery system choice as measured by the retail intensiveness measures, thus accounting for the insignificance of the retail activity variables. Overall, the payment of implied payments to increase immediacy and availability of bank services was found to increase bank net interest margins.

Bank credit risk, as measured by provisions for doubtful debts was found to have a negative and significant relationship with bank net interest margins. This is opposite to the conventional hypothesis for this variable (Angbazo, 1997). Explanation for this result can be found in the previous discussion relating to the market power variable. The buying market share effect (DeYoung and Nolle, 1996), would also be reflected in bank portfolio quality, with an expectation that buying market share would tend to result in lower quality assets being written. Thus, higher levels of provisions for doubtful debts would subsequently result, which would not be fully compensated for by net interest margins, reflecting mispricing. As shown in Table 3, panels B and C, the provisions variable demonstrates characteristics of positive skewness. Thus it is possible that a few outlier variables produced this outcome. Thus, the models were re-estimated including as an additional measure a dummy variable representing all values of provisions more than two standard deviations above the mean. This variable did not change the results, indicating that this mispricing for risk extended beyond a few extreme values.[18] This result, taken together with the result for bank market share tends to most strongly support the buying market share effect discussed above. This outcome is also consistent with that of Guiso*, et al*. (2006) who found that market liberalisation in Italy was followed by a reduction in rate spreads at the cost of an increase in bad loans.

It was found that the Foreign banks earned significantly lower net interest margins than Domestic banks, as shown in Table 4. The dummy variable representing foreign ownership is consistently negative and significant, with this outcome carried over to the models including dummy variables representing years. As any financial system is by its nature dynamic, is it highly likely that time effects have been important in determining net interest margins in Australia. Thus the models were re-estimated including dummy variables for each year. As these dummy

[18] The dummy variable for large provisions displayed strong signs of collinearity with the dummy variables for bank type, also indicating that this mispricing effect extended beyond a few banks.

variables introduced some collinearity with the other variables, the models were estimated with dummy variables for the years 1992 to 2001, with the constant representing 1989 to 1991. The results of the model including these year dummy variables are shown in Table 5.

Table 5. Dependent Variable: Net Interest Margin

Variable				
Market Power 2	−0.0239**	−0.0249**	−0.0241**	−0.0240**
Operating Cost	0.1232***	0.1209***	0.1236***	0.1243***
Capital Ratio	0.0292**	0.0324***	0.0291**	0.0289**
Std Dev of 90-day bank bill	−0.1148	−0.0691	−0.113	−0.1127
Provisions	−0.1086**	−0.1065**	−0.1090**	−0.1070**
Provisions * SD of 90-day bank bill	0.0271	0.0246	0.0272	0.0265
Retail 1	20.1556		20.0898	
Retail 2				22.2566
Implied Payments	0.8308***	0.8563***	0.8311***	0.8323***
Implied Taxes	0.0119			
Management Quality	−8.3960***	−8.5637***	−8.4036***	−8.4166***
Liquidity	−0.0007			
Big Four (dummy)	0.3505*	0.3542*	0.3537*	0.3549*
Foreign (dummy)	−0.1924**	−0.1959**	−0.1918**	−0.1959**
1992	−0.1228	−0.1442	−0.1219	−0.1234
1993	−0.3028**	−0.2984**	−0.3000*	−0.3031**
1994	0.6013***	−0.5573**	−0.5958***	−0.6003***
1995	−0.3943**	−0.3858**	−0.3903**	−0.3945***
1996	−0.5447***	−0.5075**	−0.5415***	−0.5462***
1997	−0.6301***	−0.6012***	−0.6289***	−0.6341***
1998	−0.5615***	−0.5271**	−0.5587***	−0.5645***
1999	−0.5570**	−0.5191**	−0.5579**	−0.5664**
2000	−0.6023***	−0.5883***	−0.6083***	−0.6158***
2001	−0.7760***	−0.6621***	−0.7804***	−0.7877***
Constant	8.9143***	8.9940***	8.9242***	8.9426***
N	226	237	226	226
Adjusted R^2	0.9182	0.9156	0.9189	0.9189
F Statistic	110.76***	129.02***	122.49***	122.40***
LM Test†	0.56	1.95	0.56	0.55

* = significant at 5% level; ** = significant at 1% level; *** = significant at 0.1% level.

†The LM test determines if the assumptions of OLS regression have been violated. Rejection of the null hypothesis results in OLS estimation being inappropriate. A Hausman test is then necessary to determine the appropriate pooled regression technique. In this case, as there are time-invariant dummy variables in the model, the choice is between OLS or Random Effects estimation. Generally, the LM test supports the application of OLS in the case. Heteroscedastic consistent estimation did not change the general outcome, and a LM test did not reveal significant autocorrelation.

As some of the variables in this study have been affected by time effects such as changing regulations and structural effects, the dummy variables for years induces some multicollinearity into the regressions.[19] This is particularly apparent for the measures of interest rate risk, indicating that the standard deviation of the market risk has a time-varying component. The outcome is that this variable is no longer significant when time effects are being controlled for. Thus it is possible that in this study the interest rate risk results shown in Table 4 reflect time effects rather than interest rate risk. More study in a multicountry framework would be a valuable extension to this literature.

The dummy variables for years are consistently negative and significant, illustrating that net interest margins have fallen over the study period. Given that the absolute value of the coefficient is increasing over the time period it is apparent that this decrease is larger in the latter part of the sample. The continued importance of operating costs, implied payments and management quality indicates their importance in determining bank net interest margins, consistent with Maudos and Guevara (2004). Dummy variables representing the Big Four banks remain consistently positive and significant, while those representing foreign ownership are consistently negative and significant. The negative (and perverse) relationship between bank provisions and net interest margins persists after time effects are controlled for. Further, the market power effect remains generally significant and negative when the dummy variables for bank type are included in the model.

As the Ho and Saunders model is a variance based model, it is also appropriate to consider the impact of the variance of operating costs and credit risk.[20] Several different measures of variance of these variables were considered: (i) deviations from the mean, (ii) the extreme value method suggested by Parkinson (1980), which uses the log of (high value/low value) as an efficient estimator of the variance for each bank, and (iii) the bank-specific standard deviation. The first two of these measures were found to be generally insignificant with evidence of collinearity with the bank-type dummies, suggesting some institutional effects. The third of these variables produced results that largely supported those discussed above, with some loss in overall explanatory power.

As a further alternative to the measures of credit risk employed, a yield curve measure was also employed. This was specified as the 5-year Treasury bond rate, less the 90-day bank bill rate, on average for the month, matched to balance date. It would be expected that the yield curve would reflect expectations of future economic circumstances, and as such a negative yield curve would predict future prospects of a weaker economy and increased defaults. However, no significant relationship was found between the yield curve measure and bank NIMs.

[19] The time-varying nature of the sample composition (see Table 2) may also account for some of this reduced significance of some variables.

[20] I am grateful to Tony Saunders for his suggestions in this area.

As an alternative to the management quality measure employed, measures of bank technical efficiency were also tested. The parametric input-distance function approach of Coelli and Perelman (1999) was employed.[21] Alternative specifications of inputs and outputs were tested to produce different measures of bank technical efficiency. As a baseline model, inputs were considered as employees, deposits and borrowed funds and equity capital, while outputs were considered as loans and off balance sheet activity. Two additional models were also considered in which the outputs were re-specified as (i) loans less housing loans and (ii) housing loans as well as off balance sheet activity, while the second re-specification added investments to the outputs of the baseline model. However, limited support was found for the use of this approach, which had the added disadvantages of reducing the sample size by between 10% and 15%, depending upon the specification of inputs and outputs, while also resulting in reduced explanatory power.

VI. CONCLUSION

This paper extends the existing literature relating to net interest margins across a number of dimensions. The extensions to the Ho and Saunders (1981) model have been considered and it has been determined which of those extensions are relevant in an Australian context. In particular, the importance of operating costs in determining net interest margins has been demonstrated, consistent with Maudos and Guevara (2004) and Lerner (1981). The pre-deregulation study of McShane and Sharpe (1985) has been updated to consider the post-deregulation Australian environment. The finding of McShane and Sharpe (1985) that market power increases net interest margins has been confirmed from a different perspective, together with evidence of bank buying market share in the post-deregulation environment by accepting lower net interest margins (and also lower credit quality). Overall, the core elements of the Ho and Saunders (1981) model have been confirmed, but not all elements of subsequent developments to this model have been supported.

This study has also found that buying market share resulted in some mispricing for risk, resulting in a negative relationship between credit risk and net interest margins, similar to the results of Guiso*, et al*. (2006) in Italy. The importance of control variables for payment of implied interest and management quality was also illustrated. The significance of implied payments and managerial quality, together with the importance of operating costs, illustrates the importance of these variables in determining bank net interest margins. Controls for time effects in the models showed that overall net interest margins have fallen in Australia over the time period studied. This reduction in net interest margin could reflect either (i) increased market competition, or (ii) an evolutionary process de-emphasising

[21] Thanks to Jan-Egbert Sturm for his assistance here.

traditional margin income and an associated move to disintermediation and fee-based income. Investigation of the changing nature of intermediation in Australia and globally would be another area worthy of further investigation.

The area of net interest margins is still relatively under-researched relative to the importance of bank interest income as a component of total bank income; thus there is a need for continued endeavour in this area, with both cross-border and single-nation foci. Another valuable extension would be extending this work to consider alternative measures of market power not available to this study, such as the Lerner Index approach adopted by Maudos and Guevara (2004). Likewise, the relationship between net interest margins and bank size is worthy of further research, particularly in the context of the buying market share effect and possible decreasing returns to scale. This paper has also identified a relationship between bank net interest margins and bank credit risk that would benefit from further investigation.

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VIII. NOTE ON CONTRIBUTOR/ACKNOWLEDGMENTS

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