Macroeconomic, Market and Bank-Specific Determinants of the Net Interest Margin in Austria

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The objective of this article is to identify key determinants of the net interest margin (NIM) in the Austrian banking sector. In Austria, the NIM is one of the most important income drivers of banks given the importance of relationship banking, where interest income dominates other sources of revenue. However, the NIM differs substantially among Austrian banks. Drawing on a unique supervisory dataset for the Austrian banking sector of around 42,000 observations between the first quarter of 1996 and the second quarter of 2012, we analyze under which circumstances a bank has a relatively high or low NIM. We contribute to the empirical literature on the NIM by factoring in a bank's business model in terms of its balance sheet structure and by accounting for the financial crisis from the third quarter of 2007 onward. Our estimation results suggest that not only the determinants identified in the existing empirical literature (different types of non-interest income and expenses, various risk measures, competition, macroeconomic environment) have a significant influence on the NIM, but also our two innovations (balance sheet structure, financial crisis).

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1 Introduction and Motivation

For most banks, interest income represents a substantial part of their operating income. In particular, this applies to small and medium-sized banks that are involved in relationship banking with a strong emphasis on the German-style "Hausbank" (see e.g. Allen and Gale, 1995). In Austria, interest income still accounts for nearly 50% of banks' operating income, which is why, in commercial banking, the importance of the net interest margin (NIM) as a measure of profitability of financial intermediation cannot be neglected.

Interestingly, there has been a substantial reduction in the NIM throughout Europe over the past years. Liebeg and Schwaiger (2006) report such a decline for euro area banks between 2000 and 2005. Annual Bankscope data for Western Europe confirm a further decline in rates in most countries between 2005 and 2011. Austria is no exception to this trend, as already noted earlier by Liebeg and Schwaiger (2006): the NIM shrank by almost 50% between 1996 and mid-2012 (see chart 1).

The seminal work of Ho and Saunders (1981), which is covered in section 2 in more detail, laid a good foundation for empirical research aimed at detecting the driving forces of interest margins. These papers already provide comprehensive theoretical guidance about which variables could be tested empirically. We find a considerable number of papers that present the following determinants of the NIM.

First, banks may have established complementary sources of income (e.g. income from fees and commissions) or refinancing opportunities (e.g. covered bonds). Allen (1988) extended the original Ho-Saunders model by considering different types of loans and deposits. Beyond their theoretical extension, the

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question remains whether certain types of loans/deposits are strategic substitutes or complements. For lack of sufficiently granular data, most empirical studies use the idea of different types of loans and deposits only by defining broad categories such as bank, consumer, foreign currency and corporate loan shares on the asset side and deposit shares on the liability side.[2] Another approach is to model different sources of income directly. Liebeg and Schwaiger (2006) follow this approach by considering non-interest revenues as a share of total income, income from fees and commissions and also the share of foreign currency loans.

Second, banks could have increased their efficiency by improving their cost-to-income ratios and/or reducing their staff and other expenditures. Almost all empirical papers incorporate some kind of cost-related variable. Prominent examples are the cost-to-income ratio (see e.g. Liebeg and Schwaiger, 2006, or Entrop et al., 2012), some kind of efficiency index (see Hamadi and Awdeh, 2012) or cost variables in relation to total assets (see e.g. Horvath, 2009).

Third, banks might change their risk appetite. Ho and Saunders (1981) originally considered absolute risk aversion in a bank's utility function. Empirically, there are several ways to incorporate this idea. Saunders and Schumacher (2000), among others, use interest rate volatility to control for major portfolio risks. Another approach, which is more popular in empirical work, is to link risk appetite to credit risk-related variables such as loan loss provisions and/or the nonperforming loan ratio. Hanweck and Ryu (2005) argue that risk-averse bank managers will shift to lower-yielding assets and funds that are less prone to default as credit risk increases. Controlling for the asset structure, as we suggest, could help identify the partial influence of other risk appetite variables on the NIM. Maudos and de Guevara (2004) propose that the risk of nonpayment or default on a credit requires banks to implicitly include a risk premium in interest rates and therefore the NIM.

Fourth and more market-based, competition in the banking system may have intensified, causing margins to decline. Most empirical studies use either the Herfindahl-Hirschman index (HHI; see Herfindahl, 1955, and Hirschman, 1964) or the Lerner index as a measure of competition. Whereas the HHI determines how uniformly market shares are distributed, the Lerner index measures the degree of competition on a bank-by-bank basis (see Angelini and Cetorelli, 2003, for details). As noted by Keeley (1990), banking sector competition and (de)regulation of the banking sector are closely related. In this context, the introduction of (additional) regulatory requirements such as Basel II could impose new restrictions on a bank's optimal interest margin-setting problem. The theoretical impact of capital regulations and deposit insurance was analyzed by Zarruk and Madura (1992).

Fifth, also macroeconomic conditions influence the NIM in terms of changes in the economic environment affecting the banking system as a whole at a given point in time. In most empirical studies, GDP growth is used as a control variable and is assumed to have a positive correlation (see e.g. Horvath, 2009). Many papers consider market interest rates of different maturities and/or their respective standard deviation to capture the development of both

[2] *Maudos and de Guevara (2004) include the loan-to-total assets ratio and deposit-to-total assets ratio. Horvath (2009) only considers the share of total loans.*

the short and the long end of the yield curve.[3] Only a few papers control for additional macroeconomic variables such as inflation (see e.g. Horvath, 2009, and Entrop et al., 2012) and market interest rate spreads (see Rumler and Waschiczek, 2012).

From a financial stability perspective, it is not clear whether a relatively high or relatively low NIM is optimal. On the one hand, a high NIM is associated with a low degree of efficiency, a low degree of financial deepening and noncompetitive market conditions. On the other hand, low net interest rate margins might induce aggressive and highly risky "search-for-yield" activities by banks as suggested by Delis and Kouretas (2011), which pose a threat to financial stability. The 2008 financial crisis showed how such a scenario almost caused the global financial system to collapse. From this perspective, the development of the NIM could profoundly influence the future development of the Austrian banking sector.

The purpose of our study is to identify the most important macroeconomic, market and bank-specific determinants of the NIM and thereby explain the declining margins in Austria. We combine the most suitable determinants from the existing literature and add two innovations. To the best of our knowledge, we are the first to approximate banks' business models by their balance sheet structure and to account for the financial crisis from the third quarter of 2007 onward.[4] The remainder of this article is structured as follows. Section 2 introduces the theoretical model by Ho and Saunders (1981) and game theoretic refinements that put an emphasis on competition. Section 3 describes the data base used for our empirical analysis as well as the data preparation process including outlier detection and summarizes the variables eventually used for estimation. Section 4 lays out the econometric model, and section 5 presents and discusses the estimation results. Finally, section 6 concludes.

2 Theoretical Model

In the theoretical literature, we find two major approaches to modeling the NIM. Most papers follow the seminal work of Ho and Saunders (1981), where the bank's intermediation role is defined as a passive dealer between providers and users of funds.

As mentioned by Marrouch and Turk Ariss (2011), their theory rests on banks' ability to match the random arrival and departure of deposits and loans, which allows banks to set the interest margin or spreads for deposits a and loans b with respect to the exogenously assumed money market rate m.[5] The random arrival and departure of deposits results in transaction uncertainty, which in turn produces the so-called pure spread/margin. Put simply, the pure margin in Ho and Saunders (1981) is affected by the degree of bank management's risk aversion, the market structure in which the bank operates, the average size of bank transactions and the variance of interest rates.

Maudos and Solis (2009) considerably extended the basic model by including operating costs, credit risk, interaction between credit and market risk, non-interest income, income from fees and commissions and trading income into the pure spread dealership model.

[3] *Maudos and de Guevara (2004), e.g., include the standard deviations of the three-month, three-year and ten-year interest rate.*

[4] *Memmel and Schertler (2011), who included the change of the balance sheet structure into their NIM model, match up closest with our first innovation.*

[5] *The interest on deposits and loans is then defined as $m-a$ and $b+m$, respectively, which results in a NIM of $a+b$.*

As already noted by Ho and Saunders (1981), there are other variables outside the theoretical pure margin model which influence the NIM. In the most comprehensive study by Maudos and Solis (2009), these variables, such as implicit interest payments, opportunity costs of holding reserves, quality of management and loans to total assets as well as deposits to total assets, are included in their theoretical model. Finally, GDP growth and inflation are added.

The less popular alternative for modeling the NIM applies standard theory from industrial organization. The Monti-Klein model considers a monopoly bank where it can be shown that interest rates on loans and deposits can be determined separately (separability theorem) if there is no default risk (see Monti, 1972, and Klein, 1971). With credit risk, the separability theorem no longer holds. However, as stated by van Hoose (2010), pure monopoly or monopsony is a rare occurrence in any modern setting. A bank typically faces at least a few rivals, although banking markets may not be perfectly competitive either.

Imperfectly competitive banking markets can be modeled in several ways and enrich the theory on NIM determinants. The basic idea is to integrate imperfect competition in the loan and deposit market into one game theoretic model.[6]

Not surprisingly, this approach highlights the importance of competition and, in more complex models, product differentiation as a major determinant of the NIM. As a consequence, we implement the standard measure of competition, the Lerner index, in our model. We follow the estimation approach by Angelini and Cetorelli (2003), where it is assumed that a bank sets equilibrium prices and quantities in order to maximize its profits Π_i:

$$\Pi_i^{max} = \max_{q_i} [p(Q,z) - C(q_i,\omega_i)]. \quad (1)$$

Such a decision is based on cost considerations ($C(q_i,\omega_i)$) and on the degree of competition in the market measured by the inverse demand function $p(Q,z)$ where Q is the industry output. For lack of data on different products/services of a bank, we summarize all outputs of a bank in an aggregate banking product. The same is done on the cost side.[7]

The corresponding first order condition to equation (1) is

$$p_i = C'(q_i,\omega_i) - \Theta_i / \tilde{\varepsilon} \quad (2)$$

where the second term on the right-hand side measures the departure from a perfectly competitive benchmark.[8] In line with Angelini and Cetorelli (2003), the separate identification of Θ_i and $\tilde{\varepsilon}$ is not required if one aims to analyze the bank's overall degree of market power. It is sufficient to estimate $\lambda = \Theta_i / \tilde{\varepsilon}$. Dividing λ by the average price p yields the Lerner index. The Lerner index is defined to be between 0 and 1, measuring the relative markup of price over marginal cost. A Lerner index of zero would describe a market with perfect competition, whereas an index of one would imply monopoly power.

[6] *Different combinations of loan and deposit market forms, such as oligopolies and oligopsonies or monopolisties and monopsonisties, are possible.*

[7] *The input variables are interest expenses, staff and other operating expenses, whereas the price of the aggregate banking product is defined as the ratio of the sum of interest income and income from fees and commissions to total assets.*

[8] *The term Θ is usually defined as the conjectural elasticity of total industry output with respect to the output of the i^{th} firm and $\tilde{\varepsilon}$ is the market demand semi-elasticity to the price.*

For further estimation details, we refer to Angelini and Cetorelli (2003). The result of their estimation technique is a Lerner index for each bank in each quarter, which is integrated in our empirical setup described in section 4.

3 Data and Definitions

Our empirical analysis is based on quarterly supervisory data reported by domestically operating banks at the unconsolidated level according to national GAAP. This implies that interest income earned by Austrian banks' subsidiaries in Central, Eastern and Southeastern Europe or the Commonwealth of Independent States is not included in the NIM that is analyzed in the next sections.[9] Instead, by using unconsolidated data, we put the focus on the domestic market, as we are primarily interested in gaining insight into the determinants of the decline of the NIM in Austria (see chart 1).

Bank-specific variables and the Lerner index are built from data on balance sheet items, the profit and loss statement and data on regulatory capital and capital requirements. The observation horizon runs from the first quarter of 1996 to the second quarter of 2012, yielding $T = 66$ time periods. We consider all institutions that held a banking license at some point during the observation horizon but exclude special purpose banks and affiliates of foreign banks in Austria and arrive at a sample of $N = 1{,}011$ banks.

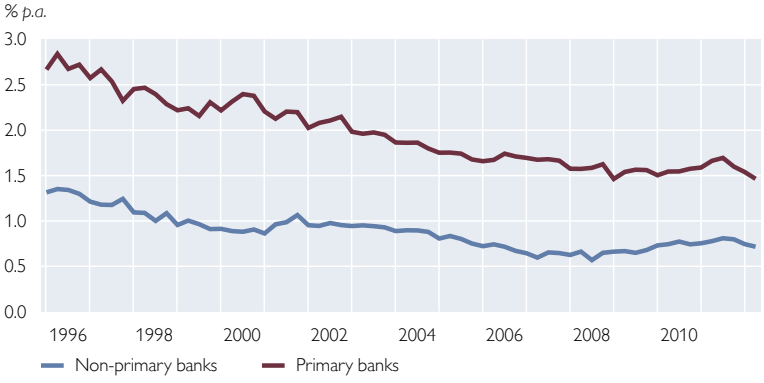
To prevent outliers from distorting the empirical analysis, we apply a two-stage cleaning algorithm to the variables used. First, we eliminate outliers across banks for each time period. An observation is considered an outlier if it is too far from the median (more than four times the distance between the median and the 2.5% or 97.5% quantile). In a second stage, we eliminate outliers across time for each bank. Here, the threshold distance is defined as 12 times the distance between the median and the 10% or 90% quantile. Such parameters ensure that the number of removed observations remains limited and the resulting distributions exhibit a reasonable shape when judged from a qualitative perspective. This procedure leaves us with around 42,000 observations.

With regard to our two innovations, we use the share of different types of assets and liabilities as approximation for the business model and a crisis dummy from the third quarter of 2007 onward to account for the new challenges banks have faced in the global financial crisis. Since the overall balance sheet structure does not change significantly at a quarterly frequency and stays reasonably stable over time, it can be considered a good proxy.

Finally, we use the Lerner index and a primary-bank dummy as market variables. The latter dummy variable indicates whether or not a bank is a

Chart 1

Austrian Banks' Net Interest Margin (unconsolidated data)



Source: OeNB.

Note: The definition of primary banks is given in this section. Interest on other assets and liabilities is included in the numerator of the NIM.

[9] *However, nondomestic business is taken into account in terms of cross-border loans granted by domestically operating banks.*

"primary bank," i.e. typically a small retail-oriented bank in the bottom layer of one of the tiered sectors of the Austrian banking system (savings banks, Raiffeisen credit cooperatives, Volksbank credit cooperatives).

Macroeconomic data are taken from the OeNB's macroeconomic dataset which serves as input for the Austrian Quarterly Macroeconomic Model AQM (see Schneider and Leibrecht, 2006). Specifically, we use real GDP growth, the GDP deflator and long- and short-term interest rates.

Descriptions of variables are given in table 1. For the ease of readability, those variables that are normalized by dividing by total assets are named by their numerator in the sequel (e.g. "bank loans" instead of "bank loans divided by total assets").[10] The column "Normalized by total assets" in table 1 indicates whether this naming convention applies. Profit data (i.e. net interest income, net

Table 1

Description of Variables

Name	Description	Normalized by total assets	Expected sign[1]
Net interest margin	Net interest income over total assets[2]	by definition	
Euro-denominated loans to domestic nonbanks	Loans to domestically domiciled nonbanks (i.e. customers) denominated in euro	yes	+
Foreign currency loans to domestic nonbanks	Loans to domestically domiciled nonbanks (i.e. customers) denominated in foreign currency	yes	+
Loans to foreign nonbanks	Loans to foreign domiciled nonbanks (i.e. customers), all currencies	yes	+
Bank loans	Loans to domestic and foreign banks, all currencies	yes	+
Interest-bearing securities	Exchange-traded interest-bearing securities (held as assets) issued by domestic and foreign banks and nonbanks, all currencies	yes	+
Nonbank deposits	Deposits taken from domestic and foreign nonbanks (i.e. customers), all currencies	yes	–
Bank deposits	Deposits taken from domestic and foreign banks, all currencies	yes	–
Securitized debt	Liabilities in the form of securitized debt obligations and transferable certificates	yes	–
Net fee income	Net income from fees and commissions (smoothed)	yes	–
Staff expenses	Staff expenses	yes	+
Other operating expenses	Operating expenses other than staff expenses	yes	+
Leverage ratio	Eligible tier 1 capital over total assets	by definition	±
RWA	Risk-weighted assets (credit risk only)	yes	±
LLP ratio	Specific loan loss provisions over gross exposure (loans to domestic and foreign nonbanks, all currencies), smoothed[3]	no	±
Lerner index	Relative markup of the price of an aggregate bank product over marginal costs; estimated by three-stage least squares in a simultaneous equation model	no	+
Crisis dummy	Time dummy from the third quarter of 2007 onward	no	–
Primary bank dummy	Dummy variable indicating whether a bank is a "primary bank"	no	+
GDP growth	Annual growth rate of quarterly real GDP	no	+
GDP deflator	Annual growth rate of the level of prices of all new, domestically produced, final goods and services in Austria	no	±
Short-term interest rate (–1)	Short-term nominal interest rate (3-month EURIBOR) p.a. at lag 1 (previous quarter)	no	+
Long-term interest rate (–1)	Long-term nominal interest rate (10-year Austrian government bond yield) p.a. at lag 1 (previous quarter)	no	+

Source: OeNB.

[1] *Theoretical considerations and/or evidence in the existing literature suggest that the impact of a variable on the NIM is either positive (+), negative (–) or mixed (±).*

[2] *Interest on other assets and other liabilities (e.g. receivables from goods and services) is excluded from net interest income. Including these items basically has only a negligible effect on the estimation results.*

[3] *According to national GAAP, specific loan loss provisions essentially are set aside only for loss events that have already occurred in the past, i.e. they do not exhibit a forward-looking character.*

[10] *In table 2, which presents the estimation results, normalization by total assets is mentioned explicitly.*

fee income, staff expenses, other operating expenses, various profit components for constructing the Lerner index) refer to quarterly flows.

4 Empirical Analysis

In this section, we briefly outline the econometric approach to the application of the Ho and Saunders (1981) model and its later refinements, as laid out in section 2, to the data described in section 3. The structure of our data (N=1,011 banks are observed for T=66 time periods) calls for a panel-data analysis. As not all institutions were active during the entire observation horizon, the resulting panel is unbalanced.

In its general form, a static one-way regression with panel-specific effects reads as follows:[11]

$$y_{i,t}=\alpha+\beta' X_{i,t}+ u_i+e_{i,t} \qquad i = 1,...,N,\ t = 1,...,T \tag{3}$$

where $y_{i,t}$ denotes the dependent variable (NIM), $X_{i,t}$ the K explanatory variables, and $e_{i,t}$ the idiosyncratic error term, which we assume – for the time being – to be independent and identically distributed (i.i.d.): $e_{i,t}\sim N(0,\sigma_e^2)$. α represents the global intercept, β the corresponding K regression coefficients, and u_i the panel-specific effect, for which we still need to determine whether it should be treated as a fixed parameter, i.e. fixed effect u_i with

$$\sum_{i=1}^{N} u_i=0$$

for the global intercept to be identified or rather as an i.i.d. random variable, i.e. random effect u_i with

$$u_i\sim N(0,\sigma_u^2),$$

$$\mathrm{Corr}[x_{i,t}^{(k)},u_i]=0 \quad t=1,...,T,\ k=1,...K.$$

The Breusch-Pagan Lagrangian multiplier test for random effects supports this view as it rejects the null of poolability at the 1% level, thereby underlining the importance of taking the presence of any type of bank-specific effect into account. Moreover, the Wooldridge test for autocorrelation in panel data rejects the null of no first-order autocorrelation in the idiosyncratic error terms at the 1% level (see Wooldridge, 2002, and Drukker, 2003). A modified Wald test for groupwise heteroskedasticity likewise rejects the null of homoskedasticity of the idiosyncratic error variances at the 1% level. In the presence of autocorrelation and heteroskedasticity within panels, we have to make a more general assumption about the distribution of the error term and thus employ robust estimators of the variance-covariance matrix hereinafter (see, e.g., Hoechle, 2007, for an overview of robust estimators in panel-data analysis).[12]

It is still unclear which specification of the bank-specific effects in static panel regression – fixed or random – better describes the data-generating process. As we are confronted with heteroskedasticity in the error variance, we need a variant of the Hausman test

[11] *We do not follow the original two-stage estimation technique of Saunders and Schumacher (2000) to distinguish the determinants of the NIM into a pure and a total margin. This approach would not mix bank-specific and macroeconomic variables in a single equation and hence would avoid any estimation bias due to group effects as argued by Moulton (1986). Our panel estimation approach, however, controls for bank-specific characteristics and for the fact that all banks operate in virtually the same macroeconomic environment.*

[12] *Note that preliminary robust fixed effects regressions allowing for variance clustering at (potential) clusters other than the panel identifier (e.g. the sectors within the banking system to which the individual banks belong or the Austrian provinces where the banks' headquarters are located) do not produce substantially different results. The correlation of the error term across panels therefore does not seem to be much of an issue. Another preliminary fixed effects regression allowing for AR(1) disturbances only but not for heteroskedasticity produces similar results.*

to decide for either random or fixed effects that is robust against heteroskedasticity. We therefore employ the Hansen (1982) J-test of overidentifying restrictions, which tests whether the additional moment condition $E_t[X_{i,t} u_i]=0$ as imposed by random effects estimation holds (see Arellano, 1993). As the null of the test of validity of this particular overidentifying restriction is rejected at the 1% level, we conclude that a model with fixed effects better describes the underlying data-generating process.[13]

Even if random effects or pooled OLS estimation may not fit the data as well as fixed effects, we will still present estimation results based on these methods since quantitatively and qualitatively similar estimation results across various estimation methods corroborate the explanatory power of the regressors. In addition, we allow for a primary-bank dummy to capture the difference in evolution of the NIM of this particular type of bank over time as depicted in chart 1. It would not be possible to include such a dummy in a fixed effects regression.

To provide additional evidence for the goodness of fit of our chosen specification, we also cover estimation results based on the feasible generalized least squares (FGLS) estimation, which is another estimator for producing results that are robust against autocorrelation and heteroskedasticity in the idiosyncratic error terms. In particular, we apply two variants: one variant estimates a common autoregressive coefficient and the other allows for panel-specific autocorrelation. As discussed in Hoechle (2007) and as can be seen in section 5, however, the reported robust standard errors of these estimators have to be interpreted with a grain of salt, as they tend to produce downward-biased results.

5 Estimation Results

We present our estimation results in table 2, where the NIM is the dependent variable. Generally speaking, not only is the vast majority of coefficient estimates highly significant and has the expected sign, but also the results discussed below hold across estimation techniques. This gives us confidence in the validity of the employed econometric model.

It is not surprising that the influence of the balance sheet structure on the NIM is substantial. The balance sheet structure not only summarizes past and current management decisions, thereby approximating the results of a multi-stage period dynamical optimization problem, but also sheds light on the business model of a bank.

On the asset side, euro-denominated loans to domestic nonbanks generate the highest positive contribution to the NIM, followed by loans to domestic nonbanks and interest-bearing securities. Foreign currency loans to domestic nonbanks only have a coefficient estimate two-thirds as high as their euro-denominated counterpart. Albacete et al. (2012), who conducted an analysis on foreign currency mortgage holders based on the Household Finance and Consumption Survey[14], show that foreign currency borrowers have substantially higher risk buffers than their domestic currency counterparts. As a consequence, the former might have a stronger position in loan contract bargaining, which results in a lower interest rate.

On the liability side, the cheapest refinancing sources are nonbank deposits, followed by bank deposits and secu-

[13] *Note that the fixed effects estimation in section 5 delivers an empirical value of* $Corr(\beta' X_{i,t}, u_i)=0.3649$.
[14] *See http://www.ecb.int/home/html/researcher_hfcn.en.html for more information.*

ritized debt. Here, their coefficient estimates are more or less in the same range and have the expected negative sign.

The negative sign for net fee income is a standard result. Maudos and Solis (2009) argue that more diversified banks have lower intermediation margins. This may reflect a strategy of cross-subsidization with traditional activities. Also Lepetit et al. (2008) find that higher income shares from fees and commissions are associated with lower margins and loan spreads. The latter result is consistent with the conjecture that banks price (or misprice) loans to increase sales of other services.

Staff and other operating expenses represent our cost- or efficiency-related variables. They have a relatively high negative impact on the NIM, which highlights the importance of banks being efficient. From a different perspective, only approximately 45% of an increase in staff or other operating expenses can be passed on to customers by increasing the NIM.

The financial crisis has uncovered the vulnerability of highly leveraged banks. Our results suggest that the higher the leverage ratio, the lower the NIM, which is in accordance with a recently published article by Hamadi and Awdeh (2012).

However, our results are in contrast to most of the empirical literature that is based on the Ho-Saunders dealership model, where the leverage ratio is used to approximate risk aversion and has a positive sign (see Saunders and Schumacher, 2000, Maudos and de Guevara, 2004, and Maudos and Solis, 2009). As we control for more variables, especially for the balance sheet structure, our findings suggest that holding regulatory tier 1 capital is costly in terms of generating net interest income. In other words, the leverage ratio has the same interpretation as other balance sheet liability variables (e.g. nonbank deposits). From a financial stability perspective, it is important to note that it is the second cheapest refinancing source, while, at the same time, a higher leverage ratio increases the risk-bearing capacity of banks, thereby contributing to the overall stability of the banking system.

To factor in the risk appetite of banks, we incorporate risk-weighted assets (RWA) and the loan loss provision (LLP) ratio in our estimation. To the best of our knowledge, we are the first to integrate both variables in a model.[15] Although it is debatable if RWA under Basel II measure risk perfectly, the coefficient estimate is still positive, which indicates that banks demand compensation for riskier assets.

The LLP ratio shows a negative sign, however. At the first glance, this result seems surprising and in contrast to most of the existing literature. Nonetheless, when we control for RWA and consider the fact that provisioning does not exhibit a forward-looking character under local GAAP, the negative coefficient makes perfect sense. Following Hanweck and Ryu (2005), our estimation shows that rising loan losses or nonperforming loans relative to earning assets causes banks to lose interest income generated from these loans and to move funds to lower-yielding assets that are less prone to default. Both effects tend to negatively influence the NIM in the short run, i.e. deteriorations in credit quality tend to decrease the NIM.

The Lerner index has the expected positive sign (see e.g. Liebeg and

[15] *Whereas only Liebeg and Schwaiger (2006) and Entrop et al. (2012) consider RWA, the LLP ratio or closely related variables are standard in the empirical literature on the NIM.*

Schwaiger, 2006, Maudos and Solis, 2009, or Entrop et al., 2012). As discussed in section 2, more market power leads to higher markups resulting in an increase in the NIM.

As described in section 2, the primary-bank dummy seems to have a prominent influence on the NIM (0.35 percentage points). However, after controlling for our variable list, its impact diminishes drastically to only 0.07 percentage points. This demonstrates that our model provides a near-perfect explanation for the difference in the NIM between primary and non-primary banks.

Table 2

Baseline Estimation Results

Dependent variable	Fixed effects		Random effects		Pooled OLS		FGLS, common AR(1) coefficient		FGLS, panel-specific AR(1) coefficient	
Net interest margin	Coefficient	SE (robust)	Coefficient	SE (robust)	Coefficient	SE (robust)	Coefficient	SE (robust)	Coefficient	SE (robust)
Euro-denominated loans to domestic nonbanks/TA	0.0094 ***	0.0004	0.0094 ***	0.0004	0.0101 ***	0.0002	0.0092 ***	0.0001	0.0092 ***	0.0001
Foreign currency loans to domestic nonbanks/TA	0.0062 ***	0.0005	0.0064 ***	0.0005	0.0082 ***	0.0002	0.0069 ***	0.0001	0.0066 ***	0.0001
Loans to foreign nonbanks/TA	0.0089 ***	0.0006	0.0095 ***	0.0006	0.0116 ***	0.0003	0.0101 ***	0.0001	0.0097 ***	0.0001
Bank loans/TA	0.0070 ***	0.0004	0.0072 ***	0.0004	0.0088 ***	0.0002	0.0077 ***	0.0001	0.0074 ***	0.0001
Interest-bearing securities/TA	0.0085 ***	0.0004	0.0087 ***	0.0004	0.0102 ***	0.0002	0.0094 ***	0.0001	0.0093 ***	0.0001
Nonbank deposits/TA	–0.0042 ***	0.0004	–0.0042 ***	0.0005	–0.0049 ***	0.0003	–0.0046 ***	0.0001	–0.0045 ***	0.0001
Bank deposits/TA	–0.0046 ***	0.0006	–0.0050 ***	0.0006	–0.0064 ***	0.0003	–0.0062 ***	0.0001	–0.0059 ***	0.0001
Securitized debt/TA	–0.0056 ***	0.0007	–0.0066 ***	0.0007	–0.0077 ***	0.0003	–0.0076 ***	0.0001	–0.0077 ***	0.0001
Net fee income/TA	–0.2811 ***	0.0435	–0.3113 ***	0.0416	–0.5587 ***	0.0276	–0.4520 ***	0.0067	–0.4367 ***	0.0065
Staff expenses/TA	0.4435 ***	0.0366	0.4640 ***	0.0387	0.6874 ***	0.0325	0.5383 ***	0.0042	0.5331 ***	0.0041
Other operating expenses/TA	0.4477 ***	0.0538	0.4658 ***	0.0555	0.6530 ***	0.0508	0.5904 ***	0.0052	0.5768 ***	0.0050
Leverage ratio	–0.0043 ***	0.0007	–0.0033 ***	0.0007	–0.0009	0.0009	–0.0031 ***	0.0002	–0.0034 ***	0.0001
RWA/TA	0.0005 ***	0.0002	0.0006 ***	0.0002	0.0011 ***	0.0001	0.0011 ***	0.0000	0.0009 ***	0.0000
LLP ratio	–0.0046 ***	0.0006	–0.0042 ***	0.0006	–0.0019 ***	0.0003	–0.0025 ***	0.0002	–0.0024 ***	0.0002
Lerner index	0.0066 ***	0.0008	0.0066 ***	0.0008	0.0080 ***	0.0009	0.0080 ***	0.0000	0.0078 ***	0.0000
Crisis dummy	–0.0003 ***	0.0000	–0.0003 ***	0.0000	–0.0003 ***	0.0000	–0.0003 ***	0.0000	–0.0003 ***	0.0000
Primary-bank dummy			0.0007 ***	0.0002	0.0003 ***	0.0001	0.0005 ***	0.0000	0.0005 ***	0.0000
GDP growth	0.0024 ***	0.0002	0.0023 ***	0.0002	0.0020 ***	0.0002	0.0020 ***	0.0002	0.0021 ***	0.0002
GDP deflator	–0.0062 ***	0.0008	–0.0060 ***	0.0008	–0.0037 ***	0.0008	–0.0053 ***	0.0005	–0.0050 ***	0.0005
Short-term interest rate (–1)	0.0001 ***	0.0000	0.0001 ***	0.0000	0.0002 ***	0.0000	0.0002 ***	0.0000	0.0002 ***	0.0000
Long-term interest rate (–1)	0.0003 ***	0.0000	0.0003 ***	0.0000	0.0003 ***	0.0000	0.0003 ***	0.0000	0.0003 ***	0.0000
Constant	–0.0029 ***	0.0003	–0.0038 ***	0.0003	–0.0053 ***	0.0002	–0.0043 ***	0.0001	–0.0041 ***	0.0000
No. of observations	42,332		42,332		42,332		42,327		42,327	
No. of groups	915		915				910		910	
R^2 within	0.723		0.722							
R^2 between	0.761		0.799							
R^2 overall	0.766		0.796		0.817					
F statistic	677				4,535					
χ^2			15,194				168,701		185,681	
Corr$[\beta' X_{i,t}, u_i]$	0.365									
Estimated AR(1) coefficient							0.343			

Source: OeNB.

*Note: *** denotes statistical significance at the 1%, ** at the 5%, and * at the 10% level. All explanatory variables denoted by "ITA" are expressed as a share of total assets. All estimation methods use robust standard errors (SE). The random effects estimator allows for unbalanced panels as it uses the Swamy-Arora estimator of the variance components. Both FGLS models allow for heteroskedasticity within panels.*

The importance of economic conditions for the NIM is reflected by the significant contribution of GDP growth, GDP deflator growth as well as short- and long-term interest rates.

Consistent with the literature, GDP growth has the expected positive influence on the NIM. Higher overall economic activity generally boosts credit demand.

Instead of GDP deflator growth, most empirical studies on the NIM use an inflation proxy based on the consumer price index (CPI). Horvath (2009) and Rumler and Waschiczek (2012) observe a positive influence on the NIM. We think, however, that GDP deflator growth is a better indicator of price changes in the economy, as it reflects price changes of all goods and services produced within the country, whereas the CPI only reflects the prices of a more or less representative basket of goods and services purchased by consumers. Moreover, our results show a negative coefficient estimate for GDP deflator growth, which coincides with the theoretical considerations of Boyd et al. (2001), who claim that there is a negative relationship between financial sector performance and inflation. They also argue that in economies with high inflation, intermediaries will lend less and allocate capital less efficiently.[16] We believe that banks try to optimally allocate their resources by setting real rates and taking inflation expectations into account. With perfect foresight of inflation there should be no influence on the NIM, at least in theory. In Austria, inflation has been stable for a long period of time, which is in contrast to the countries analyzed in the other studies mentioned here, where a positive coefficient for inflation was estimated. In other words, inflation variance has been very low, which may have caused banks to refrain from pricing in inflation.

We include long- and short-term nominal interest rates lagged by one quarter to avoid problems with interest rate adjustment clauses of banks.[17] The positive coefficient estimates of both interest rates suggest that low interest rate environments put pressure on banks' NIM as nominal (deposit) rates have a lower bound at zero. Additionally, long- and short-term interest rate coefficients enable us to indirectly observe the effects of the market interest rate spread on the NIM. The spread (long-term minus short-term interest rate) also has a positive sign, which is confirmed in Rumler and Waschiczek (2012) since a steeper yield curve helps banks boost their NIM.

To the best of our knowledge, we are the first to quantify the influence of the global financial crisis on banks' NIM. The crisis dummy has the expected negative sign, which points to the fact that the costs of the crisis could not be fully passed on to banks' customers. The significant contribution of the crisis dummy shows that the global financial crisis had an enormous impact on banks' business environment, which was not fully reflected in the macroeconomic variables considered above.

6 Summary and Conclusions

In this paper, we investigate the determinants of the net interest margin in the Austrian banking sector. We assess

[16] *The robustness of our negative coefficient for the GDP deflator is confirmed by an alternative estimation where we obtain a negative coefficient for consumer price inflation as well.*

[17] *Although the standard literature on the NIM uses interest rate volatility as an explanatory variable, we think that in the special case of Austria, where the majority of loans are floaters, banks have a natural hedge against interest rate risk and therefore we can gain more insight by including rates. An alternative estimation shows that the short-term interest rate volatility coefficient estimate has the expected positive sign.*

to what extent macroeconomic, market and bank-specific variables influence the NIM. Based on a unique supervisory panel-data set for the Austrian banking sector, which comprises around 42,000 observations between the first quarter of 1996 and the second quarter of 2012, we apply different panel estimation techniques to the determinants of the NIM that have proven to work best according to the existing literature as well as to our two new contributions, namely banks' business models in terms of their balance sheet structure and the global financial crisis. Our estimation results suggest that not only the determinants identified in the existing empirical literature (different types of non-interest income and expenses, various risk measures, competition, the macroeconomic environment) have significant explanatory power with regard to the NIM, but also our two innovations (balance sheet structure, global financial crisis). Since the results are generally robust across estimation techniques and since alternative specifications of dependent and explanatory variables yield very similar outcomes, we are confident that we have identified the key contributors to the NIM in the Austrian banking sector.

For the bank-specific variables net fee income, staff expenses and other operating expenses, we obtain results in accordance with the existing empirical literature. On average, the efficiency of Austrian banks has increased since 1996, which has led to lower positive contributions of staff expenses and – to a minor extent – of other operating expenses to the NIM.

The balance sheet structure is an important driver of the NIM. In fact, the reduction of euro-denominated loans to domestic nonbanks in favor of foreign currency loans to domestic nonbanks and loans to foreign nonbanks (i.e. cross-border loans), which is particularly pronounced for non-primary banks, has driven down the NIM considerably since 1996.[18] The balance sheet structure as a proxy for banks' business models is also the most significant difference between primary and non-primary banks. In fact, this shift partly reflects the expansion to banking markets in Central, Eastern and Southeastern Europe and the Commonwealth of Independent States.

In the context of regulatory requirements, risk-weighted assets play an important role in determining the NIM. Their positive influence is consistent with theoretical considerations that, for riskier assets, higher margins are requested from a forward-looking perspective. Moreover, in contrast to most other empirical studies, the LLP ratio has a negative impact on the NIM. However, this result fits in perfectly with the legal framework when considering the backward-looking character of loan loss provisioning.

Our last bank-specific variable, namely the leverage ratio, confirms that holding more equity is costly in terms of generating net interest income.

The policy implications of these findings are twofold: First, banks price RWA into their NIM. Second, the leverage ratio, which will be an additional part of the Basel III framework, also has a significant impact on the NIM. As more equity (in terms of tier 1 capital) is supposed to serve as a buffer to absorb shocks, the leverage ratio must be gradually increased after the

[18] *This shift toward foreign currency loans to domestic nonbanks and loans to foreign nonbanks was already highlighted as a driving force of the declining NIM by Liebeg and Schwaiger (2006), who analyzed a similar Austrian dataset covering the period from 1996 to 2005.*

introduction of Basel III. However, our findings suggest that holding more equity is only 1 basis point more expensive than customer deposits (the cheapest refinancing source) in terms of a contribution to the NIM. In light of our analysis, the argument that a higher leverage ratio will put downward pressure on credit supply cannot be supported. In fact, the estimated impact of a higher leverage ratio is much lower than the benefits from an increased leverage ratio in terms of the shock-absorbing capacity of the banking system.

Aside from bank-specific variables and the regulatory environment, the Lerner index has the foreseen positive impact on the NIM. Therefore, we can support the structure-conduct-performance theory from industrial organization.[19] Our findings uncover the following: First, the Lerner index had been rather stable between the first quarter of 1996 and the second quarter of 2007 before dropping during the financial crisis, after which the index came back to its long-run level. Second, there is a significant difference between the Lerner index of primary and non-primary banks. Based on the classification of Fischer and Hempell (2006), primary banks with an average Lerner index of 0.22 operate in regional markets with low competition, whereas non-primary banks with an average Lerner index of 0.12 face high competition.

Finally, the macroeconomic environment – approximated by Austrian short- and long-term interest rates, GDP growth and the GDP deflator – has a significant impact on the NIM. The most significant contribution stems from the interest rate environment. More specifically, a low interest rate environment and/or a low spread between long- and short-term market interest rates are a detrimental scenario for the NIM.

As expected, GDP growth boosts the NIM. In contrast to most findings in the literature, inflation does not have a positive impact on the NIM in Austria. We obtain a negative relationship, which could be attributed to the fact that Austria is a low-inflation country with a high share of floating-rate loans that serve as a natural hedge against inflation.

From a macroprudential perspective, it is crucial to monitor banking activities in the current low interest rate environment, as such conditions had prevailed at the beginning of the subprime crisis. In the years to come, detecting excessive search for yield behavior by banks will therefore be high on banking supervisors' radar.

[19] *This paradigm assumes that the market structure determines firm conduct, which in turn determines performance.*

References

Albacete, N., P. Fessler and M. Schürz. 2012. Risk Buffer Profiles of Foreign Currency Mortgage Holders. In: OeNB Financial Stability Report 23. 62–75.

Allen, F. and D. Gale. 1995. A welfare comparison of intermediaries and financial markets in Germany and the US. In: European Economic Review 39. 179–209.

Allen, L. 1988. The Determinants of Bank Interest Margins: A Note. In: The Journal of Financial and Quantitative Analysis 23(2). 231–235.

Angelini, P. and N. Cetorelli. 2003. The Effects of Regulatory Reform on Competition in the Banking Industry. In: Journal of Money, Credit and Banking 35(5). 663–684.

Arellano, M. 1993. On the testing of correlated effects with panel data. In: Journal of Econometrics 59. 87–97.

Boyd, J., R. Levine and B. Smith. 2001. The impact of inflation on financial sector performance. In: Journal of Monetary Economics 47(2). 221–248.

Delis, M. and G. Kouretas. 2011. Interest rates and bank risk-taking. In: Journal of Banking and Finance 35(4). 840–855.

Drukker, D. M. 2003. Testing for serial correlation in linear panel-data models. In: The Stata Journal 3. 1–10.

Entrop, O., C. Memmel, B. Ruprecht and M. Wilkens. 2012. Determinants of Bank Interest Margins: Impact of Maturity Transformation. Deutsche Bundesbank Discussion Paper 17/2012.

Fischer, K. and H. Hempell. 2006. Regional Markets, Oligopoly, and Market Power in Banking. Unpublished.

Hamadi, H. and A. Awdeh. 2012. The Determinants of Bank Net Interest Margin: Evidence from the Lebanese Banking Sector. In: Journal of Money, Investment and Banking 23(3). 85–98.

Hansen, L. P. 1982. Large sample properties of generalized method of moments estimators. In: Econometrica 50. 1029–1054.

Hanweck, G. and L. Ryu. 2005. The sensitivity of bank net interest margins and profitability to credit, interest rate, and term-structure shocks across bank product specializations. Technical report. School of Management, George Mason University and Federal Insurance Corporation.

Herfindahl, O. 1955. Comment on Rosenbluth's measures of concentration. In: Stigler, G. J. (ed.). Business Concentration and Price Policy. Princeton: Princeton University Press.

Hirschman, A. 1964. The paternity of an index. In: American Economic Review 54(5). 761–762.

Ho, T. and A. Saunders. 1981. The Determinants of Bank Interest Margins: Theory and Empirical Evidence. In: The Journal of Financial and Quantitative Analysis 16(4). 581–600.

Hoechle, D. 2007. Robust standard errors for panel regressions with cross-sectional dependence. In: The Stata Journal 7. 281–312.

Horvath, R. 2009. Interest Margins Determinants of Czech Banks. Working Papers IES 2009/11. Charles University Prague, Faculty of Social Sciences, Institute of Economic Studies.

Keeley, M. 1990. Deposit insurance, risk, and market power in banking. In: American Economic Review 80(5). 1183–1200.

Klein, M. 1971. A theory of the banking firm. In: Journal of Money, Credit, and Banking 3. 205–218.

Lepetit, L., E. Nys, P. Rous and A. Tarazi. 2008. The expansion of services in European banking: Implications for loan pricing and interest margins. In: Journal of Banking and Finance 32(11). 2325–2335.

Liebeg, D. and M. Schwaiger. 2006. Determinants of the Interest Rate Margins of Austrian Banks. In: OeNB Financial Stability Report 12. 104–116.

Marrouch, W. and R. Turk Ariss. 2011. Bank Pricing under Oligopsonistic-Oligopoly: Evidence from 103 Developing Countries. Working papers series. Lebanese American University.

Maudos, J. and J. de Guevara. 2004. Factors explaining the interest margin in the banking sectors of the European Union. In: Journal of Banking and Finance 28(9). 2259–2281.

Maudos, J. and L. Solis. 2009. The determinants of net interest income in the Mexican banking system: An integrated model. In: Journal of Banking and Finance 33(10). 1920–1931.

Memmel, C. and A. Schertler. 2011. Banks' management of the net interest margin: evidence from Germany. Deutsche Bundesbank Discussion Paper 13/2011.

Monti, M. 1972. Deposit, credit, and interest rate determination under alternative bank objectives. In: Szego, G. P. and K. Shell (eds.). Mathematical Methods in Investment and Finance. Amsterdam: North-Holland.

Moulton, B. 1986. Random group effects and the precision of regression estimates. In: Journal of Econometrics 32(3). 385–397.

Rumler, F. and W. Waschiczek. 2012. Have Changes in the Financial Structure Affected Bank Profitability? Evidence for Austria. OeNB Working Paper 180.

Saunders, A. and L. Schumacher. 2000. The determinants of bank interest rate margins: an international study. In: Journal of International Money and Finance 19(6).

Schneider, M. and M. Leibrecht. 2006. AQM-06: The Macroeconomic Model of the OeNB. OeNB Working Paper 132.

Van Hoose, D. 2010. The Industrial Organization of Banking. Dordrecht, Heidelberg, London, New York: Springer.

Wooldridge, J. M. 2002. Econometric Analysis of Cross Section and Panel Data. Cambridge, MA: The MIT Press.

Zarruk, E. and J. Madura. 1992. Optimal Bank Interest Margin under Capital Regulation and Deposit Insurance. In: The Journal of Financial and Quantitative Analysis 27(1). 143–149.