The Effect of Capital Requirement Regulation on the Transmission of Monetary Policy: Evidence from Austria.

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Abstract:

This paper investigates the existence of a *bank lending* and a *bank capital channel* in Austria by applying the dynamic Arellano-Bond GMM-estimator to a quarterly bank level dataset spanning from 1997 to 2003. While we do find evidence that the *bank lending channel* is in existence, with an important role active for capitalization, we are unable to confirm that the *bank capital channel* is in force in Austria. Our results indicate some counter-cyclicality in lending activity, a finding that is in line with the existing Austrian literature.

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1. Introduction

Traditionally, theory relating to the monetary policy transmission process- the set of links through which monetary policy affects the economy - has largely ignored the role of bank equity, focusing rather on the financial conditions of firms and households. While the role of banks in this process has gained a lot of attention in recent decades, an outstanding and relevant issue that has largely been ignored is the role of capital requirement regulation, as defined by the Basel Accord.

The importance of considering capital requirement regulation is guided by the hypothesis that rigid minimum capital ratios act to amplify macroeconomic fluctuations in a non-Modigliani-Miller world. The complex relationship between capital requirement regulation, bank lending and monetary policy transmission, therefore originates from the premise that if a bank's access to capital is limited, the required capital-loans regulation becomes binding, then the amount of capital affects the volume of lending.

This paper tries to fill a gap in the empirical literature by considering how capital requirement regulation can affect lending decisions and consequently the transmission of monetary policy from the central bank to the economy. Research concerning the bank capital channel as an additional transmission mechanism of monetary policy has not yet been performed for Austria. In our analysis, we focus on the transmission of monetary policy, namely the reaction of bank lending due to a change in the interest rate, and test if there are differences in banks' lending behavior depending on the degree of capitalization. Furthermore, we apply a proxy for maturity transformation costs and employ a new data set including quarterly bank level statistics for Austrian banks, spanning from January 1997 to December 2003. In addition, we experiment with an alternative measure for the monetary policy indicator, thus inspecting the accuracy of the information contained in the typically adopted Vienna Interbank Offered Rate (VIBOR). In order to examine both the bank capital and the bank lending channels we use a dynamic panel framework giving us an insight into the heterogeneity of the Austrian banking system. The GMM estimator developed by Arellano and Bond (1991) is applied thereafter.

The remainder of the paper is organized as follows: In section 2 we describe the role that banks play in the transmission of monetary policy. In section 3 some stylized facts of the Austrian banking system and its regulation are presented. Section 4 contains a description of the data used for the econometric study. The econometric model is shown in section 5 and the results are presented and discussed in section 6. Section 7 shortly concludes.

2. The role of banks in monetary transmission

Bank capital regulation and the macro economy

According to Mishkin (2000) the main instruments of banking regulation can be organized into several broad categories namely the government safety net, restrictions on bank asset holdings, capital requirements, chartering and bank examination, disclosure requirements, consumer protection and restrictions of competition.[3] Such instruments are commonly adopted as a measure for preventing systemic risk, ensuring that banks and investment firms are able to respond quickly to market change, allowing them to operate flexibly, while simultaneously safeguarding consistency within the international banking sector.

The 1988 Basel Capital Accord and its subsequent amendments address the capital requirement aspect of the above-mentioned instruments. The Accord requires banks to hold an amount of capital specified as a percentage of their risk-weighted assets. The requisite capital is to lie above a certain threshold defined as a function of two types of risk (credit risk and market risk). Such capital acts as a "buffer" for possible future losses effectively regulating the safety and soundness of each single institution in an attempt to create a banking system generally less prone to risk and crises. The objective behind the 8%-capital requirements is purely micro-economic: A high level of equity capital is designed to overcome the asymmetric information problems implied by an entirely deposit financed banking system. Depositors are always paid out their holdings

[3] A similar system of classification is adopted by other sources including among others Freixas and Rochet (1997) and Greenbaum and Thakor (1995).

on a first come first served basis, thus reducing their incentive to properly monitor bank management. The combination of the illiquid nature of banks' assets coupled with the risk of not being paid out under the first come first serve basis, together create an incentive for depositors to run during cases of perceived or real problems that a bank may face. Equity capital holders however, do not have an incentive to run as they will always be served last, they rather have a strong incentive to monitor bank management in its loan policy ex ante (see Diamond and Rajan (2000) for a slightly different explanation). A "high" level of bank equity capital is therefore supposed to enhance monitoring and reduce the risk exposure of the individual bank, thereby increasing the stability of the entire industry.

Over the last years economists have conducted a large amount of research on further implications of such capital requirements. One strand of literature focuses on the risk aversion and risk-taking characteristics of banks under capital regulation (see e.g. Kim and Santomero, 1988; Flannery, 1989), another approach highlights the effect of the levels of capital holdings on loan growth (Diamond and Rajan, 2000 and 2001). This literature states that there is a trade-off between capitalization and lending. Hahn (2002) finds evidence in favor of this approach for Austria within the framework of a static panel model with annual bank level data for 1996-2000. In this paper we will focus on a third topic, the reaction of bank lending to macroeconomic shocks, especially monetary shocks, while operating under rigid capital requirements. The question we address is the following: If the regulatory capital-asset ratio is affected by a shock, how will banks react in order to adjust this ratio? Will bank management adjust on the asset side (the denominator), i.e. change the loan supply, or will it rather change the liability side (the numerator), i.e. the holding of capital? Several authors (e.g. Kishan and Opiela, 2000; Van den Heuvel, 2002a, 2002b, 2003) have pointed out that it will be a change in the loan supply due to an imperfect market for bank equity thereby having an effect on economic activity[4]. The exact line of reasoning will be elaborated in the next section.

Bank capital and bank lending

Information asymmetries and the costly enforcement of contracts generate agency problems within the financial markets. Agency costs are, according to Bernanke and Gertler (1995), reflected in the *external finance premium*, which is the primary cause for the existence of a "*credit channel*" of monetary transmission. The credit channel works through three separate channels namely the "*balance sheet channel*", the "*bank lending channel*" and the "*bank capital channel*". The balance sheet channel stresses the impact of monetary policy on borrowers' financial position (net worth, cash flow and liquid assets), on the size of the external finance premium and consequently on investment spending. The bank lending channel stresses however, that monetary policy may affect the supply of intermediated credit, bank loans in particular, and is active through an imperfect market for bank debt (Kashyap and Stein, 2000; Stein, 1998). Empirically both links have been investigated extensively with the use of both macro- and microeconomic data. For Austria, the empirical findings for the bank lending channel are somewhat contradictory, as an "interest rate puzzle" seems to exist. A positive effect of a change in interest rates documents an accommodative lending behavior of banks (Kaufmann, 2001; Braumann, 2004). The most recent study (Frühwirth-Schnatter und Kaufmann, 2004)

[4] An additional condition for an effect on real activity is the existence of bank dependent borrowers who are not able to perfectly substitute other forms of external finance for bank loans.

finds that, though the the interest rate puzzle applies to the majority of banks in Austria, it is rather small. More importantly, the authors conclude that traditional bank characteristics, such as the size or the liquidity, cannot be used to reveal asymmetric lending reactions in the sense of the bank lending channel.

Recent literature has examined the role of the bank lending channel of monetary policy in the presence of capital requirement regulation. The imperfection in the market for bank debt consists essentially of information asymmetries relating to the quality of the banks´ loan portfolios. This imperfection may be reinforced by an additional imperfection in the market for bank equity: Capital serves as a buffer for loan losses. Therefore, high capitalization may indicate lower risk for investors in uninsured bank debt if the market for bank equity (i.e. capital) is imperfect, i.e. if a bank cannot raise new capital frictionlessly. Thus the external finance premium decreases with the degree of capitalization and consequently, better capitalized banks may on average find it easier than low capitalized banks to finance their lending business. This property also becomes important in case of a monetary tightening by the central bank. Reserves are reduced and banks have to substitute their insured deposits with other more senior forms of debt. Banks with a low degree of capitalization, and thus a high external finance premium, will find it harder to finance their activities issuing debt and are hence more likely to be forced to reduce lending after increases in interest rates. Kishan and Opiela (2000) find evidence for differential lending reactions after changes in interest rates for differently capitalized banks in the US, although only among small banks.

The *bank capital channel* implies a more continuous relationship between capitalization and lending than the bank lending channel does as it considers the dynamic effects of bank capital due to changes in the stance of monetary policy. The logic is such that banks are exposed to interest rate risk whenever the interest sensitivity of their assets does not match the sensitivity of their liabilities, or off-balance sheet positions. For a bank whose liabilities re-price faster than its assets, a rise in interest rates can reduce net interest income by increasing the institution's cost of funds relative to its yield on assets and vice versa. Hence, a monetary tightening will reduce bank profits, which are, if retained, part of the regulatory capital. If, as in the case discussed above, the market for bank capital is imperfect and if capitalization is low enough (i.e. close to the minimum), then the bank will have to reduce lending in order to avoid a fall of capital under the minimum regulatory level (Van den Heuvel, 2003a, 2003b).

Three preconditions are therefore necessary for the bank capital channel to be operative: an imperfect market for bank equity, a maturity mismatch between assets and liabilities exposing banks to interest rate risks as well as the existence of minimum capital requirements. Van den Heuvel (2002a) presents indirect evidence for the bank lending channel for the US by regressing state level output on capital to assets ratios. Gambacorta and Mistrulli (2003) model lending directly by a measure of capital in excess of the regulatory minimum and thereby present evidence for the bank capital channel in Italy.

3. The structure of the Austrian banking system

The Austrian banking system is a universal banking system whereby no statutory requirement to separate commercial banking activities from investment banking activities exists. The system is organized by "sectors" where the 897 independent banks[5] (December 2002) are divided into seven categories: joint stock banks (59), savings banks (64), state mortgage banks (9), Raiffeisenbanken (609), Volksbanken (70), special purpose banks (81) and housing construction savings and loan associations (5). Each sector has its own association to represent its interests. The classification of banks by sector is determined by their legal form or by the industry association to which they belong.

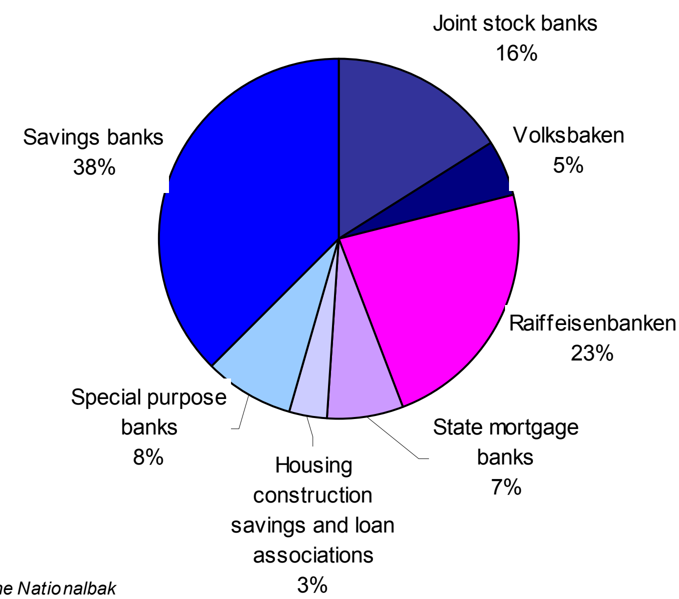
The sectors are organized in "single-tier" and "multi-tier" structures. State mortgage banks, joint stock banks, housing construction savings and loan associations, along with specialized credit institutions are organized under the "single-tier" system. Savings banks and *Volksbanken* are organized under the "two-tier" system with *Erste Bank* and the *Oesterreichische Volksbanken AG* serving as the central institutions respectively. Most savings banks are owned either by a municipality or by a foundation. Publicly owned savings banks are backed by a public guarantee which is underpinned and superseded by a mutual assistance obligation. *Raiffeisenbanken* are characterized by a "three-tier" system with *Raiffeisen Zentralbank* and 8 *Raiffeisenlandesbanken* as central and regional institutions respectively. Credit co-operatives (*Volksbanken* and

[5] Including special purpose banks established for special financing purposes, such banks do not have full banking licenses.

Raiffeisenbanken) include mostly very small banks where depositors are the shareholders. A mutual assistance obligation similar to that of the savings banks' sector links the *Raiffeisenbanken* with the *Volksbanken*.

Chart 1: Individual sector percentage shares of the Austrian banks' aggregate balance-sheet total

December 2002



Source: Oesterreichische Nationalbak

Within the "multi-tier" sectors, the central or head institution assumes the task of coordination, including sectoral funding. Moreover, the head institution serves as a central hub for business done with other sectors. Members of the "two-tier" and "three-tier" structure co-operate closely alleviating insolvency problems and preventing difficulties that could otherwise affect small banks. A particularly strong awareness of belonging together exists between the credit co-operatives *and* savings banks. Together they form more than 90% of the entire industry. The sectoral organization of the banking industry has historical roots and while there is little difference in the activities of the different sectors, the structure remains in place. Such a network structure has important consequences for our analysis, as commonly intra-network liquidity management is made possible by large head institutions leading to possible affects on the reaction of member banks to a shift in monetary policy. Ehrmann and Worms (2004) analyze the reaction of inter-bank lending to a monetary policy shock and argue that the existence of bank networks are indeed important for a banks' reaction to monetary policy. They find evidence that smaller banks are able to access the inter-bank market through the head institution of their network organization. They demonstrate that the reactions of banks forming part of a network are not solely dependent on bank specific characteristics, but that rather they depend on the position of the network in the inter-bank market.

Table 1: Banking Systems Overview

	Austria	Belgium	Finland	Germany	Netherlands	UK	USA
Number of banks per 100,000 people	11,9	1,2	0,2	3,9	5,1	0,8	3,9
% of deposits accounted for by 5 largest banks	38	74	97	12	88	n.a.	21
% of total bank assets government owned	4	n.a	22	42	6	0	0
% of total bank assets foreign owned	5	n.a	8	4	n.a	n.a.	5
Overall bank activities & ownership restrictiveness	1,3	2,3	1,8	1,3	1,5	1,3	3
Professional supervisors per bank	1	0,7	0,1	1	n.a	0,7	0,1
Does an explicit deposit insurance scheme exist?	yes	yes	yes	yes	yes	yes	yes
% of 10 largest banks rated by int'l agencies	80	50	100	100	30	100	100

Source: Barth, Caprio and Levine (2001).

Due to the large number of independent banks and branch offices that exist (5,453), Austria has for many years been considered as being over-banked, with as many as 11.9 banks existing per 100,000 people a large proportion when compared to just 3.9 in Germany or the US (see table 1). In analyzing the bank structure of Austria, it is evident that while the number of banks is extremely high, the degree of concentration[6] is relatively low largely due to the high number of credit institutions in existence. Austria is therefore characterized by a banking system with many very small banks, a large proportion of which can be attributed to its network structure.

Bank supervision and regulation

Compared to other countries, Austria enjoys a high standard of financial supervision, based on strong institutions and a modern legal framework. A new integrated supervisory regime took effect in April 2002, under which the Financial Market Authority performs the banking, securities, insurance, and pension fund supervision and ensures the adherence of the banking sector to EU banking laws. With the dominant role that banks play in the Austrian financial sector, supervision holds an important function in ensuring the ability of the banking system to absorb risks, which is crucial for its stability.

In Austria, the capital requirements for credit risk and market risk were introduced in 1993 and 2001 respectively. In terms of credit risk, the Austrian Banking Act requires banks to hold capital of at least 8% of the total amount of risk-weighted assets.[7] Assets are assigned risk weights according to their assumed rate of credit risk. (0% for items

[6] The percentage of deposits accounted for by the five largest banks.

with low credit risk, 20% for items with below average credit risk, 50% for items with medium credit risk, 100% for items with high credit risk).[8] Capital requirements for market risks aim to reduce the risk of losses in both on and off-balance sheet positions arising from movements in market prices. The requirements are therefore relevant for interest rate related instruments, as well as equities, foreign exchange and commodities in the trading book. The risk is broken down into *"specific risk"*[9] pertaining to each individual security and *"general risk"*[10] for the combined portfolio, where short and long positions in different securities and instruments can be offset. The total capital ratio is calculated by adding the sum of risk-weighted assets for credit risks to a measure of market risk multiplied by 12.5 (the reciprocal of the minimum capital ratio of 8%). [11]

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[7] The figure may be increased to 8.5% if it appears to be in the national economic interest in a functioning banking system.

[8] Interested readers should consult Chapter V "The Austrian Banking Act and The Austrian Financial Market Authority Act" (OeNB 2002a) for further classification of how asset weights are assigned.

[9] Specific risk relates to losses that can be determined by market price fluctuations, which are specific to the economic conditions of the issuer.

[10] General risk relates to asset price fluctuations correlated to market developments.

[11] In the calculation of capital requirements for credit and market risk a numerical link should be created by multiplying the measure of 12.5 (the reciprocal of the minimum capital ratio of 8%).

4. The data

To estimate the model employed in our analysis, we use a sample that includes quarterly balance sheet data from the first quarter of 1997 to the fourth quarter of 2003. The data was obtained from the Oesterreichische National Bank (OeNB), which collects the statistics from all Austrian banks. Effectively, the estimations of the dependent variable started in 1998 as regulatory capital and maturity classes were only available from this time. Thus, data preceding 1998 was used only in order to obtain lagged values of some of the variables.

Only banks that were in business at the end of 2003 were included in our dataset. The original sample consequently includes 894 banks. In a first step towards cleaning the data, specialized banks were identified by their banking code and were subsequently deleted from the sample. In most cases these are banks owned by car producers whose loans are heavily dependent on new car models, or then foreign banks with branches in Austria. Many banks in these two groups show a highly volatile loan series. In considering mergers, we assigned a dummy variable for the buying bank in the quarter when the merger took place. Since we use the differences of logs for claims on customers as our proxy for loan growth, we detected further outliers by looking for jumps larger than 50 or smaller than -50 percent. If a bank showed more than one jump of this kind, it was omitted from the sample. Quite often this was a good way to identify some more specialized banks which were not deleted before as they did not bear an according banking code. If only one jump was identified, which was not explicable by a reported merger, another dummy variable was added. This was the case for seven banks.

To keep as much information as possible and in contrast to existing work done with Austrian bank level data (see Kaufmann, 2001; Frühwirth-Schnatter and Kaufmann, 2003), we use an unbalanced panel, additionally including all banks that were founded during the sample period and that still existed at the end. After the cleaning process was completed, 760 banks were left in our dataset. They cover almost 90% of the total loans and total assets of the initial sample.

Table 2: The Structure of the Banking Sector (sample after cleaning)

	Total Assets Dec. 2003		**Total Loans to non-financial institutions Dec. 2003**		
	EUR million	**% share in aggregate total assets**	**EUR million**	**% share in aggregate total assets**	**Number of banks**
Sparkassen (Savings banks)	115,750	22	55,260	20	64
Erste Bank (central inst.)	*61,802*		*20,753*		*1*
Volksbanken (industrial credit cooperatives)	33,624	6	17,253	6	68
Oesterreichische Volksbank AG	*12,742*		*4,309*		*1*
State mortgage banks	45,750	9	28,304	10	8
Commercial banks*	178,762	33	96,977	36	24
Raiffeisenkassen (agricultural credit cooperatives)	149,583	28	67,635	25	595
Raiffeisenzentralbank (head institute)	*37,836*		*10,512*		*1*
Raiffeisenlandesbanken	*45,413*		*18,104*		*8*
Other banks**	13,884	3	6,708	2	1
Total	537,352		272,136		760
Total assets of banking sector	605,106				
Percentage in sample	89				

* Note: BA-CA, Austria's largest bank (105.659 millions of assets) is included in the group of commercial banks even though it is often shown in Sparkassen.
**We only included Postsparkasse and excluded all other specialised banks from our sample.

5. The model

To test for the existence of the bank lending and bank capital channels under different degrees of capitalization in Austria, as well as to provide some comparability, we employ an empirical model that is related to the work of the "monetary transmission network"[12]. We estimate the following equations through the use of instrumental variable estimators for panels developed by Arellano and Bond (1991). For consistent estimates, the test of overidentification can not be rejected and therefore autocorrelation of order two or higher should not exist. In all of the following results, the tests indicated that there is no autocorrelation of higher order. As this is a common finding within the existing literature, we only show the results for the autocorrelation test of first and second order. Furthermore, we estimate heteroscedasticity robust variance-covariance matrices. In this case the Sargan test of overidentification cannot be performed as the distribution is not known. In appendix 3 the test of overidentification for the estimations without heteroscedasticity robust variance-covariance matrices is shown. It is assumed to be extremely conservative under the aforementioned circumstances. The estimated equation is given by:

$$\begin{aligned}\Delta \ln L_{it} &= \sum_{j=1}^{8}\alpha_j \Delta \ln L_{it-j} + \sum_{j=0}^{3}\beta_j \Delta MP_{t-j} + \sum_{j=0}^{3}\varphi_j \Delta \ln REER_{t-j} + \sum_{j=0}^{3}\delta_j \Delta \ln y_{t-j} + \lambda X_{it-1} + \\ &\phi\Delta(\rho_i \Delta MP)_{t-1} + \sum_{j=1}^{3}\gamma_j X_{it-1}\Delta MP_{t-j} + \sum_{j=1}^{3}\eta_j X_{it-1}\Delta \ln REER_{t-j} + \sum_{j=1}^{3}\tau_j X_{it-1}\Delta \ln y_{t-j} + \\ &\sum_{j=1}^{3} o_j SD_j + \sum \kappa D + \vartheta \Psi_{it} + \varepsilon_{it}\end{aligned} \quad (1)$$

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[12] The "monetary transmission network" is a joint venture between the European Central Bank and national central banks which investigated the transmission of monetary policy. See Angeloni / Kashyap / Mojon (2003).

with i=1,….,N (N=number of banks) and t =1,….,T (t = quarters).

L_{it}	= loans of bank i in quarter t
MP_t	= monetary policy indicator (in percentage) [13]
y_t	= real GDP
$REER_t$	= real effective exchange rate
X_{it}	= measure of excess capital
ρ_{it}	= cost per unit of asset that a bank incurs due to a one per cent increase in MP_t
D	= a set of shift dummies that controls for jumps caused by mergers
SD	= three seasonal dummies
Ψ_{it}	= ln(assets) as control variable

To obtain loan growth as an endogenous variable, we make use of a series containing the banks' claims to non-financial customers which takes the differences of the logarithms in two subsequent periods.[14] We have applied the three-month money market rate (VIBOR) from 1998 to 2003 as the indicator for monetary policy.[15] The rate is a non-weighted average of daily offered rates for inter-bank deposits of the most

[13] One percent and a one percentage point change are scaled to 0.01 for all variables to guarantee consistency with the differences of the logarithm.
[14] In this series foreign loans are included and make up 18.7% of the total loans. Using total loans, leads to consistency with the maturity transformation costs (see appendix 2). This last figure can only be calculated based on domestic and foreign assets and liabilities for data availability reasons.
[15] Over the observation period, the Austrian Shilling was pegged to the German Mark and consequently, the German monetary policy as mirrored by the German interest rate played a relevant role in Austria. We use the Austrian interest rate as the correlation between the two rates is extremely high.

important banks on the basis of transactions by these banks. The estimated coefficient of MP indicates the average-capitalized bank's reaction to a change in the monetary policy indicator.

The quarter-on-quarter changes of the real effective exchange rate and quarterly GDP growth are included to control for loan demand effects. To check for robustness we take the real estate index IATX instead of GDP.[16]

The importance of the level of capital for bank lending is tested for by the inclusion of the normalized variable for excess capital (actual regulatory capital minus minimum regulatory capital) relative to the average:

(2) $$X_{it} = \frac{EC_{it}}{A_{it}} - \sum_t \left(\frac{\sum_i EC_{it} / A_{it}}{N_t} \right) / T$$

where EC_{it} measures excess capital while A_{it} represents total assets of bank *i* in quarter *t*. A distribution curve for excess capital can be found in chart 2 of Appendix 4. By normalizing excess capital, the average-capitalized bank has an X_{it} of zero. This will simplify the interpretation of the estimated coefficients.

Notice that we use a measure of excess capital instead of the capital-to-assets ratio. There are mainly three reasons for measuring capital in this way. First, the amount of capital held in excess of the required minimum may be interpreted as a "cushion" that would prevent a fall below the minimum requirement in the future, which could result in intervention by the supervisor. The simple capital-to-asset ratio only considers the total amount of capital affectively held by a bank, it does not take into account the minimum

[16] Since the results are rather similar to those obtained for GDP, they will not be shown.

that the bank is required by law to hold. Therefore, the measure of excess capital more accurately reflects the extent to which a bank is well capitalized, as it considers the individual capital requirements to be met. Second, the employed measure implicitly accounts for risk as defined by the Basel I Accord. Finally, by normalizing the relative capitalization of all banks for the entire sample, the average capitalized bank has a relative capitalization of zero (see Appendix 4), which will simplify our interpretations.

The coefficient λ captures the influence that the level of a bank´s excess capitalization has on its average loan growth. A negative and significant value would support the theory of Diamond and Rajan (2000, 2001). It was shown by Hahn (2002)[17] that for Austria, increasing levels of capital held by banks are traded off by a reduction in lending.

The interaction terms $\sum_{j=1}^{3}\gamma_j X_{it-1}\Delta MP_{t-j}$, $\sum_{j=1}^{3}\eta_j X_{it-1}\Delta \ln REER_{t-j}$, and $\sum_{j=1}^{3}\tau_j X_{it-1}\Delta \ln y_{t-j}$ are used to control for endogeneity. Furthermore, they serve to test for asymmetric reactions across banks to macroeconomic shocks due to their degree of capitalization. As the average-capitalized bank has a capitalization of 0, its reaction to changes in the interest rate, REER, and GDP is reflected in the estimated coefficients for these macro-variables. With the above interaction terms, we can see whether low and high-capitalized banks react in a different manner. If the estimated total effects of the interaction terms[18] are significant, then there is an asymmetric reaction. In addition, a

[17] However, Hahn's results have to be treated cautiously as the study uses yearly data and thus only consists of five points in time. Furthermore, a static estimation is used and not regulatory numbers are taken into consideration.

[18] In the calculation of the total effect of monetary policy (generally called long-term coefficient in the literature), the dynamic structure of the model has to be taken into account. The coefficient for the

positive and significant sign for the total effect of $\sum_{j=1}^{3} \gamma_j X_{it-1} \Delta MP_{t-j}$ (for j = 1 to 3) would mean that banks' lending reaction to an interest rate change depends on the degree of capitalization. This would indicate that low capitalized banks react more restrictively to an increase in the monetary policy indicator than well capitalized banks and would thus provide evidence in favor of the existence of an active bank-lending channel.

The existence of the bank capital channel is based on a maturity mismatch resulting in transformation costs incurred by changes in the stance of monetary policy. The calculation of such a maturity transformation therefore facilitates the calculation of the overall potential cost bank i faces due to its interest rate exposure.

(3) $$\rho_i = \frac{\sum_i (\chi_i \cdot A_i - \zeta_i \cdot P_i)}{\sum_i A_i}$$

The calculation above demonstrates that the cost ρ_i a bank faces depends on the amount of assets A or liabilities P of j months-to-maturity as well as on the sensitivity of assets χ_j or liabilities ζ_j to a one-per-cent increase in the interest rate.[19] The justification of the calculation of ρ_i is expanded in Appendix 2. For each bank and for each time period, a bank specific variable ρ_i has been calculated. The variable ρ_i assumes positive values for costs (per unit of assets) after an increase of the monetary

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monetary policy indicator is calculated as follows: $\sum_{j=0}^{3} \beta_j / (1 - \sum_{j=1}^{8} \alpha_j)$. Other total effects are calculated in the same way.

[19] If $\sum(\chi_j \cdot A_j - \zeta_j \cdot P_j) > 0$ then ρ_i represents the cost per unit of asset i that the bank suffers in the case of a one percentage point rise in the interest rate. In case of a negative sign there is a profit of maturity transformation for an increase of the interest rate.

policy indicator by one percentage point. ρ_i has then been multiplied by the absolute change in the interest rate in order to obtain a proxy for the maturity transformation costs for each bank in each period. Afterwards, differences are taken to estimate the reaction of bank lending due to a change in maturity transformation costs. In order to verify the existence of a bank capital channel in this set-up, the parameter estimate has to be negative; i.e. transformation costs have a negative effect on lending.

We used the logarithm of total assets as a variable to control for bank size.[20] Furthermore, three seasonal dummies are introduced to capture seasonal effects. Explanations on the shift dummies for mergers are provided in section 4.

[20] When using the assets lagged by one period or alternatively, when omitting this variable entirely, the estimated coefficients are rather similar. The estimation does however suffer from some higher order autocorrelation as a consequence, which may be due to jumps caused by merger activity. Thus we chose the above equation that is assumed not to run into a simultaneity bias as the alternative specifications deliver similar results.

6. The results

The standard specification indicates that the "average" Austrian bank shows almost no reaction to changes in the interest rate in the long run (see table 3 in appendix 3). The estimated total effect for MP is slightly negative but not significant. Interestingly, the short run coefficients (which are not shown in the table) show that during the period of the interest rate increase as well as one quarter later, lending decreases by between 1% and 1.5%. Two periods following the shift, lending increases by almost the same amount. The estimated short term coefficients are all highly significant at the 1% level.

According to the highly significant estimated coefficient for γ_j (for j = 1 to 3), low and high-capitalized banks react in a different way to changes in the interest rate. Low-capitalized banks behave more restrictively in cases of an interest rate increase while high-capitalized banks react more expansively. To illustrate this: using the estimated coefficient, a bank that belongs to the group of 10% best capitalized banks reduces lending by 0.3% less than the "average" bank. For the low-capitalized bank the additional decrease would be 0.1%.[21] The results provide evidence for the existence of a bank lending channel in Austria. These results differ somewhat to the existing literature for Austria (Kaufmann, 2001, Frühwirth-Schnatter and Kaufmann, 2003) which finds some evidence for the bank lending channel when using liquidity[22] as a distinguishing

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[21] The total elasticity with respect to a change in the stance of monetary policy for a high capitalized bank (i.e. a bank lying in the 10[th] highest percentile of the capitalization distribution) is given by: $\sum_{j=0}^{3}\beta_j/(1-\sum_{j=1}^{8}\alpha_j)+\sum_{j=0}^{3}\gamma_j/(1-\sum_{j=1}^{8}\alpha_j)\overline{X}_{>90}$.

[22] During the sample periods of the aforementioned studies, numbers for regulatory capital were not yet available.

feature. The asymmetric reaction is however due to the existence of very small banks. Thus the effect on the Austrian economy is considered to be rather irrelevant. As shown in Appendix 4 the 10% lowest capitalized banks in our sample make up about 10% of the banking sector's assets and loans, whereas the highest capitalized banks constitute a much smaller portion. As a consequence, the reaction of the low capitalized banks can not be neglected as expected effects of the transmission of monetary policy to the real economy may exist.

Lending increases by 1.26% when GDP rises by 1%. This positive relation is in line with expectations. Again, there is an asymmetric reaction due to capitalization. Low-capitalized banks are more "procyclical" than well-capitalized banks. The estimated coefficient for REER has to be considered with caution as it is only significant at the 10% level, whereas the asymmetric reaction on REER changes show significance at the 5% level.

We do not find evidence for the bank capital channel in the specification as the estimated coefficient for the maturity transformation costs is not significant. This could be due to the structure of maturity transformation in the Austrian system. Especially small banks' liabilities have a longer maturity structure than their assets. As a result, these banks do not suffer from maturity transformation costs in case of a monetary tightening. It is possible that this phenomenon could be explained by the network structure of Austrian banks. As written in Section 3, local savings and cooperative banks are organized in a one and two tier system respectively. Head institutes can thus play an important role in times of a monetary contraction by providing liquidity. Our results are in line with the paper from Ehrmann and Worms (2004) who examine banks' network structure in Germany (see Appendix 4 for further explanations related to this issue). Furthermore, most of the Austrian loans are either short term or have flexible interest rates. As a consequence in times of monetary tightening Austrian banks can adjust the interest rates for medium- and long-term loans, while they have to adjust the interest rate for deposits. This means that they do not bear maturity transformation costs. Another reason could be the structure of the overall banking system which consists mainly of savings banks and credit cooperatives which do not necessarily only maximize their profits.

Finally, the estimated coefficient for excess capital gives no indication that well and low-capitalized banks have a differing average loan growth. Thus Hahn´s (2002) result within a different model set-up and a different sample period could not be confirmed.[23]

In order to account for the potentially different reaction in lending of certain sectors of the Austrian banking industry, we applied the same model setup as in the standard regression for the cooperative banks alone (Genossenschaftsbanken). As shown in table 4 in appendix 3 the signs in this regression, as well as the insignificance of the monetary policy variable, are the same as in the standard regression. The difference lies in the significance levels (none of the variables is significant at the 1% level). The size of the effects are all larger than those for the entire sample. There also remains the discrepancy in reaction for different degrees of capitalization, which is significant at the 5% level for GDP and REER and at the 10% level for interest rate changes. Maturity transformation and the level of capitalization play no role here either.

[23] See footnote 17 for the criticism of his model set-up.

7. Alternative specifications to test for robustness

i) Time Dummies

In a first robustness check, we examine whether all time effects are captured by the macro-variables. The following model is specified:

$$\Delta \ln L_{it} = \sum_{j=1}^{8} \alpha_j \Delta \ln L_{it-j} + \sum_{j=10}^{28} \beta_j TD_t + \lambda X_{it-1} + \phi \Delta(\rho_i \Delta MP)_{t-1} + \sum_{j=1}^{3} \gamma_j X_{it-1} \Delta MP_{t-j} + \sum_{j=1}^{3} \eta_j X_{it-1} \Delta REER_{t-j} + \sum_{j=1}^{3} \tau_j X_{it-1} \Delta \ln y_{t-j} + \sum_{j=1}^{3} o_j SD_j + \sum \kappa D + \vartheta \Psi_{it} + \varepsilon_{it} \tag{4}$$

where TD_t is a time dummy for each period, which replaces changes in *MP*, *GDP*, and *REER* in the standard specification. If the estimated coefficients of the remaining variables are similar to those already obtained, then we would have an indication that the previous equation has been well specified with regard to the time effect of the panel. This robustness check (see table 5) confirms the choice of the macro-variables. The estimated coefficients for the interaction terms as well as the micro-variables and their significances are comparable to those in the specification above.

ii) VECM Residuals as alternative indicator for monetary policy

In a second specification to test for robustness, we identify an alternative measure for monetary policy shocks given by the disturbance term of a Vector Error Correction Model (VECM). The logic behind this procedure is to capture the information contained by the deviations (the residuals) from the assumed rule followed by the monetary policy, (the VECM) to influence main macroeconomic variables. In other words, the residuals of the VECM are likely to contain additional information that is not observable in the simple interest rate series, namely, the deviations from the systematic part of the monetary policy. In this context, the VECM specification is given by:

(5)
$$A_0 Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + ... + A_p Y_{t-p} + u_t$$

with $$u_t \sim iid\ N(0, \Sigma_u)$$

The variables included in the vector Y_t are ordered as follows: logarithm of gross domestic product, logarithm of consumer price index, monetary policy indicator (VIBOR) and the logarithm of the real effective exchange rate.[24] We then replace the monetary policy indicator VIBOR by a vector that contains the residuals of the interest rate equation in the VECM model. Under this new specification the econometric model is given by:

(6)
$$\begin{aligned}\Delta \ln L_{it} = &\sum_{j=1}^{8}\alpha_j \Delta \ln L_{it-j} + \sum_{j=0}^{3}\beta_j \Delta MPRvecm_{t-j} + \sum_{j=0}^{3}\varphi_j \Delta \ln REER_{t-j} + \sum_{j=0}^{3}\delta_j \Delta \ln y_{t-j} + \\ &\lambda X_{it-1} + \phi\Delta(\rho_i \Delta MPRvecm)_{t-1} + \sum_{j=1}^{3}\gamma_j X_{it-1}\Delta MPRvecm_{t-j} + \sum_{j=1}^{3}\eta_j X_{it-1}\Delta \ln REER_{t-j} + \\ &\sum_{j=1}^{3}\tau_j X_{it-1}\Delta \ln y_{t-j} + \sum_{j=1}^{3} o_j SD_j + \sum \kappa D + \vartheta \Psi_{it} + \varepsilon_{it}\end{aligned}$$

where MP_{t-j} in equation (1) is replaced by $MPRvecm_{t-j}$. The results are shown in table 6. The total effect of our identified monetary policy shocks is positive and significant at the 5% level. This is an interesting finding for two reasons. First, it is in line with the

[24] See appendix 1 for a detailed description of the VECM model used to identify the monetary policy shocks.

evidence found in prior studies and indicates that Austrian banks react by expanding lending when the monetary policy is tightened.[25] Long-term bank-customer relationships are strongly rooted and important in Austria ("Hausbankprinzip") and serve as a possible explanation for the puzzling finding. Kaufmann (2001) finds evidence of this counter-cyclical effect during periods of an economic slump. The majority of banks in Austria are small cooperatives or savings banks that do not necessarily follow only profit maximizing principles. In our sample we have 661 cooperatives, 63 local savings banks. The situation may have been amplified due to our data cleaning procedure as we omitted several private banks due to their large loan volatility (see section 4). Second, it suggests that the real monetary policy indicator could be different from the commonly adopted three-month interest rate (VIBOR) and it could therefore be better identified by the residuals of a VECM model.[26] The estimated coefficient for REER is negative (-0.57) and significant at the 1%. In other words, Austrian banks expand their lending following a depreciation,[27] which should not be surprising for a country whose exports represent about 49% of GDP. The total effect of the interaction term between excess capital and REER is positive and significant at the 5 % level, and is similar in magnitude to the coefficient obtained under the standard specification.

While the coefficient for GDP is negative and not significant, the coefficient of the interaction term between GDP and excess capital is negative and significant at the 1% level. This last result is somewhat controversial and goes against our findings under other

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[25] See Kaufmann (2001) and Frühwirth-Schnatter and Kaufmann (2003).

[26] Since this alternative measure of the monetary policy indicator is given by estimated residual values the results presented under this specification must be interpreted carefully. It would be advisable to perform a bootstrap procedure in order to investigate the convergence of our results. Due to the limited amount of time we had during our research stay at the Austrian National Bank, we were unable to perform such an analysis.

[27] REER is defined in a way that increasing values indicate a real appreciation.

specifications. Also, interestingly the coefficient of the interaction term between excess capital and $MPRvecm_{t-j}$ is much larger in magnitude than the stand-alone coefficient for $MPRvecm_{t-j}$ and significant at the 5% level. This finding is also consistent with the evidence presented by Gambacorta and Mistrulli (2003) for the case of Italy. Finally, the coefficients of the maturity transformation cost variable and of excess capital are not significantly different from 0, indicating that both the bank capital channel hypothesis and the level of capitalization do not play a role in explaining the growth in lending.

c) Real lending

In a final check of robustness (table 7), real loan growth and the real interest rate are used instead of nominal values. Thus we can compare the reaction in nominal terms to that in real terms. The average reaction of lending to a change in the stance of monetary policy is positive and significant at the 1% percent significance level and thus confirms the results of the studies mentioned above. It further confirms the specification with VECM residuals for nominal values. In contrast, the insignificant effect in our standard model is again put into question. Capitalization causes a differential lending reaction as indicated by the significant coefficients of the interaction term.

The coefficients for real GDP, and that of its interaction with capitalization, are both highly significant and with the expected signs. The real effective exchange rate has a significant but unexpected positive sign. The coefficients for the change in the maturity transformation costs and the level effect of capitalization are, as in all specifications, insignificant. Hence we cannot find evidence for either the bank capital channel or an effect of the level of capitalization on lending.

8. Conclusion

In this paper we have tested for the existence of a bank lending and a bank capital channel, under different degrees of capitalization. Using quarterly balance sheet data from the OeNB covering all Austrian banks, we employed an unbalanced panel to test for both channels.

While we are able to find evidence of the bank-lending channel, we are unable to confirm the existence of a bank capital channel in Austria. A possible reason for our inability to identify the capital channel could be the fact that until recently the OeNB only collected five maturity classes for bank assets and liabilities instead of the thirteen classes suggested by the amendment of the Basel Accord to include market risk (1996). Another potential source of weakness could be the structure of maturity transformation in the Austrian system. An irregularity appears to exist whereby many Austrian banks show maturity transformation profits rather than transformation costs. The important network structure in place within the country, serves as a further possible explanation as the existence of networks have a powerful implication on the reaction of banks' to changes in monetary policy.

We are able to make an interesting finding, relating to the measure commonly adopted as the indicator for monetary policy shocks. When we identify monetary policy shocks by the deviation of the rule followed by the central bank, i.e. the systematic part of the monetary policy, we observe that the estimated coefficients show both different signs as well as a different magnitude. The latter measure for monetary policy shocks has not been used frequently in the literature for Austria. Our results indicate that further research in this area may be fruitful.

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Appendix 1

Vector Autoregressions (VARs) and Vector Error Correction Models (VECMs) have become a standard tool in economics to identify the response of macroeconomic variables to monetary policy shocks. Christiano et al. (1996) specify a model that has become the standard for the US. For the case of Austria however, it is more difficult to find such a “benchmark” model. Here we use the specification of Ehrmann (2000) in order to compare our estimations. All such models relate back to Sims (1980) and assume that the economy can be described by the following structural equation:

(A1.1)

$$A_0 Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + ... + A_p Y_{t-p} + u_t$$

with $u_t \sim iid\ N(0, \Sigma_u)$

where Y_{t-i} (with i = 0,1, …, p) is an n × 1 vector of endogenous (macroeconomic) variables. This model represents the rule followed by the central bank to influence other macroeconomic variables. Since our goal is to identify monetary shocks, our interest lies not on the rule itself but rather on deviations from that rule. This allows us to observe the response of macroeconomic variables to unexpected monetary shocks. The model has to be estimated in its reduced form though, which is given by:

(A1.2)

$$Y_t = A_0^{-1} C(L) Y_{t-1} + v_t$$

where $C(L)$ is a finite-order lag polynomial matrix. The relationship between the structural and the reduced form disturbances is given by[28]:

(A1.3) $$v_t = A_0^{-1} u_t$$

The set of macroeconomic variables included in the vector Y_t were ordered as follows: logarithm GDP, logarithm of consumer price index (CPI), VIBOR and the logarithm of the real effective exchange rate. Since the variable VIBOR does not enter in logarithms in the panel regression we do not apply logarithms to the variable VIBOR in the VECM regression. This allows us to compare the results of the panel regression when we use the VECM residuals as the monetary policy shock indicator. The model is estimated by 2SLS, the chosen order of cointegration is 2 and the number of lags of the endogenous variables is 4.[29]

[28] For an excellent discussion on models used to identify monetary policy shocks, see Christiano et al. (1999). Watson (1994) offers a straightforward presentation of VAR and SVAR systems and the problem of their identification.

[29] Ehrmann (2000) also uses a cointegration rank of order 2 to estimate the monetary rule for Austria, however, he uses only 2 lags for the endogenous variable.

Appendix 2

In order to calculate ρ_i, the cost a bank faces due to the maturity transformation, we employ the following:

$$\rho_i = \frac{\sum_j (\chi_j \cdot A_j - \zeta_j \cdot P_j)}{\sum_j A_j}$$

The sensitivities (χ_j and ζ_j) are obtained directly from the supervisory regulation,[30] which gives banks the liberty to decide whether to opt for the "maturity method" or the "duration method"[31] in its treatment of general market risk for all securities forming part of the trading portfolio. Under the "maturity method" assets and liabilities are grouped according to maturity bands and risk weights are subsequently imposed on the netted out positions. While banks are potentially exposed to interest rate risk on all of their interest-rate related assets and liabilities,[32] the regulation deals only with the trading portfolio. In order to determine the existence of a bank capital channel however, it is necessary to consider the change in the economic value of a bank due to a change in the interest rate rather than purely the change in the capital requirement for the bank. It is therefore required to take into account total assets and liabilities rather than those merely existing in the trading portfolio. The extent to which the economic value of a bank is exposed to interest rate changes is dependent on the degree of maturity

[30] The amendment to the Basel Accord to incorporate Market Risks, Basle Committee January 1996.
[31] With the supervisors consent allows the bank to calculate the price sensitivity of each position separately, giving a more accurate measure for overall market risk.
[32] Independent of whether they are held for trading and marked to market or for a longer time horizon and carried at book value.

mismatch that the bank is ρ_i holding.[33] While several arguments against the use of the same methodology for all assets and liabilities irrespective of whether they have been marked to market or held at book value have been brought forward, it is equally clear that from an economic perspective the effect of a change in interest rates on any given financial instrument is the same regardless of whether the instrument is held in a trading portfolio or on the banking book ("Measurement of Bank's Exposure to Interest Rate Risk", Committees at the Bank for International Settlement). We have therefore adopted the risk weights for the interest rate risk in market risk proposals as from Table 1 from the amended Accord.[34] In order to differentiate between the assets that are marked to market and those that are carried at book value, the latter have been multiplied not only by a risk weight (as those marked to market) but also by a duration weight which adjusts the figure in order to reflect the relative volatility of interest rates across the term structure. For each bank, for each time period, a bank specific variable has been calculated. This figure has then been multiplied by the change in interest rate in order to gain an insight into the relative gain or loss per unit of asset in each period.

[33] If a bank is funding five-year fixed rate loans with short-term deposits, it is exposed to changes in interest rates. But if it funds these loans with deposits having the same maturity and cash-flow characteristics, it is not exposed, since any change in the economic value of the loans would be offset by a change in the economic value of the deposits.

[34] Amendment to the Capital Accord to include Market Risk, Basel Committee (1996)

Appendix 3:

Table 3: Results of the standard specification

Variable	L.T. Coefficient	p-value
ΔMP	-0,06	0,73
X*ΔMP	4,82	0.01***
ΔlnGDP	1,26	0.00***
X*ΔlnGDP	-1,12	0.03**
ΔlnREER	-0,61	0.06*
X*ΔlnREER	8,00	0.02**
Mat. Trans. Cost	3,79	0,24
Excess Capital	-0,04	0,35
A-B-test for autocorrelation in residuals (p-value):		
	order one:	0,00
	order two:	0,39
	(H0: no autocorrelation)	
Sargan-test for non-robust estimation (p-value):		
		0,82

Table 4: Cooperative Banks (Genossenschaftsbanken)

Variable	L.T. Coefficient	p-value
ΔMP	-0,45	0,17
X*ΔMP	6,91	0.08*
ΔlnGDP	2,16	0.02**
X*ΔlnGDP	-1,67	0.04**
ΔlnREER	-0,92	0,10
X*ΔlnREER	12,19	0.04**
Mat. Trans. Cost	0,08	0,16
Excess Capital	0,06	0,50
A-B-test for autocorrelation in residuals (p-value):		
	order one:	0,00
	order two:	0,19
	(H0: no autocorrelation)	
Sargan-test for non-robust estimation (p-value):		
		1,00

Table 5: Time Dummies

Variable	L.T. Coefficient	p-value
X*ΔMP	5,26	0.01***
X*ΔlnGDP	-1,14	0.04**
X*ΔlnREER	7,93	0.04**
Mat. Trans. Cost	4,78	0,18
Excess Capital	-0,05	0,38
A-B-test for autocorrelation in residuals (p-value):		
	order one:	0,00
	order two:	0,44
	(H0: no autocorrelation)	
Sargan-test for non-robust estimation (p-value):		
		0,76

Table 6: VECM Residuals

Variable	L.T. Coefficient	p-value
Δ ResVECM	0,77	0.03**
X*Δ ResVECM	12,56	0.05**
ΔlnGDP	-0,01	0,94
X*ΔlnGDP	-1,41	0.00***
ΔlnREER	-0,57	0.00***
X*ΔlnREER	7,46	0.03**
Mat. Trans. Cost	4,58	0,33
Excess Capital	-0,01	0,89
A-B-test for autocorrelation in residuals (p-value):		
	order one:	0,00
	order two:	0,70
	(H0: no autocorrelation)	
Sargan-test for non-robust estimation (p-value):		
		0,69

Table 7: Real Variables

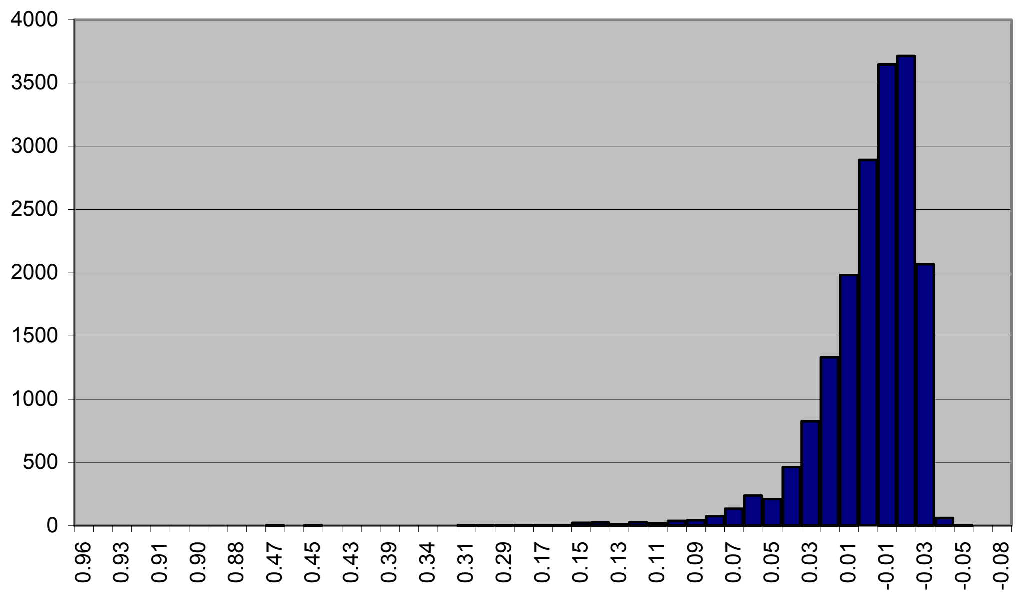
Variable	L.T. Coefficient	p-value
ΔReal-MP	0,54	0.01***
X*ΔReal-MP	3,64	0.04**
ΔlnReal-GDP	0,66	0.00***
X*ΔlnReal-GDP	-1,35	0.01***
ΔlnREER	1,30	0.00***
X*ΔlnREER	8,21	0.01***
Mat. Trans. Cost	0,93	0,73
Excess Capital	0,00	0,95
A-B-test for autocorrelation in residuals (p-value):		
	order one:	0,00
	order two:	0,73
	(H0: no autocorrelation)	
Sargan-test for non-robust estimation (p-value):		
		1,00

Appendix 4:

i) Distribution of excess capital

The distribution of excess capital for the banks in our sample for all time periods can be seen in Chart 2 below.

Chart 2: Distribution of excess capital over all banks and time periods



Source: OeNB and own calculations.

As we use a relative measure of capitalization, the size of differently capitalized banks may provide some further insights. The lowest capitalized banks, which make up the 10th percentile of capitalization (-0.03 on average), have 9.0% (10.7%) of the total banking sector's assets (loans) on their books. In contrast, the 'best' capitalized banks in the 90th percentile (+0.03 on average) make up 2.2% (2.1%) of the total banking sector's assets (loans). This means that low-capitalized banks have about the size of the 'average' bank, whereas high-capitalized banks are disproportionally small.

ii) Structure of maturity transformation costs

The distribution of the maturity transformation costs looks as follows:

Table 8: Structure of unweighted rhos in the Austrian banking system

	Overall sector	Cooperative Banks	Savings Banks	State mortgage banks	Joint stock banks
Rho	-0.20	-0.22	-0.01	0.38	0.44

Surprisingly, the unweighted *rho* of the overall banking sector is negative. This means that many banks have maturity transformation profits, which is counter-intuitive as performing a maturity transformation, is one of the basic functions of any bank. In the sample, there are 17,369 quarterly observations for *rho*. We observe 9,244 negative *rhos* (maturity transformation profits), while only 8,125 positive *rhos* (costs).

At a first glance at the data, it is already evident that cooperative banks show maturity transformation profits and that they dominate the unweighted average. As many as 595 out of 760 banks belonged to the cooperatives sector in December 2003.

We therefore weight the rhos with the assets in the following way:

$$rho-weighted=\frac{\sum_{t=1}^{T}\sum_{n=1}^{N} rho_{it} * A_{it}}{\sum_{t=1}^{T}\sum_{n=1}^{N} A_{it}}$$

By doing this, we get an average *rho* of 0.44 for the total banking sector which is coincidentally the same as that for joint stock banks. This is a clear sign that Austrian banks on average do perform maturity transformation, but that smaller banks in the cooperatives' sector do not.

Ehrmann and Worms (2004) analyse the importance of bank networks for banks' reaction to changes in monetary policy. They show that for Germany, networks' head institutions accept short-term deposits from member banks in return for longer-term loans to those banks. Based on this, when a shift in monetary policy occurs, funds are distributed within the network. In the case of a monetary tightening for example, member banks are able to make use of liquidity buffers held with their head institution. Such activity has powerful implications for monetary policy transmission as it counteracts any size-related distributional effects between banks in any country where such networks are in existence.

To test for such a network structure in Austria, we merged the balance sheets of the local cooperative banks and savings banks with their respective head institutions (8 head institutes for cooperative banks on a state level and Erste Bank for the savings banks) and calculated *rhos* for the fictively merged banks. In 2003, only one out of the eight merged cooperative head institutes had on average a negative *rho*. All others, including the merged Erste Bank had on average positive *rhos* in 2003. Bearing in mind that the cooperatives sector is organised according to the 'two-tier' system, when merging the whole sector, we get positive *rhos*. It is therefore evident that a similar network structure exists in Austria as described for Germany by Ehrmann and Worms (2004).

When we ran panel estimations with the merged head institutions and the rest of the banking sector, the estimated coefficients were not significant. This provides an indication while the network structure plays a very important role, lending decisions are largely taken at the local level.