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Bank portfolios and the credit channel in Austria

Abstract

This paper analyzes the adjustments in the structure of assets and liabilities of the Austrian banking sector taking place after a monetary tightening. Following increases in short-term interest rates, the share of loans to non-banks in interest-earning assets rises, which is at odds with the predictions from the credit channel of monetary policy transmission. As regards the volume of total credit, a temporary increase can be observed. The analysis of loan subaggregates reveals that not only the lendings to companies but also those to households increase at least temporarily following a policy-induced interest rate hike. Several explanations are discussed, including characteristics of the Austrian banking sector.

Keywords: monetary policy transmission, credit channel, bank portfolios, loan supply.
JEL Classification: E51, E52, G11, G21.

Introduction

The credit channel of monetary policy transmission comprises a special role of bank behavior as a decisive factor for the spending decisions of firms and households[1]. Capital market imperfections at the level of the banking firm are emphasized as the rationale behind the bank lending channel, which argues that one reason for monetary policy affecting the behavior of the private sector is that bank balance sheets adjust. Informational asymmetries prevent some type(s) of banks from offsetting the drain of funds due to a contractionary monetary policy through non-deposit borrowing. Alternatively, banks may be unable or unwilling to incur the additional cost of raising supplementary (uninsured, non-reservable) deposits. On similar grounds, also bank assets are imperfect substitutes and, consequently, the supply of loans is reduced because some banks are not capable of or ready to retain their prior lending policy by, for example, suitably high reductions in bond holdings. With bank customers mainly relying on bank finance, the policy-induced reduction of bank loan supply leads to decreases in the expenditures of firms and households on goods and services.

Many studies analyze the distributional aspects of monetary policy both with lenders and borrowers. Selected examples of studies using disaggregated (bank balance sheet) data are Kashyap and Stein (1995, 2000), Kishan and Opiela (2000), Ashcraft (2006), as well as Altunbas et al. (2002), Ehrmann et al. (2003) and Chatelain et al. (2003). Bank capitalization, size, liquidity and sector (bank network) affiliation seem to determine which banks react (strongly) to restrictive monetary policy[2]. On the other hand, firms and households must be bank-dependent with respect to the funding of their expenses for the channel to work as described above. Using aggregate data to examine the bank lending channel is not as common (examples are McMillin, 1996; Hülsewig et al., 2006; den Haan et al., 2007; and Eickmeier et al., 2009), due to the problem to assign observed variations in bank lending to supply and demand effects.

Nevertheless, the present paper applies aggregate data to examine which adjustments of the Austrian banking sector's assets and liabilities structure occur following policy-induced changes in interest rates. Its purpose is to enlarge the empirical evidence on and to improve knowledge about the role of banks in monetary policy transmission. There is, however, no thorough distinction made between the 'narrow' bank lending channel and the broader balance sheet channel with the latter arguing that, for borrowers, whose creditworthiness worsens following a monetary contraction, there is reduced supply of all forms of external finance. Adjustments of bank credit, observed after policy actions, may, therefore, also be due to variations in borrowers' financial positions and the value of provided collateral. Although this study mostly refers to the bank lending channel literature (as no information about bank customers' financial conditions and their financing structures is processed), reasoning from the balance sheet

[1] Early influential studies on the so-called lending view of monetary policy transmission include Bernanke and Blinder (1992), Bernanke and Gertler (1995) and Hubbard (1995). It should be noted that issues related to loan supply and pricing are not only important for the propagation of aggregate shocks, but also affect financial stability via bank profits.

[2] Kashyap and Stein (1995, 2000) and Kishan and Opiela (2000) apply U.S. data and present results supporting the lending view. Also Ashcraft (2006) finds differential lending responses to be connected to financial constraints, while U.S. banks affiliated with multibank holding companies (and, therefore, with access to internal capital markets) are able to retain their level of credit. Altunbas et al. (2002) study the existence of a bank lending channel in EMU (European Monetary Union) countries with mixed results. Ehrmann et al. (2003) and Chatelain et al. (2003) observe heterogeneity of lending reactions only with respect to different liquidity positions of banks in the four largest EMU countries.

channel will prove helpful in explaining some of the empirical outcomes.

As loans from domestic banks still play a dominant role in the funding of most Austrian firms and households, one could expect a significant role of credit supply in the policy transmission process. However, it seems to be the case that the financial sector in Austria (as well as similar ones in other countries) exhibits some characteristics that may work against an operating bank lending channel (see also Frühwirth-Schnatter and Kaufmann, 2006). One of these is the significance of relationship banking (the house-bank principle) which aims at reducing information asymmetries and leads Austrian banks to pursue intertemporal smoothing of lending (see, e.g., Braumann, 2004). Another one is the multi-tier structure of the banking sector with central institutions which, in case of shortages, provide liquidity to small banks that are part of the network[1].

However, studying a single country, like Austria, can additionally be justified by the fact that, also with a uniform monetary policy in Europe, national peculiarities remain important in credit markets as these are not fully integrated up to now (see, e.g., Fernández de Guevara et al., 2007). Regional differences in transmission channels increase the information demand for and the difficulties associated with the monetary policy pursued by the European Central Bank (ECB). All this fits to the fact that, for European countries, the results on the operation of a bank lending channel are much less uniform and more mixed than those for the USA (Altunbas et al., 2002; Frühwirth-Schnatter and Kaufmann, 2006). Improving knowledge about national differences in the transmission process, therefore, is indispensable. To our knowledge, this is the first study on the existence of a bank lending channel in Austria using aggregate time series data. Previous research from an evaluation of bank-level data reports that there is only weak evidence for cross-sectional differences in bank lending reactions following a monetary policy contraction (Kaufmann, 2003; Frühwirth-Schnatter and Kaufmann, 2006).

The paper proceeds as follows. Section 1 contains a short review of the related literature with importance attached mainly on time series studies. Matters related to the data and the methodology applied are discussed in Section 2. The main empirical results, presented in Section 3, are generated for balance sheet shares from the viewpoint of banks' portfolio and refinancing choices, as well as for the log real levels of the measures of interest. As aggregated data are applied, also the supply-vs-demand identification problem is explicitly addressed. The results suggest that there is no evidence for a credit channel operating through bank lending volumes in Austria. On the contrary, the share of loans to non-banks in interest-earning assets of the banking sector even increases after a monetary tightening, as does the total loan volume. An analysis of credit subaggregates shows that increases in loans to non-financial enterprises, as well as to households, are responsible for this result. The last section summarizes and concludes.

1. Literature review

Bernanke and Blinder (1992) and Kashyap et al. (1993) are influental papers on the reaction of lending to a monetary tightening, both using aggregate U.S. data. While the former apply a vector autoregressive (VAR) model and conclude that the level of loans in the banking sector's balance sheet shrinks after an unanticipated rise in the federal funds rate, Kashyap et al. (1993) observe a decrease in the ratio of bank loans to the sum of loans and commercial paper (both referring to domestic non-financial corporations) in times of restrictive policy.

As Suzuki (2004) argues, these results are consistent with the credit view, but could also be obtained if there is no operative credit channel. Reductions in loans could also be due to demand effects through the conventional interest rate channel of monetary transmission. To resolve the identification problem emerging, it is important to analyze both prices and quantities of loans to 'simplify' the issue to a classical simultaneous equation bias problem (Suzuki, 2004).

Following Bernanke and Blinder (1992), McMillin (1996) also uses aggregate data for the USA to estimate a VAR, including a policy variable (the federal funds rate), the unemployment rate (as the demand proxy), the log of the consumer price index, and the log levels of real bank deposits, real bank security holdings, and real bank loans[2]. To disentangle supply and demand effects, he tries to eliminate changes in bank portfolios that are due to feedback from the macroeconomy, resulting from the contractions of economy activity and, consequently, loan demand. When restricting the

[1] Ehrmann and Worms (2004) provide corresponding evidence for Germany. Kaufmann (2003), for example, provides a detailed description of the structure of the banking sector in Austria. Braumann (2004) additionally argues that the long-lasting state influence on and cartelization in the Austrian banking sector, as well as the large share of non-profit banks also work against a credit channel in Austria.

[2] The log level of real commercial paper issued by non-financial corporations (describing the composition of firm finance) and the spread between the prime rate on bank loans and the commercial paper rate are added to the model in a subsequent step.

coefficients of economic activity and consumer prices on bank portfolio composition variables to zero – and, therefore, only indirect feedback via the monetary policy measure is left in the model, he observes that the resulting responses of e.g. loans are not significantly different from the 'regular' ones. McMillin (1996), therefore, argues that the observed decline of bank loans after a monetary tightening mainly stems from a reduced loan supply. These results, however, are not found to be stable over time.

A similar approach is applied by Ashcraft (2006), who makes use of quarterly U.S. time series data (1954-2002). The impulse-response functions from a small VAR model (containing the growth rates of aggregate loans and real GDP, as well as the change in the federal funds rate) reveal that the variations in aggregate bank lending hardly affect real output. Thus, Ashcraft (2006) concludes that the bank lending channel does not play a significant role in the transmission of U.S. monetary policy. Eickmeier et al. (2009) report analogous results for Germany and the euro area for the 1985-2005 period.

Hülsewig et al. (2004) choose another way to model and identify presumed loan supply effects due to an operating bank lending channel. They identify cointegrating vectors in the form of loan supply and demand relations, based on a VAR, comprising the real loan volume, real equity capital from the banking sector balance sheet, the yield on bonds, issued by domestic residents (as a proxy for the lending rate), the three-month money market rate, the inflation rate and real GDP. Following an assessment of both the short-run dynamics and the adjustments to the estimated long-run relations, Hülsewig et al. (2004) propose an operating bank lending channel in Germany. Also Hülsewig et al. (2006) find that real lending of German banks declines (both on supply and demand grounds) after increases in the three-month interbank rate.

Kakes and Sturm (2002) examine time series for different German banking sectors and provide evidence that lending declines most for the group of credit co-operatives (which are small on average). In contrast, Ehrmann and Worms (2004) (as well as Eickmeier et al., 2009) find that, after a monetary contraction, smaller German banks, being more likely to be organized in networks (with intra-network liquidity management by large head institutions), "do not decrease their lending by more than large banks do. Instead, rather the opposite seems to be the case, which contradicts the predictions of the bank-lending channel".

There are several studies observing matters that are not consistent with the implications of the credit channel theory. For some banking groups, Kakes and Sturm (2002) report a rise in lending after short-term interest rates increase. In most cases, however, differences in the adjustment to monetary policy with respect to types of loans or, respectively, bank customers are observed. For example, den Haan et al. (2007), who analyze quarterly U.S. data on different loan subaggregates within a structural VAR, report increases in commercial and industrial loans after a monetary tightening[1].

Kakes and Sturm (2002) argue that a rise in short-term loans (something also stretched by Gertler and Gilchrist, 1993) is responsible for their result. After an increase in lending rates, firms increase their demand for short-term loans to cope with declining cash flows and, additionally, they have the incentive to "shorten the maturity of their debts as a reaction to increases – and anticipation to future decreases – in the lending rate" (Kakes and Sturm, 2002).

Explanations offered by den Haan et al. (2007), on the other hand, are rather based on banks' behavior. In the wake of tight money (with high short-term interest rates and low economic activity), they argue, banks substitute out of longer-term and more risky assets into short-term loans, which are relatively safe. Such short-term loans (mainly granted to commercial and industrial customers) in this case also imply relatively higher margins than consumer and mortgage loans because their rates are more flexible. Other explanations include a possibly stronger balance sheet channel for consumers and the incentive for banks to reduce balance sheet mismaturities (also emerging because expected maturities of, for example, mortgage loans are likely to increase with rising rates). Garretsen and Swank (1998) combine both lines of reasoning to the suggestion that borrowers demanding more credit with higher interest rates (to buffer declines in cashflows) are mainly 'high-quality' borrowers such as large firms. For the above-mentioned reasons, banks grant these loans, whereas other borrowers have to cope with a reduced credit supply.

2. Data and empirical framework

Quarterly data on the structure of the (interest-related) assets and liabilities of the Austrian banking sector is constructed from aggregate bank balance sheet data made public by the Austrian Central Bank (OeNB)[2]. Bank asset classes considered are cash, interbank claims, loans to (or, more precisely, non-securitized claims against) non-banks, fixed-interest

[1] Their model comprises three loan components, the federal funds rate, a price index, a real activity measure, retail rates, inventories and bank equity capital.

[2] Data sources are quoted in a brief section at the end of the article.

securities ('bonds'), and a residual containing shares, investment certificates, fixed assets, and so on. Liabilities are divided into interbank liabilities, deposits, secured debt, equity capital (and a rest). For the calculations of shares in balance sheet measures, related to banks' interest business, interbank claims, loans and bonds are defined to make up the interest-earning assets, whereas interbank liabilities, deposits and secured debt add up to the interest-bearing liabilites[1]. Data on credit subaggregates, which are also applied, contain short-term loans to enterprises, loans to households, hypothecary loans and housing loans (not being secured by a mortgage)[2].

Table 1 conveys information about the evolution of the balance sheet structure of the Austrian banking sector over the sample period, which ranges from the first quarter of 1987 up to the end of 2006. It can be observed that, while the relative importance of credit is more or less unchanged, the share of bond holdings in interest-earning assets rose at the expense of interbank claims. During the observation period, however, the relevance of total interest-earning assets, mainly relative to shareholdings, declined. Within the interest-bearing liabilities, secured debt became relatively more important, thereby replacing deposits from non-banks, especially at the end of the sample period.

How to measure the price of loans and the choice of the appropriate interest rates, connected to the balance sheet measures, is a more difficult issue. Although ex-ante retail interest rates (on new business) are available for three out of the four credit subaggregates for a relatively long time period, the question is which rate to choose when describing total loans and bonds (and the associated trade-off). Average ex-post interest rates on these (and other) parts of the balance sheet are applied here, calculated by use of data from the banking sector's income statements.

The overnight money market rate is applied as the indicator of the monetary policy stance since the ECB focuses on short-term interbank rates to convey policy signals (European Central Bank, 2006). The same applied to the German Bundesbank (Hülsewig et al., 2004), which set the monetary policy rates relevant for Austria before 1999. In principle, even the overnight money market rate might mirror (time-varying) risk premia which would interfere the above interpretation. On the other hand, the actual deviations of the overnight rates from the 'policy rate' of the ECB (represented by a fixed rate in times of fixed rate tenders and the minimum bid rate in times of interest rate tenders) were rather small during our sample period. From a time series perspective, interbank rates are preferrable over the policy rate due to the relatively low variation of the latter.

The set of variables examined in the empirical models will contain the growth rate of real GDP, the inflation rate (calculated from the consumer price index[3]), the overnight money market rate, and the share of equity capital of the banking sector in its total assets. Additionally, there is one of the balance sheet variables (e.g., the ratio of total loans to total interest-eaning assets) and a corresponding average ex-post interest rate (e.g., the interest income from granting loans divided by the stock of loans). All six variables are treated as endogenous and, at the outset, the interrelations between them are modelled by a standard vector autoregression (VAR). The VAR order is chosen via the Schwarz information criterion, and all models additionally consider a deterministic linear time trend.

Table 1. Banking sector balance sheet developments

Variable	1987:1 -1993:4	1994:1 -1998:4	1999:1 -2006:4
Interest-earning assets (IEA, % of balance sheet total)	90.76	89.86	86.05
Interest-bearing liabilities (IBL, % of balance sheet total)	91.70	91.08	90.69
Equity capital (% of balance sheet total)	3.96	4.70	5.06
Interbank claims (% of IEA)	36.55	32.29	31.68
Loans to non-banks (% of IEA)	53.97	55.71	54.17
Bond holdings (% of IEA)	9.48	11.99	14.15
Interbank liabilities (% of IBL)	36.88	33.21	34.81
Deposits from non-banks (% of IBL)	45.02	46.59	40.49
Secured debt (% of IBL)	18.10	20.20	24.70

Notes: This table provides information about the development of variables describing the Austrian banking sector's balance sheet structure. All measures are calculated as averages from quarterly data. Interest-earning assets consist of interbank claims, loans and bonds (fixed-income securities), interest-bearing liabilities are made up by interbank liabilities, deposits and secured debt. Loans to and deposits from non-banks, in fact, contain all non-securitized claims against and liabilities to non-banks.

For each of the measures of interest, the first step of the empirical strategy consists of reckoning its comovement with the interbank rate. Then, again separately for each bank balance sheet variable, an unrestricted six-variable VAR is estimated, using a

[1] If these measures are to appear in levels, the logarithm is taken of real values (nominal ones are deflated by the consumer price index).

[2] Note that these loan subaggregates are available only from the fourth quarter of 1995 on, that they overlap and, opposed to total loans (and the other balance sheet variables), only comprise business with domestic customers.

[3] The results are virtually unchanged if the GDP deflator is applied instead of the consumer price index.

recursive identification scheme (Cholesky decomposition method). Thereby, the variable ordering (for the example of the loan ratio) is {GDP growth, inflation rate, short-term interest rate, loan ratio, equity ratio, ex-post lending rate}[1]. Impulse response functions and forecast error variance decompositions describe the dynamic reactions of balance sheet variables to changes (scaled to represent unit shocks) in the interbank rate[2]. Error bands for the response functions are simulated via Monte Carlo integration (importance sampling) with 2000 draws. For the assessment of the responses' statistical significance, 95% confidence intervals are approximated by means of the 0.025 and 0.975 fractiles of the response distribution. Responses are reported for the quarter the shock occurs and quarters 1, 2, 4 and 8 thereafter, forecast error variance decompositions presented are the ones for the eighth after-shock quarter.

In the next step, the focus should be on adapting the estimated loans equation (still as a part of the simultaneous equations model) to represent a supply relation. Following Hülsewig et al. (2004), loan supply is specified as a function of both interest rates and bank equity capital, with the difference that both loans and equity are shares as mentioned above[3].

First, the lag(s) of GDP growth and the inflation rate are dropped from the equations of the loan ratio and the average lending rate, which is similar to the procedure in McMillin (1996), Ashcraft (2006) and Eickmeier et al. (2009) to 'remove' feedback effects from economic activity on bank loans. The reduced form of the near VAR is estimated by seemingly unrelated regression (SUR). Second, the restrictions that GPD growth and inflation have no impact on the loan ratio and the lending rate are also imposed on the contemporaneous relations inherent to the identification scheme. This results in an overidentified structural VAR with restrictions of Bernanke-Sims style (Bernanke, 1986; Sims, 1986). As in this case (structurally overidentified near VAR) simulations via importance sampling are not feasible, responses are bootstrapped with 2000 replications, and their statistical significance is evaluated based on Hall percentile intervals (Hall, 1992)[4].

It should be noted that the 'feedback removal procedure' described above only provides an upper bound for the reaction of loan supply to a monetary contraction. The approach deals with loan demand effects connected to macroeconomic data (the response to a lower marginal product of capital and deteriorated firm balance sheets), because "it is unlikely that the response of bank lending to output has anything to do with the lending channel" (Ashcraft, 2006). However, it does not shut down all the channels through which loan demand reactions take place. As Ashcraft (2006) argues, demand effects are still present via changes in lending rates and effects on customers' creditworthiness through increased interest payments. Nevertheless, the issue strongly affects the interpretations of results in terms of the bank lending channel only if credit shrinks following a restrictive policy action. If no such reduction in lending is present (as it will be the case with the following results), there is no room left for mistaking a demand reaction (which should, by theory, be negative) for a supply effect.

Some remarks about the characteristics of the monetary policy 'shocks' seem advisable at this point as well. As these shocks are based on the residuals of the equation of the interbank rate, their innovational content depends on how well the corresponding equation represents a policy reaction function. For selected estimated systems (detailed results not reported), the extracted shocks were correlated to measures of the term structure. It turns out that these correlations are relatively high with respect to the money market term structure (up to 12 months), but much lower with long-term expectations in the bond market. In an additional exercise, macroeconomic data for Germany and the euro area were added to the VAR models to obtain an improved representation of a policy reaction function. This, however, does hardly affect the shocks' innovational content and, moreover, would not qualitatively affect the results presented in Section 3. The fact that the employed shocks are not pure policy surprises should, however, not severely impair the interpretation of the results. Banks will also react in consequence of predictable policy interventions. As Kashyap and Stein (2000) argue in their cross-sectional study on the bank lending channel in the USA, "even if a contraction in policy is partially anticipated by banks, it should still have the ... effects that we hypothesize."

[1] The interbank interest rate may also be put first if it is assumed that monetary policy reacts with a lag to developments of economic activity and prices (see also McMillin, 1996). For quarterly data, the identification scheme proposed here, which is almost identical to the one used by Hülsewig et al. (2004), seems to be more adequate.

[2] The impulse response function (IRF) for variable y due to an unexpected impulse (shock) in variable x describes the deviations of the response variable y from its no-shock path over time. The second innovation accounting tool, forecast error variance decomposition (FEVD), is used to split the mean squared forecasting error of the response variable at time $t + s$ into the contributions of the individual endogenous variables' innovations.

[3] The demand relation in Hülsewig et al. (2004) relates loans to the lending rate and aggregate activity (as well as the aggregate price level).

[4] For these calculations, JMulti (Lütkepohl and Krätzig, 2004) was used.

3. Results

Bivariate vector autoregressions are applied to get a first impression on how banking sector balance sheet variables behave after a shock in short-term interest rates. Dynamics of the systems are chosen according to the Schwarz information criterion, with a maximum lag order of four set in advance. Responses of the latter to a unit innovation in the overnight interbank rate are reported in Table 2.

Table 2. Responses of banking sector balance sheet variables to interest rate shocks I

After quarter	0	1	2	4	8	FEVD
Interbank claims (% of IEA)	-0.49*	-0.36	-0.23	-0.04	0.10	5
Loans to non-banks (% of IEA)	0.54*	0.52	0.53	0.52*	0.42	18
Bond holdings (% of IEA)	0.08	0.11	-0.01	-0.32*	-0.63*	36
Interbank liabilities (% of IBL)	-0.11	-0.21	-0.37	-0.71	-1.10*	22
Deposits from non-banks (% of IBL)	-0.08	-0.08	0.04	0.34	0.70*	11
Secured debt (% of IBL)	0.17	0.29	0.37	0.44	0.43	18

Notes: This table presents within-quarter and selected subsequent responses of several variables describing the structure of the balance sheet of the Austrian banking sector to one-unit impulses in the overnight money market rate (available from 1989:2 on). Error bands for the responses are obtained via Monte Carlo integration with 2000 draws, and 95% confidence intervals are approximated by means of the 0.025 and 0.975 fractiles of the response distribution. Asterisks indicate statistical significance at the 5% level. FEVD is the percentage of the mean squared forecasting error in the response variable after eight quarters due to innovations in the money market rate. A lag order of 2 is chosen for all vector autoregressions by use of the Schwarz information criterion. The abbreviation IEA stands for interest-earning assets, IBL for interest-bearing liabilities.

The interesting results here are that, following a restrictive monetary policy shock, the deposits ratio does not shrink and that, as the deposits ratio does in the longer term, the loan ratio even increases. Both of these adjustments do not appear to be very large economically, though being statistically significant for some quarters. To check whether these results are driven by developments in the levels of total or interest-related assets (liabilities), also VAR models with log real loans and the other balance sheet variables (as well as total assets, interest-earning assets and interest-bearing liabilities) transformed in the same manner were estimated.

In this setting (results are not reported here in tabular form, but more details, as well as figures, will be provided with the results from multivariate models), log real loans also increase after a one percentage point shock in the interbank rate, but only temporarily. On the other hand, log real deposits decrease, but only marginally – the effect is insignificant and quickly vanishing. Relatively larger movements are shown by interbank liabilites and log real bond holdings (both decreasing). As neither total and interest-earning assets nor interest-bearing liabilites change much with short-term interest rates (they all decrease slightly), it seems that the choice of reference values in calculating balance sheet ratios does not largely affect the results. Another reason for an analysis of ratios possibly being flawed is the fact that the value of bonds simply decreases if interest rates go up. As a result, the loan ratio in interest-earning assets might increase even if the amount of loans granted by the banking sector shrinks. The results reported here suggest that this is not the case – the asset portfolio of the average Austrian bank indeed exhibits a slight tendency towards more credit within its assets after monetary contractions.

Next, results are generated from six-variable VAR models to evaluate how the above results change with including additional information and with respecifications that focus on loan supply reactions to monetary policy. In the loan ratio example, the model includes (the following order is also used for identification) GDP growth, the inflation rate, the overnight money market rate, the share of loans in interest-earning assets of the banking sector, the share of equity capital in the banking sector's balance sheet, and the average (ex-post) interest rate on loans to non-banks. With the models of the other balance sheet variables, corresponding ex-post interest rates are applied.

The first panel of Table 3 reports the responses from the unrestricted VAR. Compared to the results in Table 2, all adjustments on the liabilities side of the balance sheet are found to be smaller and statistically insignificant. Concerning the asset variables, loan ratio reactions to an interest rate shock are found to vanish more quickly with longer forecast horizons. However, with direct feedback from economic activity onto the balance sheet ratios and the respective ex-post interest rates completely removed (see the third panel of Table 3), the former result of banks exchanging interbank liabilites for deposits and secured debt is more apparent again.

Table 3. Responses of banking sector balance sheet variables to interest rate shocks II

After quarter	0	1	2	4	8	FEVD
Responses from unrestricted VAR (Cholesky decomposition)						
Interbank claims (% of IEA)	-0.74*	-0.53*	-0.37	-0.16	0.00	7
Loans to non-banks (% of IEA)	0.66*	0.62*	0.54*	0.39	0.24	14
Bond holdings (% of IEA)	0.01	-0.18	-0.31*	-0.46*	-0.50*	34
Interbank liabilities (% of IBL)	-0.24	-0.38	-0.46	-0.58	-0.68	10
Deposits from non-banks (% of IBL)	0.05	0.11	0.16	0.29	0.50	6
Secured debt (% of IBL)	0.22	0.24	0.25	0.24	0.20	6
Responses from near VAR (Cholesky decomposition)						
Interbank claims (% of IEA)	-0.74*	-0.60*	-0.48*	-0.30	-0.09	10
Loans to non-banks (% of IEA)	0.67*	0.62*	0.54*	0.39	0.25	13
Bond holdings (% of IEA)	0.01	-0.11	-0.21*	-0.38*	-0.51	28
Interbank liabilities (% of IBL)	-0.24	-0.46*	-0.60*	-0.72*	-0.75	12
Deposits from non-banks (% of IBL)	0.04	0.22	0.31	0.41	0.48	8
Secured debt (% of IBL)	0.22	0.26	0.28	0.28	0.22	7
Responses from near VAR (Bernanke-Sims style identification)						
Interbank claims (% of IEA)	-0.73*	-0.57*	-0.44*	-0.24	-0.03	9
Loans to non-banks (% of IEA)	0.61*	0.58*	0.52*	0.39*	0.25	13
Bond holdings (% of IEA)	0.05	-0.07	-0.18	-0.36*	-0.51*	22
Interbank liabilities (% of IBL)	-0.19	-0.41*	-0.55*	-0.68*	-0.73*	11
Deposits from non-banks (% of IBL)	-0.10	0.09	0.20	0.35	0.48*	6
Secured debt (% of IBL)	0.26*	0.29*	0.31*	0.30*	0.22*	9

Notes: This table presents within-quarter and selected subsequent responses of several variables, describing the structure of the balance sheet of the Austrian banking sector to one-unit impulses in the overnight money market rate (available from 1989:2 on). By use of the Schwarz information criterion, a VAR order of 1 is chosen throughout. The abbreviation IEA stands for interest-earning assets, IBL for interest-bearing liabilities. The VAR models used in the first panel of the table include (in the order of identification) GDP growth, the inflation rate, the overnight money market interest rate, the respective balance sheet ratio, the share of equity capital in total assets, and an average ex-post interest rate corresponding to the particular balance sheet ratio. For the results in the second panel (the near VAR), lagged GDP growth and the lagged inflation rate are removed from the reduced-form equations of the balance sheet ratios. Error bands for the responses from both of these models are obtained via Monte Carlo integration with 2000 draws, and 95% confidence intervals are approximated by means of the 0.025 and 0.975 fractiles of the response distribution. Asterisks indicate statistical significance at the 5% level. FEVD is the percentage of the mean squared forecasting error in the response variable after eight quarters due to innovations in the money market rate. For the overidentified near VAR in the third panel of the table (the structural identification scheme is adapted in a way so that the contemporaneous effects of GDP growth and the inflation rate on bank balance sheet ratios are restricted to zero), responses are bootstrapped with 2000 replications, and their statistical significance is evaluated based on Hall percentile intervals.

As mentioned above, it has to be confirmed that these results are not (entirely) driven by adjustments of bond values and, therefore, of assets and liabilities totals. Responses to be found in Table 4 are from VAR models using all variables in levels. Therebey, we follow the recommendations of Ashley and Verbrugge (2009), who argue (based on results from Monte Carlo simulations) that VAR models in levels are well suited to obtain impulse response function confidence intervals with good coverage. Logarithms were taken of real GDP, the consumer price index (CPI) and the real bank balance sheet measures (including equity capital), with the latter obtained by use of the CPI. Results from the near VAR models with the Bernanke-Sims style identification scheme are reported, with responses being multiplied by 100 to represent percentages and percentage points, respectively.

One striking difference to the prior results concerns the deposits from non-banks. Their volume response to the interest rate shock is mildly negative and, which is the case also for other variables' reactions, more short-lived. The Austrian banking sector, however, does not seem to experience a significant drop in deposits after a monetary tightening, a result compatible with banks either continuing to attract (non-reservable) deposits, previously holding excess reserves or both. To some extent, the previous results obtained for ratios appear delusive for the reaction of bank liabilities, but this is not the case for bank credit. It can be observed that, for several quarters, the level of loans to non-banks is above the path it would have taken without the one-percentage-point impulse in the short-term rate. Neither the initial response of log real loans of 0.8 percent is extraordinarily large, nor are the following declines in their reaction. It can, therefore, be safely concluded that there is no cutback in the lending activity of the Austrian banking sector after restrictive monetary policy. In balance sheet terms, lending tends to be retained at the expense of interbank claims at the very short horizon, whereas bond holdings shrink significantly in the longer term.

Table 4. Responses of banking sector balance sheet variables to interest rate shocks III

After quarter	0	1	2	4	8	FEVD
Log real interbank claims	-1.96*	-1.71*	-1.57	-1.36	-0.96	4
Log real loans to non-banks	0.80*	0.59*	0.42	0.10	-0.28	3
Log real bond holdings	0.43	-0.86	-1.95	-3.39*	-4.05*	19
Log real interbank liabilities	-1.65	-3.30	-4.63*	-5.97*	-3.86	14
Log real deposits from non-banks	-0.44	-0.38	-0.31	-0.17	-0.03	2
Log real secured debt	0.71	0.35	0.07	-0.35	-0.78	1

Notes: This table presents within-quarter and selected subsequent responses of several variables from the balance sheet of the Austrian banking sector to one-unit impulses in the overnight money market rate (available from 1989:2 on). By use of the Schwarz information criterion, a VAR order of 1 is chosen throughout. The VAR models include (in the order of identification) the logarithms of real GDP and the consumer price index (CPI), the overnight money market interest rate, the logarithms of the respective real balance sheet variable and the real equity capital of the banking sector, and an average ex-post interest rate corresponding to the particular balance sheet measure. Real figures (except for GDP) were obtained by deflating nominal values using the consumer price index. A near VAR with a Bernanke-Sims style scheme for structural identification is applied, whereby all effects of real GDP and the CPI on the variables from the banking sector balance sheet are restricted to zero. All models include a deterministic linear time trend and seasonal dummy variables. Responses are bootstrapped with 2000 replications, and their statistical significance is evaluated based on Hall percentile intervals. Asterisks indicate statistical significance at the 5% level. FEVD is the percentage of the mean squared forecasting error in the response variable after eight quarters due to innovations in the money market rate.

To obtain a more detailed view about results being at odds with the credit channel theory, it may prove advisable to look what happens within the loan portfolio of the banking sector. Credit subaggregates, referring to different (domestic) customer groups on the credit market, are also analyzed within separate but similar VAR models. Corresponding ex-ante (appointed, offered) retail interest rates are available for loans to non-financial enterprises, loans to households, and for loans used for purchasing housing space (that are not mortgage loans). For the fourth kind of loans, hypothecary credit, there is no retail rate available for such a long sample period, so the rate on housing loans is used instead[1]. Table 5 presents the results for the log real values of the different kinds of loans with using an order for identification which places the ex-ante rates before the respective credit subaggregates.

[1] These retail rates have the 'disadvantage' that they are compiled for new business. Therefore, also the ex-post rate on total loans was applied for robustness purposes. Results hardly depend on which of these rates is chosen.

Table 5. Responses of credit subaggregates to interest rate shocks

After quarter	0	1	2	4	8	FEVD
Log real loans to non-financial enterprises	2.05*	2.10*	2.10*	2.14*	1.78*	14
Log real loans to households	1.18*	0.84*	0.39	-0.11	-0.51	4
Log real hypothecary loans	1.35	0.99	0.72	0.50	-0.09	3
Log real housing loans	1.19	-0.59	-1.46*	-1.73*	-0.23	11

Notes: This table presents within-quarter and selected subsequent responses of four log real levels of loan subaggregates (available from 1995:4 on) to one-unit impulses in the overnight money market rate. By use of the Schwarz information criterion, a VAR order of 1 is chosen throughout. The VAR models include (in the order of identification) the logarithms of real GDP and the consumer price index (CPI), the overnight money market interest rate, an ex-ante retail interest rate corresponding to the loan ratio examined (with the exception of the interest rate on housing loans is also used with log real hypothecary credit), as well as the logarithms of the respective real loan subaggregate and the real equity capital of the banking sector. Real figures (except for GDP) were obtained by deflating nominal values using the consumer price index. A near VAR with a Bernanke-Sims style scheme for structural identification is applied, whereby all effects of real GDP and the CPI on the loan variables and the respective interest rates are restricted to zero. All models include a deterministic linear time trend and seasonal dummy variables. Responses are bootstrapped with 2000 replications, and their statistical significance is evaluated based on Hall percentile intervals. Asterisks indicate statistical significance at the 5% level. FEVD is the percentage of the mean squared forecasting error in the response variable after eight quarters due to innovations in the money market rate.

It turns out that, above all, real loans to non-financial enterprises are responsible for the observed increase of aggregate credit. This outcome, however, is not acutely astonishing because (as argued in Section 1) a rise in loans to businesses following a monetary contraction was documented before by, for example, Gertler and Gilchrist (1993) or den Haan et al. (2007). The rather surprising result is that also the subaggregates of real household and hypothecary credit increase during the first months after a shock in the overnight interbank interest rate, although only the short-term reactions of loans to households are statistically different from zero. Housing loans, the remaining credit subaggregate, significantly decrease, albeit with some delay. In terms of shares within the loan portfolio of the banking sector, a substitution of housing for business loans takes place as the changes of consumer and hypothecary credit are relatively more similar to the observed increase of total credit. In this form, the results here are in line with several explanations from the literature. First, as put forward by Gertler and Gilchrist (1993), the loan demand of firms increases after a tightening of monetary policy "reflecting an increased need for credit to smooth the impact of declining sales".

Second, and related to credit supply, banks have an incentive to partly switch from more risky longer-term credit to 'safer' loans with a shorter maturity and a more flexible interest rate, which mainly applies to short-term loans to large firms (termed 'high-quality' borrowers by Garretsen and Swank, 1998). As the volumes of other forms of lending do not shrink as well, the above explanations are not sufficient in the Austrian case. Certain characteristics of the Austrian banking sector, like the tight bank-customer relationships and the liquidity provision within bank networks, are also likely to determine the observed bank behavior.

Concluding remarks

Based on quarterly data for the Austrian banking sector, this paper analyzes bank balance sheet structure and portfolio choices related to the credit channel of monetary transmission. Impulse response analysis reveals that, following increases in short-term interest rates, there is neither a drop in the share of loans to non-banks in interest-earning assets nor in the share of deposits from non-banks in interest-bearing liabilities of the banking sector. Instead, both shares even rise in the medium and longer term, following an unexpected monetary tightening. However, there is no increase – but also no significant decrease – of the volume of deposits, whereas the increase in lending is, at least temporarily, also present in an analysis of bank asset volumes. As this result, which is at odds with the predictions of the credit channel theory, is robust to separating out feedback effects from the macroeconomy on loan demand, it can be concluded that the increase in the loan supply is a result of banks' portfolio choices. Further analysis of loan subaggregates shows that an extension of lending to non-financial enterprises (at the expense of housing loans), in combination with continued lending also to households, is responsible for the increasing share of loans in the balance sheet of the banking sector. Several explanations, for why this could be the case with rising interest rates, are offered in the literature along with similar results for commercial and industrial loans. According to these, banks are more likely to accomodate an increased loan demand in case these loans are short-term in nature, relatively riskless, and earn a satisfactory margin – attributes which are most likely to be present with loans to large firms. Also, some characteristics of the Austrian banking sector, such as close bank-customer relations and the importance of networks for the liquidity of small banks, add to the above explanations. Future research should provide more evidence on the specific roles these factors play in monetary policy transmission. All in all, the evidence from aggregated Austrian bank data does not support a distinctive propagation of monetary shocks through bank lending.

Data sources. Data on profit and loss account items for the banking sector comes from quarterly bank reports, balance sheet data from monthly balance sheet reports (almost all banks operating in Austria report on the legal basis of the Austrian Banking Act). Balance sheet items are quarterly averages of monthly (of three end-of-month) figures and, as the items from the income statement, in millions of euros. The source of the data on banking sector financial statements and on retail interest rates (on new business) is the Austrian Central Bank (Oesterreichische Nationalbank, OeNB). Real GDP comes from the Austrian Institute of Economic Research (Wirtschaftsforschungsinstitut, WIFO), GDP growth is the percentage growth rate of real (quarterly level) GDP relative to real GDP four quarters ago. The money market rate is the overnight VIBOR (Vienna Interbank Offered Rate). From 1999 on, the overnight money market rate is represented by the Euro Overnight Index Average (EONIA), published by the European Central Bank (ECB). The consumer price indices to be chained for calculating the inflation rate (relative to the same quarter of the previous year) come from Statistics Austria.

References

1. Altunbas, Y., Fazylov, O., Molyneux, P. (2002). Evidence on the bank lending channel in Europe, *Journal of Banking and Finance* 26, 2093-2110.
2. Ashcraft, A.B. (2006). New evidence on the Lending Channel. *Journal of Money, Credit and Banking* 38, 751-775.
3. Ashley, R.A., Verbrugge, R.J. (2009). To difference or not to difference: a Monte Carlo investigation of inference in vector autoregressive models. *International Journal of Data Analysis Techniques and Strategies* 1, 242-274.
4. Bernanke, B.S. (1986). Alternative Explanations of the Money-Income Correlation. *Carnegie-Rochester Conference Series on Public Policy* 25, 49-99.
5. Bernanke, B.S., Blinder, A.S. (1992). The Federal Funds Rate and the Channels of Monetary Transmission. *American Economic Review* 82, 901-921.
6. Bernanke, B.S., Gertler, M. (1995). Inside the Black Box: The Credit Channel of Monetary Policy Transmission. *Journal of Economic Perspectives* 9, 27-48.
7. Braumann, B. (2004). Tu Felix Austria: Evidence for a de-celerator in financial reform. *International Economics and Economic Policy* 1, 53-72.

8. Chatelain, J.-B., Ehrmann, M., Generale, A., Martínez-Pagés, J., Vermeulen, P., Worms, A. (2003). Monetary policy transmission in the euro area: New evidence from micro data on firms and banks. *Journal of the European Economic Association* 1, 731-742.
9. Den Haan, W.J., Sumner, S.W., Yamashiro, G.M. (2007). Bank loan portfolios and the monetary transmission mechanism. *Journal of Monetary Economics* 54, 904-924.
10. Ehrmann, M., Gambacorta, L., Martínez-Pagés, J., Sevestre, P., Worms, A. (2003). Financial systems and the role of banks in monetary policy transmission in the euro area. In: Angeloni, I., Kashyap, A.K., Mojon, B. (Eds.), Monetary Policy Transmission in the Euro Area, Cambridge University Press, Cambridge, 235-269.
11. Ehrmann, M., Worms, A. (2004). Bank networks and monetary policy transmission. *Journal of the European Economic Association* 2, 1148-1171.
12. Eickmeier, S., Hofmann, B., Worms, A. (2009). Macroeconomic Fluctuations and Bank Lending: Evidence for Germany and the Euro Area. *German Economic Review* 10, 193-223.
13. European Central Bank (2006). The Eurosystem's Operational Framework and the Volatility of the Overnight Interest Rate. Monthly Bulletin, July, 24-29.
14. Fernández de Guevara, J., Maudos, J., Pérez, F. (2007). Integration and competition in the European financial markets. *Journal of International Money and Finance* 26, 26-45.
15. Frühwirth-Schnatter, S., Kaufmann, S. (2006). How do changes in monetary policy affect bank lending? An analysis of Austrian bank data. *Journal of Applied Econometrics* 21, 275-305.
16. Garretsen, H., Swank, J. (1998). The Transmission of Interest Rate Changes and the Role of Bank Balance Sheets: A VAR-Analysis for the Netherlands. *Journal of Macroeconomics* 20, 325-339.
17. Gertler, M., Gilchrist, S. (1993). The Cyclical Behavior of Short-Term Business Lending: Implications for Financial Propagation Mechanisms. *European Economic Review* 37, 623-631.
18. Hall, P. (1992). The Bootstrap and Edgeworth Expansion. Springer, Berlin.
19. Hülsewig, O., Mayer, E., Wollmershäuser, T. (2006). Bank loan supply and monetary policy transmission in Germany: An assessment based on matching impulse responses. *Journal of Banking and Finance* 30, 2893-2910.
20. Hülsewig, O., Winker, P., Worms, A. (2004). Bank Lending and Monetary Policy Transmission: A VECM Analysis for Germany. *Journal of Economics and Statistics* (Jahrbücher für Nationalökonomie und Statistik) 224, 511-529.
21. Hubbard, R.G. (1995). Is There a "Credit Channel" for Monetary Policy? Federal Reserve Bank of St. Louis Review 77, 63-77.
22. Kakes, J., Sturm, J.-E. (2002). Monetary policy and bank lending: Evidence from German banking groups. *Journal of Banking and Finance* 26, 2077-2092.
23. Kashyap, A.K., Stein, J.C. (1995). The impact of monetary policy on bank balance sheets. Carnegie-Rochester Conference Series on Public Policy 42, 151-195.
24. Kashyap, A.K., Stein, J.C. (2000). What Do a Million Observations on Banks Say About the Transmission of Monetary Policy? *American Economic Review* 90, 407-428.
25. Kashyap, A.K., Stein, J.C., Wilcox, D.W. (1993). Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance. *American Economic Review* 83, 78-98.
26. Kaufmann, S. (2003). The cross-sectional and the time dimension of the bank-lending channel: the Austrian case. In: Angeloni, I., Kashyap, A.K., Mojon, B. (Eds.), Monetary Policy Transmission in the Euro Area, Cambridge University Press, Cambridge, 347-358.
27. Kishan, R.P., Opiela, T.P. (2000). Bank Size, Bank Capital, and the Bank Lending Channel. *Journal of Money, Credit and Banking* 32, 121-141.
28. Lütkepohl, H., Krätzig, M. (Eds.) (2004). Applied Time Series Econometrics. Cambridge University Press, Cambridge.
29. McMillin, W.D. (1996). Monetary Policy and Bank Portfolios. *Journal of Economics and Business* 48, 315-335.
30. Sims, C.A. (1986). Are Forecasting Models Usable for Policy Analysis? Federal Reserve Bank of Minneapolis Quarterly Review 10, 2-16.
31. Suzuki, T. (2004). Credit channel of monetary policy in Japan: resolving the supply versus demand puzzle. *Applied Economics* 36, 2385-2396.