The Impact of Monetary Policy on Financing of Czech Firms*

Ruslan ALIYEV—ADA University, Baku, and Affiliate Fellow at CERGE-EI, Prague

Dana HÁJKOVÁ—Česká spořitelna, a.s., *corresponding author* (dahajkova@csas.cz)

Ivana KUBICOVÁ—Czech National Bank

Abstract

This paper uses firm-level financial data for Czech firms in the period from 2003 to 2011 and tests for the role of companies' financial structure in the transmission of monetary policy. Our results indicate that higher short-term interest rates coincide with lower shares of total debt and long-term debt and higher shares of short-term bank loans and trade credit. We find that firm-specific characteristics, such as size, age, collateral and profit affect the way monetary policy influences the external financing decisions of firms. These findings indicate the presence of informational frictions in credit markets and thus provide some empirical evidence of the existence of a broad credit channel in the Czech Republic.

1. Introduction

In a perfect-information world, changes in monetary policy rates would (*via* the interest rate channel) affect the financing decisions of firms directly by changing their borrowing costs. However, in reality, credit market imperfections influence bank lending and firm financing behavior and (*via* the broad credit channel) alter monetary policy transmission.

The extent to which changes in monetary policy rates are transmitted to client rates depends on the functioning of financial markets, which set the financing costs for banks, and on the conditions on retail-lending markets. The first part of transmission tends to be fast and complete; the second part, however, is slower and often incomplete, while being heterogeneous across agents (Bernanke and Gertler, 1995) and countries (see, for example, Sørensen and Werner, 2006). This has also been documented for the Czech Republic (Crespo-Cuaresma, Égert and Reininger, 2007; Pruteanu-Podpiera, 2007; Horváth and Podpiera, 2012). One of the primary reasons for the delays and unevenness in interest rate transmission is the existence of information asymmetries among banks and clients; a bank's imperfect knowledge about its client's economic situation increases the transaction cost and hence the borrowing costs for the client. Information frictions typically amplify the effects of the interest rate channel. Country-specific reasons for the heterogeneity in transmission include differences in the prevailing structure of financing and in the level of competition on the retail-banking market.

The concept of the broad credit channel addresses those aspects of monetary policy transmission that the interest rate channel does not capture. It concerns

the supply of and demand for bank loans in general or in a client-specific relationship. Several mechanisms of operation of the broad credit channel have been established and analyzed in the literature, most of them distinguishing between the effects of bank-level characteristics and firm-level characteristics.

In this paper, we are interested in how firm-specific characteristics are reflected in the financing structure of Czech firms. In order to control for and assess the effects of monetary policy changes, we mainly follow the lines established in the literature regarding the bank lending, balance sheet and relationship channels. We look at firm-level data to analyze firms' use of external financing. Our approach is to map the patterns in the financing of entrepreneurial firms in the Czech Republic and their implications for monetary policy transmission. We focus on the response of firms' external financing indicators to monetary policy rate changes. The heterogeneity of the individual responses depending on the firm's size, age, collateral and profitability indicates the importance of the broad credit channel for Czech monetary policy.

It is important to point out that Czech firm financing is characterized by significant use of trade credit and non-bank financing. Although bank loans are an important source of financing, too, their share in the financial liabilities of Czech firms is lower than in the euro area (CNB, 2011). The use of market financing by equity and commercial paper is limited to a small number of large firms.

The evidence on the balance sheet channel of monetary transmission in the Czech Republic has been limited. A notable exception is a study of balance sheet data and bankruptcy information by Pospíšil and Schwarz (2014), who find evidence of financial constraints for small Czech firms after 2008.

Our study extends the empirical evidence in two respects: First, we cover 2003–2011 and use firm-level balance sheet data for about 57,000 Czech firms. This allows us to analyze recent developments in firms' balances and describe recent patterns in firm financing. Second, we directly focus on the role of firm-specific characteristics such as age, size, profitability and collateral in the relationship between firm-level financing and monetary policy. Thus we are able to estimate the effects of information asymmetries between firms and banks on the transmission of monetary policy and contribute to the debate about the importance of the broad credit channel with recent empirical evidence.

The paper is organized as follows. In Section 2, we explore the existing literature on the topic. In Sections 3 and 4, we explain our methodology and describe the data. Section 5 reports our findings and robustness tests. Section 6 concludes the paper.

2. Literature Review

The mechanism for the balance sheet channel is that, after a monetary tightening, external financing becomes scarce for firms and households with certain characteristics. For instance, small firms are more likely to be more vulnerable to information asymmetries arising from credit market frictions (Gertler and Gilchrist, 1994; Oliner and Rudebusch, 1996). Less capitalized firms with weak balance sheets have lower access to bank credit and/or a higher price of external funds as compared to large, well-capitalized firms. Banks do not have perfect information and therefore approximate the creditworthiness of firms by the strength of their balance sheets.

In addition, banks tend to make their lending standards stricter in times of uncertainty. After a monetary tightening, individual firms' bank debt may decrease not only because of the firm's own reaction to the higher interest rates, but also because of banks' tightened lending standards, especially in a situation where they cannot easily replace bank credit with other types of financing. Hence, the balance sheet position of a firm determines the accessibility of market funds for borrowing (Bernanke and Gertler, 1995).

The effects of the balance sheet channel have been intensively analyzed on the micro level from the point of view of the conditions faced by firms and households and the financing behavior of firms and households (Gertler and Gilchrist, 1994; Fidrmuc *et al.*, 2009; Bougheas *et al.*, 2006). In the literature, different firm-specific indicators have been analyzed for their role in the balance sheet channel. For example, de Haan and Sterken (2000) look at the effects of corporate governance and find that private firms are more dependent on bank debt and external funds and thus more sensitive to changes in the monetary policy conditions. Mizen and Yalcin (2002) and Bougheas *et al.* (2006) show that risky, young and small firms have decreased access to lending when monetary policy is tight. Also, Prasad and Saibal Ghosh (2005) find that corporations behave differently depending on their ownership and size and the period.

However, changes in bank debt in the balance sheets of firms may also result from shifts in the supply of bank debt alone. This channel became relatively important in some countries during the recent economic and financial crisis.[1] Identification of the supply and demand channels has featured in the literature since the debate between Kashyap *et al.* (1993 and 1996) and Oliner and Rudebusch (1996a) and requires very detailed data to be addressed correctly. For example, Jiménez *et al.* (2012) analyze a Spanish micro-dataset with information on old and new loans, credit applications and loan conditions, along with firm and bank characteristics. Ciccarelli *et al.* (2010) use comprehensive data from US and euro area bank lending surveys.

The so-called relationship lending channel assumes that the existence of a long-term relationship between banks and their debtors alleviates information asymmetries (Boot, 2000; Elsas, 2005). This long-term relationship thus creates benefits in terms of intertemporal smoothing, increased credit availability, enhancement of borrowers' project payoffs and more efficient decisions if borrowers face financial distress (Petersen and Rajan, 1994).

As regards the relationship channel, Elsas and Krahnen (1998) and Harhoff and Korting (1998) find that companies which have a relationship with a finance provider have easier access to loans. Alternative evidence is presented by de Haan and Sterken (2006), who find higher sensitivity of firms to monetary policy shocks in market-based systems than in bank-based ones.

For the Czech Republic, the evidence on the balance sheet channel of monetary transmission is limited and only covers the period up to 2003.[2] Horváth (2006

---

[1] The different sources of shocks to the supply of bank debt were discussed, for example, by Acharya and Naqvi (2012) and Dell'Ariccia and Marquez (2006).

[2] Égert (2009) provides a description of the empirical evidence across the majority of monetary policy transmission channels in the countries of Central and Eastern Europe. The bank lending channel is analyzed by Pruteanu (2007) and Matousek and Sarantis (2009).

and 2009) and Fidrmuc *et al.* (2009) analyze financial accelerator effects in firms' balance sheets in the Czech Republic and find that monetary policy has stronger effects on small firms than on big ones and that debt structure and cash-flow have a significant influence on firm-level interest rates.

Geršl and Jakubík (2010) analyze the relationship banking channel in the Czech Republic and underline the high relevance of single relationship banking for small and young firms in technology- and knowledge-intensive industries.

The methodology used in our paper provides an alternative view on the balance sheet channel by describing various measures of indebtedness of Czech firms, which is complementary to previous analyses of financial accelerator effects. Furthermore, besides the effects of monetary policy on average debt ratios, our study extends the focus to different firm-specific characteristics.

3. Methodology

We borrow our methodology mainly from Bougheas *et al.* (2006) and de Haan and Sterken (2006). Following their approach, we consider the impact of monetary policy on different indicators of firms' external financing drawn from annual balance sheet data. We analyze how these financing indicators react to monetary policy changes depending on firm heterogeneity and control for firm-specific variables that may influence capital structure choices. To do so, we regress different financing indicators on the monetary policy variable, size, age, profit, collateral, gearing and their inter-action terms with the monetary policy variable and control for some other variables. Our basic regression model is given below:

$$Y_{i,t} = \alpha_1 + \alpha_2 MP_t + \beta X_{i,t} + \gamma MP_t \times X_{i,t} + \alpha_3 \Delta GDP_{t-1} + \varepsilon_{i,t} \qquad (1)$$

where

$Y_{i,t}$ denotes one of the following four debt ratios of firm i in period t:

TODEBT—the total debt to total assets ratio, i.e. the overall use of external debt,

SHLOAN—the short-term bank loans to total assets ratio,

SHTRADE—the trade credit to total assets ratio; this is a component of working capital which can be a substitute for bank debt (Petersen and Rajan, 1997),

LDEBT—the long-term debt to total assets ratio.

MP_t is a monetary policy indicator, an increase in which corresponds to monetary tightening. Following the standard literature, we focus mainly on the short-term market interest rate, which is typically closely linked to the monetary policy rate. As a measure of the short-term interest rate, we use the three-month PRIBOR (Prague Interbank Offered Rate). In the robustness test, we check our results using the one-year PRIBOR. Since interest rates are yearly averages and balance sheet variables are indicators reported at the end of the year, there is a lag in the effect of market rates on firms' financing decisions.

$X_{i,t}$ denotes firm-specific characteristics. These analyzed firm characteristics are:

SIZE—the natural logarithm of total assets (Kashyap and Stein, 1995),

AGE—the number of years in existence since 1996,[3]

COLLATERAL—the ratio of tangible fixed assets to total assets,

PROFIT—the ratio of earnings before interest and taxes to total assets.

ΔGDP_{t-1} is the one-year-lagged real GDP growth rate. This variable is included to control for the business cycle.

$\varepsilon_{i,t}$ is the error term.

We use a panel model to analyze the above-mentioned relationships.[4] We test for a fixed versus random effects structure of the model using a Hausman specification test in order to determine the precise structure of the general model. In most cases, the null hypothesis of firm-specific effects being uncorrelated with the regressors was rejected and hence the fixed effect model is favored.

In analyzing the relationship between monetary policy and loan supply, the identification is very important and deserves some explanation. Some studies use more detailed data to meet this challenge. For example, Jiménez *et al.* (2012) use loan-level data to separate loan supply from demand.[5] Given the limitations of our dataset—which does not contain detailed information about loan applications and their results, linked with firm/bank-specific characteristics—we are not able to clearly identify supply and demand effects.

4. Data

The data used in the main part of our paper comprise information on firms' yearly balance sheets and financial results from the Bureau van Dijk Amadeus[6] database and macroeconomic data on interest rates and output from the CNB's ARAD time series database, all for the 2003–2011 period.

Our final sample contains about 312,000 observations for 57,000 firms from the manufacturing, construction, wholesale, retail, car repair and transport sectors. We include only active firms belonging to all size categories (called very large, large, medium and small) in our analysis. The original raw data were much larger and included 1.5 billion observations for about 530,000 firms for the 1993–2013 period. The availability of data for 2012 and 2013 was rather limited, so we decided that 2011 would be the last year of the data. In addition, irrespective of the year,

---

[3] We use this approach to quantify the firm's reputation build-up and relationship with financial institutions since the establishment of the free market economy. By picking 1996, we disregard some initial years of transition, when the Czech banking sector failed to operate on prudent principles, which led to bank consolidation and stabilization programs in 1995–1996.

[4] Given the possible endogeneity problem indicated in the literature and a lack of good instruments, we considered using the panel GMM estimator suggested by Arellano and Bond (1991), as it ensures efficiency and consistency, being robust to heteroscedasticity and autocorrelation, especially on samples with short time dimensions and large firm dimensions. However, the Sargan test of over-identifying restrictions indicated that all the proposed instruments are invalid. Therefore, we do not report results obtained using the Arellano and Bond GMM methodology.

[5] Jiménez *et al.* (2012) use confidential information from the Credit Register of Spain to study the effects of bank specific characteristics on the success of loan applications. Specifically, they focus on how banks' capital or liquidity positions influence the probability of granting a loan.

[6] Amadeus is a database of comparable financial information for public and private companies across Europe. It contains company financial information in a standardized format created by Bureau van Dijk to ensure cross-country comparability. Companies are included in the database based on the availability of financial data or firm size if financial data are not available. Financial information is gathered from all available official sources.

Table 1 Summary Statistics

		Mean	Standard deviation	Min	Max
TODEBT	total debt to total assets ratio	0.51	0.30	0.0	1.0
SHLOAN	short-term bank loans to total assets ratio	0.04	0.11	0.0	1.0
SHTRADE	short-term trade credit to total assets ratio	0.12	0.20	0.0	1.0
LDEBT	long-term debt to total assets ratio	0.05	0.15	0.0	1.0
SIZE	log of total assets	15.8	2.2	7.0	25.0
AGE	age of firm	8.3	4.1	0.0	15.0
COLLATERAL	tangible fixed assets to total assets ratio	0.2	0.3	0.0	1.0
PROFIT	EBIT to total assets ratio	0.1	0.4	-19.8	19.2
PRIBOR 3M	3-month PRIBOR	2.6%	1.0%	1.2%	4.1%
ΔGDP	real GDP growth rate	3.4%	3.5%	-4.5%	7.0%

the financial information for many of the observations was incomplete, and there were occurrences of misleading and wrong numbers, such as negative total assets, inequality between total assets and total liabilities, and components of total liabilities being larger than total liabilities. The raw data also contained firms in liquidation, bankrupt, dissolved and inactive firms (defined by health status), which may not react to monetary policy changes properly. To obtain the final dataset, we excluded all the irrelevant observations. We also performed the Grubbs test for outliers, which indicated that the data do not contain any outliers.

The summary statistics of the main variables are given in *Table 1*. All firm-specific variables except AGE and SIZE are scaled by total assets.

Figure A1 in *Appendix A1* describes the structure of liabilities averaged across firms for different time periods and for different size and age categories.[7] The financing of Czech firms is, on average, evenly divided between debt and shareholder funds (*Figure A1*, Panel a). More than three-quarters of debt financing is of a short-term nature on average: total debt consists mainly of current liabilities, which are made up mostly of trade credit and other current liabilities, while short-term bank loans provide a relatively small proportion of the funds. Just over half of non-current liabilities are in long-term bank debt. Panel b in *Figure A1* depicts how the structure of debt has changed over the last decade. We observe that there was very little variation in the debt structure during 2003–2007, when the share of total debt was slightly larger than that of shareholder funds. However, in 2011 the situation changed somewhat, with shareholder funds having a little more weight than the total debt.

There is heterogeneity of financing regarding the size and age of firms. We divide the sample of firms into three groups of equal size. The firms are assigned to

[7] In the descriptive part we compare the top and bottom thirds of size and age, while in the regressions we use continuous variables for each firm-specific indicator. Also, we provide robustness tests where categorized firm-specific variables are used instead of continuous variables. The *t*-test of differences between the means of different debt ratios for different years and size and age categories indicate that there exist significant differences between the means for different categories.

Figure 1 Change in the Average Debt Structure and Macro Variables over Time
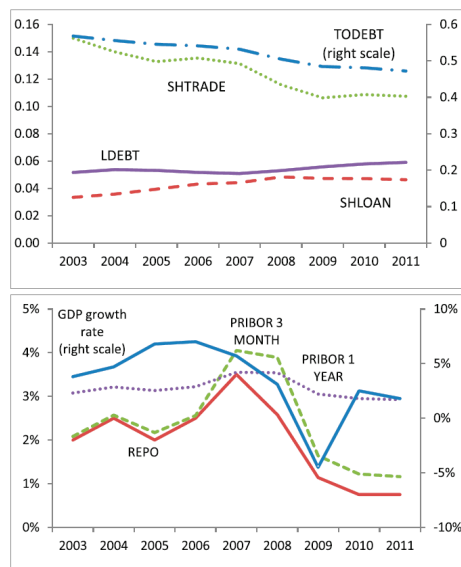
their respective groups according to their size (small, medium or large) and according to their age (young, medium or) old. This distinction reveals that small and young firms tend to have more debt and less shareholder funds than large and old companies (*Figure A1*, Panels c and d). Firms in different size and age categories also differ in terms of maturity of debt: smaller and older firms hold more short-term debt than larger and younger firms, respectively. Larger firms have a larger share of short-term bank loans and trade credit in their current liabilities,[8] while age does not play a crucial role for the maturity of short-term debt.

Next, we describe the evolution of our debt ratios, which are depicted in *Figure 1*. The data reveals that total TODEBT decreased continuously between the beginning and the end of the analyzed period, while the decline was more pronounced after 2006. This decline occurred mainly because of a drop in other current liabilities and SHTRADE. The variability of LDEBT and SHLOAN was smaller.

In the second graph, we see that the movements in market interest rates traced the changes in monetary policy rates, except for the years affected by the financial crisis, when monetary policy had to be more aggressive to ease the monetary conditions adequately. Since we use market rates in the regressions, we capture the part of the transmission that occurs between money market and client rates, which—in normal times—is a good representation of the transmission of monetary policy rates.

The correlations between the debt ratios and other firm-specific indicators and the interest rate are shown in *Table 2*. TODEBT is positively correlated with all other

---

[8] Other current liabilities appear to be quite important for small firms. Unfortunately, the data set does not yield more details about this item. Other current liabilities typically include taxes, payroll, customer advances and rental liabilities.

Table 2 Correlation Coefficients

	TODEBT	*SHLOAN*	*SHTRADE*	*LDEBT*	*SIZE*	*AGE*
TODEBT	1.000					
SHLOAN	0.260	1.000				
SHTRADE	0.359	-0.013	1.000			
LDEBT	0.270	-0.047	-0.084	1.000		
SIZE	0.230	0.160	0.295	0.051	1.000	
AGE	-0.144	0.020	-0.021	-0.036	0.202	1.000
COLLATERAL	0.101	0.134	-0.074	0.185	0.309	0.118
PROFIT	-0.042	-0.022	-0.013	-0.037	0.065	-0.031
PRIBOR 3M	0.049	0.000	0.031	-0.015	-0.008	-0.190

debt ratios by construction. A positive correlation exists between SIZE and all the debt ratios, though the correlation with long-term debt is weaker. We also observe a negative correlation between AGE and TODEBT. AGE and SIZE are positively correlated, indicating that the older a firm becomes, the more assets it tends to accumulate.[9] PROFIT does not have strong correlations with the other variables. COLLATERAL is positively correlated with both short-term bank loans and long-term debt. The correlations between the three-month PRIBOR and the debt ratios are negligible.

5. Results

In this section, we present our estimation results and findings. The regression results are summarized in *Table 3*, where each column corresponds to one of the four measures of debt. We report the results of the regressions of the financing ratios on market interest rates while controlling for firm specificities, business cycles and interaction terms between interest rates and firm-specific indicators, which would capture the heterogeneity of responses to monetary policy. While the majority of the explanatory variables have significant effects on the debt ratios, we find some heterogeneity in the reactions to monetary policy.

First, we describe the main effect of monetary policy and firm-specific variables on debt ratios. Since we have interaction terms in the regression model, the coefficients in *Table 3* cannot be interpreted directly. The pure effects of interest variables are estimated by holding the remaining variables at their mean (*Table 4*). According to the interest rate channel, an increase in the price of external financing makes debt financing more expensive, which should be reflected in a decreasing share of debt. In our results, an increase in the lagged short-term interbank rate (THREE-MONTH PRIBOR) reduces the overall shares of total debt (TODEBT) and long-term debt (LDEBT). However, we observe an increase in short-term bank loans (SHLOAN) and a negligible increase in short-term trade credit (SHTRADE). We explain this result by the following argument: loans of a short nature are less flexible

---

[9] To test for multicollinearity among the variables, we estimate the variance inflation factor (VIF) and the condition index. Test results indicate the presence of some multicollinearity, which is common in models that include interaction terms. Centering of the multiplicative variables solves this problem. The final estimated VIFs are smaller than 10 and the condition index is smaller than 30, which indicates that there is no multicollinearity among the variables used in our analysis.

Table 3 Estimation Results
(number of observations: 312 366; number of firms: 56 631)

Y_{it}	TODEBT	SHLOAN	SHTRADE	LDEBT
	(1)	(2)	(3)	(4)
3 month PRIBOR$_{t-1}$	0.008*** (0.0009)	0.001*** (0.0002)	0.0005* (0.0003)	-0.001*** (0.0005)
Size$_{it}$	0.109*** (0.0013)	0.011*** (0.0004)	0.035*** (0.0008)	0.013*** (0.0007)
3 month PRIBOR$_{t-1}$ * * Size$_{it}$	0.0032*** (0.0001)	0.0004*** (0.0001)	0.001*** (0.0001)	0.000*** (0.0001)
Age$_{it}$	-0.025*** (0.0003)	0.001*** (0.0001)	-0.006*** (0.0002)	-0.002*** (0.0001)
3 month PRIBOR$_{t-1}$ * * Age$_{it}$	-0.0016*** (0.0001)	0.0001*** (0.0000)	-0.0005*** (0.0001)	-0.0001 (0.0001)
Collateral$_{it}$	0.096*** (0.0051)	0.066*** (0.0025)	-0.086*** (0.0030)	0.080*** (0.0036)
3 month PRIBOR$_{t-1}$ * * Collateral$_{it}$	-0.008*** (0.0012)	0.004*** (0.0007)	-0.004*** (0.0008)	-0.003*** (0.001)
Profit$_{it}$	-0.500*** (0.0031)	-0.008*** (0.0006)	-0.016*** (0.0012)	-0.006*** (0.0008)
3 month PRIBOR$_{t-1}$ * * Profit$_{it}$	0.012*** (0.0021)	0.001 (0.0004)	0.0001 (0.0009)	0.0018*** (0.0005)
ΔGDP$_t$	0.038*** (0.0086)	0.008* (0.0043)	0.005 (0.0068)	-0.008 (0.0057)
Intercept	0.698*** (0.0003)	0.044*** (0.0001)	0.121*** (0.0002)	0.053*** (0.0014)
R^2	0.09	0.03	0.12	0.02

Notes: Robust standard errors in parentheses. Significantly different from zero at the 90% (*), 95% (**), and 99% (***) confidence levels.

Table 4 Main Effects

	TODEBT	SHLOAN	SHTRADE	LDEBT
3 MONTH PRIBOR$_{t-1}$	-0.006	0.001	0.0005	-0.002
SIZE$_{it}$	0.109	0.011	0.035	0.013
AGE$_{it}$	-0.025	0.001	-0.006	-0.002
COLLATERAL$_{it}$	0.096	0.066	-0.086	0.080
PROFIT$_{it}$	-0.050	-0.008	-0.016	-0.006

and are used to meet the urgent needs of the firms. Therefore these types of financing do not instantaneously respond to changes in the price of external debt. However, firms are not willing to borrow long-term debt at an increased interest rate.

The size and age of a firm are found to be important determinants of debt. For example, larger firms tend to have higher debt ratios than smaller firms, *ceteris paribus*. Large firms have more power and better contacts and reputation. With respect to age, older firms tend to have less total debt, trade credit and long-term debt, and more short-term bank debt than younger firms do. Presumably, after more years in existence, firms use less external financing, especially debts of a long-term nature. However, with more years of relations with commercial banks, they can easily access short-term bank loans.

Figure 2 The Effect of THREE-MONTH PRIBOR on External Financing Decisions for Various Sets of Firm-Specific Characteristics
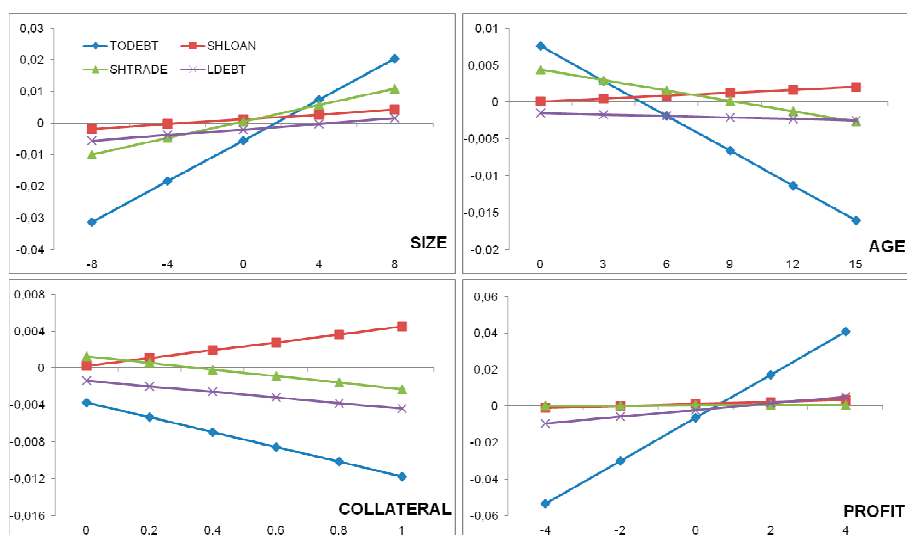
The use of debt is also determined by the firm's COLLATERAL, which is measured as the ratio of tangible fixed assets to total assets. Firms with more collateral tend to have more total, short-term and long-term bank debt, but less trade credit. This would be in line with the hypothesis that—because of better guarantees—this subset of firms can easily access bank debt and therefore such firms are not in need of trade credit.

PROFIT has a negative impact on all debt ratios, meaning that firms with higher earnings use less external financing. This result is reasonable, since more profitable firms may use more of their generated income—which tends to be less expensive—and hence be less dependent on external financing as compared to less profitable firms.

Finally, higher shares of total debt and short-term bank loans coincide with higher GDP growth rates. This result would be in line with the hypothesis that more credit is issued in good times because of better economic prospects and higher profitability of investment perceived by both banks and firms. However, according to the results for long-term bank debt this hypothesis does not hold, since the GDP growth rate has an insignificant coefficient for this debt ratio.

We have to note that, according to our econometric model, the effect of the interest rate cannot be studied independently. As we mentioned above, there are firm-specific parameters that influence the way the interest rate affects the financing decisions of firms. To analyze how firms respond to changes in the interest rate depending on their characteristics, we focus on the interaction terms between the interest rate and firm-specific characteristics. The marginal effects of PRIBOR_3M on debt ratios for different firm-specific parameters are summarized in *Figure 2*.

As we can see, smaller firms decrease and larger firms increase their external financing in response to monetary contraction. This effect is more pronounced for

total debt and weaker for other external debt measures. Small firms may be more informationally opaque and therefore more likely to be sensitive to external debt price changes compared to large firms. This argument is supported by Pospíšil and Schwarz (2014), who find that small and medium-sized Czech firms are sensitive to external debt, which is not the case for larger companies. The observed diverse responses can be explained by the supply-side effects: the interest rate is high when the economy is growing and there is excess demand for credit. In this situation, large companies are less financially constrained and can access bank credit more easily to finance their expansion. In contrast, small firms are more financially constrained and should decrease the share of external debt in financing their investments.

Surprisingly, age works in the reverse direction: total debt and short-term trade credit decreases for older firms and increases for younger firms if the interest rate rises. On average, younger firms do not change the share of short-term bank loans, though older firms increase their short-term bank borrowing in response to monetary contraction. We also observe a decrease in long-term debt between both groups, though this decrease is stronger for older firms. One explanation can be the fact that older firms are relatively mature and are not as in need of external financing as younger firms.

The data also reveal that during a monetary tightening, more collateralized firms reduce their total debt and long-term bank credit more than less collateralized ones do. The effect of monetary contraction on short-term debt is trivial for less collateralized firms. Conversely, firms with more collateral decrease their short-term trade credit and increase short-term bank loans if the interest rate rises. More collateral means better backing of debt and therefore higher credibility among banks. In other words, highly collateralized firms, which have better access to short-term bank debt, may be more flexible in shifting from long-term to short-term debt during periods when money is expensive.

Profit has a similar effect as size on monetary transmission: firms that generate positive profit increase and firms that operate with loss decrease their external financing in response to a monetary tightening. The effect is stronger for total debt and weaker for other external debt measures. The explanation for this finding may be similar to the one provided for the size effect.

5.1 Robustness Checks

In this subsection, we provide three robustness tests: by using one-year interest rates for monetary policy, by including the available data for the year 2012 and by categorizing firm-specific characteristics. The outcomes of the tests are provided in *Appendix A2*. In general, our previous findings are robust to these tests, although there are some interesting differences *vis-à-vis* our baseline model.

Three-month interbank rates are more commonly used in the literature as a measure of the short-term interest rate, since these rates more accurately reflect the monetary conditions. However, in order to check the robustness of our results, we re-estimate them by using a longer term interest rate, the one-year PRIBOR instead of the benchmark measure, the three-month PRIBOR. The one-year PRIBOR might better capture the pricing of different financing measures (e.g. short-term bank loans) of firms. As we can see, the results are qualitatively identical to our previous estimates (*Table A1* and *Figure A2* in *Appendix A2*).

In our benchmark regressions, we excluded the year 2012 due to missing data for about half of the firms. We do have a significant chunk of data for 2012 (about 22,000 observations, or 7% of the total), but we did not include it in our baseline estimation because of concerns about sample selection bias. If we include 2012, the results do not significantly differ from those where it is excluded (*Table A2* and *Figure A3* in *Appendix A2*).

Finally, instead of continuous variables we use dummy variables to capture the effects of firm-specific variables. Sometimes this method is used to obtain more straightforward interpretations for the estimation results. We categorize the firm-specific variables in three groups: the top 33%, the middle 33% and the bottom 33%. The distribution of each firm-specific variable (*Figure A5*) and the categorization criteria, i.e. the cut-off points between groups (*Table A4*) are given in *Appendix A3*. The regression results with dummy variables are summarized in *Table A3* and *Figure A4* in *Appendix A2*.

If we compare *Figure 2* with *Figure A4,* we can see that the relative trends for different firm-specific characteristics are identical. However, we observe differences in the relative effects. For instance, when we use dummies, large firms also decrease their long-term debt in response to monetary tightening, though this decrease is smaller compared to that of small firms. Everything else is almost identical to the case where the continuous size variable is used. With respect to age, now both age categories increase their total debt and short-term trade credit ratios when the interest rate rises. However, this increase is smaller for old firms. Firms with low collateral increase and firms with high collateral decrease their total debt ratio if the cost of borrowing rises. The effect of profit on monetary transmission is not changed substantially when profit dummies are used.

6. Conclusions

In this study we looked for evidence of balance sheet, bank lending and relationship channels of monetary policy transmission in the Czech Republic. We concentrated on the heterogeneous response of firms' financing decisions to monetary shocks depending on their size, age, collateral and profit. We used the Amadeus firm-level database from Bureau van Dijk and our sample contains financial and other yearly data for about 57,000 firms over the 2003–2011 period.

The data show that—for Czech firms—firms' own capital makes up on average about one-half of total liabilities and that financial loans account for about 20% of liabilities.[10] The share of shareholder funds in total liabilities increased from 48.1% to 52.3% during 2003–2011. About 16%–18% of the total liabilities of Czech firms are in the form of trade credit.

Our regression results indicate that a monetary contraction leads to a reduction in the shares of total debt and long-term debt and an increase in the shares of short-term bank loans and trade credit. We also confirm that the size, age, collateral and profitability of a firm are important determinants of debt. For example, larger firms tend to have higher debt ratios than smaller firms, *ceteris paribus*. With respect to age, older firms tend to have less total debt, trade credit and long-term debt, and

---

[10] This is confirmed by aggregate information from the Quarterly Financial Accounts, a statistical system produced by the Czech National Bank which records the financial relationships within the economy.

more short-term bank debt than younger firms do. Firms with more collateral tend to have more total, short-term and long-term bank debt, but less trade credit. The profitability of a firm has a negative impact on all debt ratios, meaning that firms with higher earnings use less external financing.

Our main finding is that smaller and less profitable firms are affected more by a monetary contraction compared to larger and more profitable firms. Specifically, smaller and less profitable firms reduce their external financing, while larger and more profitable firms increase their external financing during periods of tight monetary policy. The data also show that higher interest rates lead to an increase of total debt among young firms and a decrease among old firms. We also find that more collateralized firms increase their short-term bank credit and reduce short-term trade credit when the interest rate rises. Total debt and long-term debt decreases for all firms, while this decrease is higher for more collateralized firms.

The evidence of the heterogeneity of reactions to interest rate changes, depending on the given firm's size, age and balance sheet positions, indicates the presence of informational frictions in the markets for firm financing in the Czech Republic. The heterogeneous response of firms with different balance sheet positions points to the existence of a balance sheet channel in the Czech Republic. The observed varying response of small firms, which are more dependent on external financing in comparison with large firms, which are less dependent on external financing, may be an indirect indicator of the existence of a bank lending channel, with the caveat that we do not control for the supply of loans. In general, all these findings provide some evidence of broad credit channels in the Czech Republic.
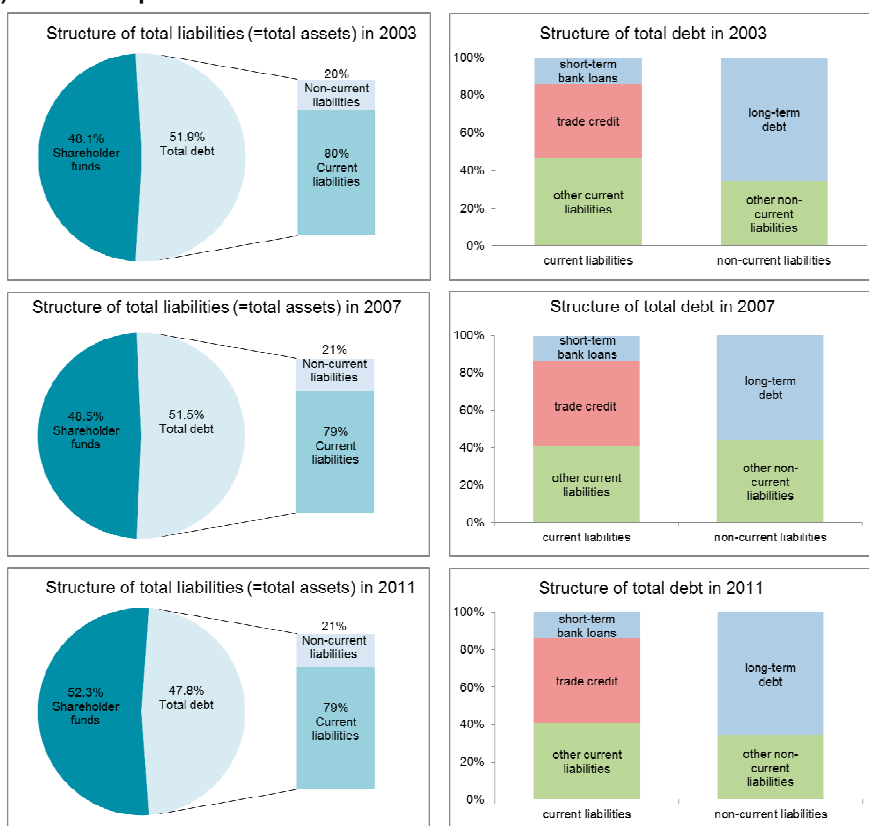
APPENDICES

Appendix A1 Structure of Liabilities

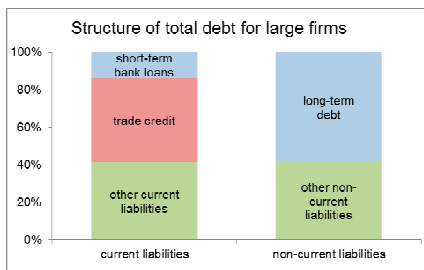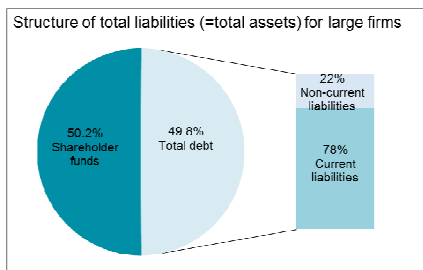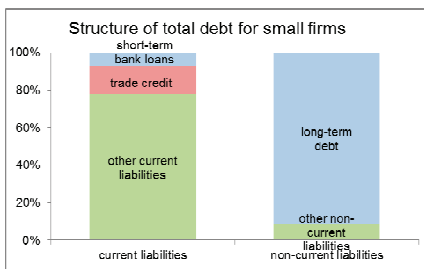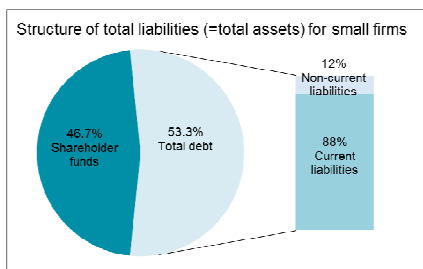**Figure A1 Average Structure of Liabilities**

a) aggregate
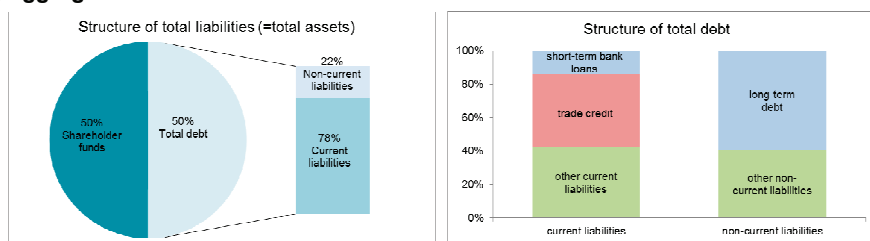
b) in different periods

c) for different size categories

Structure of total liabilities (=total assets) for small firms

Structure of total debt for small firms

Structure of total liabilities (=total assets) for large firms

Structure of total debt for large firms

d) for different age categories

Structure of total liabilities (=total assets) for young firms

Structure of total debt for young firms

Structure of total liabilities (=total assets) for old firms

Structure of total debt for old firms
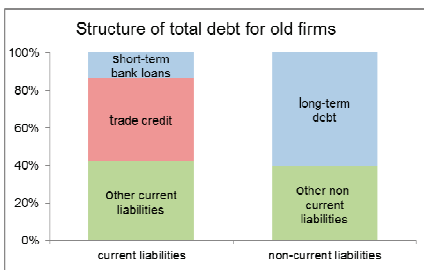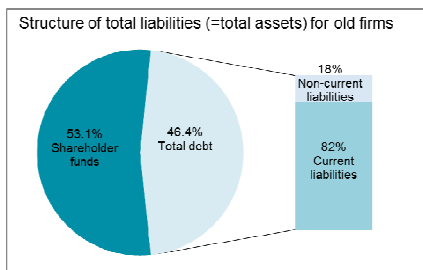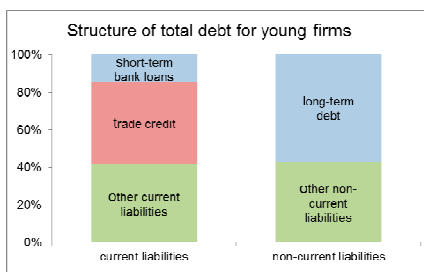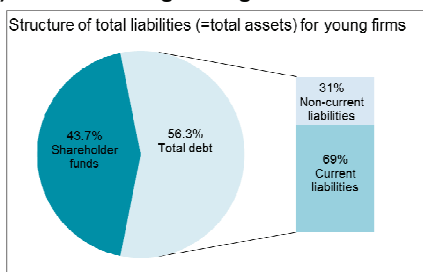
Appendix A2 Robustness Tests

Table A1 Estimation Results: with 1 YEAR PRIBOR

Y_{it}	TODEBT	SHLOAN	SHTRADE	LDEBT
	(1)	(2)	(3)	(4)
1 YEAR PRIBOR$_{t-1}$	0.008***	-0.001*	0.005***	-0.001**
	(0.0010)	(0.0004)	(0.0007)	(0.0006)
SIZE$_{it}$	0.109***	0.011***	0.035***	0.013***
	(0.0013)	(0.0004)	(0.0008)	(0.0007)
1 YEAR PRIBOR$_{t-1}$ * SIZE$_{it}$	0.003***	0.000***	0.001***	0.000***
	(0.0002)	(0.0001)	(0.0001)	(0.0001)
AGE$_{it}$	-0.025***	0.001***	-0.006***	-0.002***
	(0.0003)	(0.0001)	(0.0002)	(0.0001)
1 YEAR PRIBOR$_{t-1}$ * AGE$_{it}$	-0.002***	0.000***	-0.001***	0.000
	(0.0001)	(0.0000)	(0.0001)	(0.0001)
COLLATERAL$_{it}$	0.096***	0.066***	-0.086***	0.080***
	(0.0051)	(0.0025)	(0.0030)	(0.0036)
1 YEAR PRIBOR$_{t-1}$ * COLLATERAL$_{it}$	-0.007***	0.005***	-0.003***	-0.004***
	(0.0014)	(0.0008)	(0.0009)	(0.0012)
PROFIT$_{it}$	-0.050***	-0.008***	-0.016***	-0.006***
	(0.0031)	(0.0006)	(0.0012)	(0.0008)
1 YEAR PRIBOR$_{t-1}$ * PROFIT$_{it}$	0.011***	0.000	0.000***	0.002***
	(0.0023)	(0.0005)	(0.0010)	(0.0006)
ΔGDP_t	0.044***	0.007	0.009	-0.007
	(0.0085)	(0.0043)	(0.0067)	(0.0057)
INTERCEPT	0.697***	0.019***	0.193***	0.053***
	(0.0025)	(0.0010)	(0.0018)	(0.0014)
R^2	0.09	0.03	0.12	0.02

Notes: Robust standard errors in parentheses. Significantly different from zero at the 90% (*), 95% (**), and 99% (***) confidence levels.

Figure A2 The Effect of ONE-YEAR PRIBOR on External Financing Decisions for Various Sets of Firm-Specific Characteristics
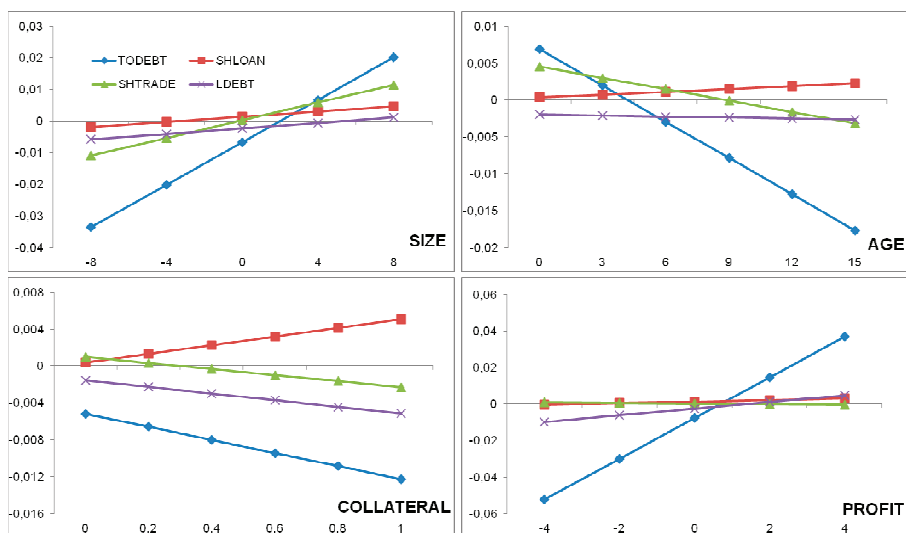
Figure A3 The Effect of THREE-MONTH PRIBOR on External Financing Decisions for Various Sets of Firm-Specific Characteristics: with the Year 2012
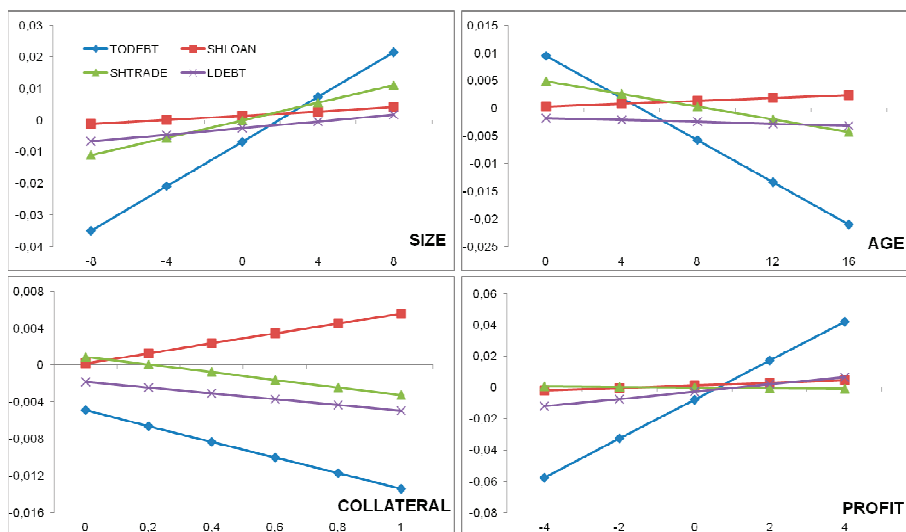
Table A2 Estimation Results: with the Year 2012
(number of observations: 334 737; number of firms: 56 816)

| Y_{it}	TODEBT	SHLOAN	SHTRADE	LDEBT
	(1)	(2)	(3)	(4)
3 MONTH PRIBOR$_{t-1}$	0.010***	-0.001**	0.006***	-0.001***
	(0.0009)	(0.0004)	(0.0006)	(0.0005)
SIZE$_{it}$	0.107***	0.011***	0.034***	0.013***
	(0.0013)	(0.0004)	(0.0008)	(0.0007)
3 MONTH PRIBOR$_{t-1}$ * SIZE$_{it}$	0.004***	0.000***	0.001***	0.001***
	(0.0002)	(0.0001)	(0.0001)	(0.0001)
AGE$_{it}$	-0.024***	0.001***	-0.006***	-0.002***
	(0.0003)	(0.0001)	(0.0002)	(0.0001)
3 MONTH PRIBOR$_{t-1}$ * AGE$_{it}$	-0.002***	0.000***	-0.001***	0.000*
	(0.0001)	(0.0000)	(0.0001)	(0.0001)
COLLATERAL$_{it}$	0.098***	0.065***	-0.085***	0.081***
	(0.0049)	(0.0024)	(0.0029)	(0.0035)
3 MONTH PRIBOR$_{t-1}$ * COLLATERAL$_{it}$	-0.009***	0.005***	-0.004***	-0.003***
	(0.0012)	(0.0007)	(0.0008)	(0.0011)
PROFIT$_{it}$	-0.049***	-0.008***	-0.015***	-0.006***
	(0.0029)	(0.0006)	(0.0011)	(0.0007)
3 MONTH PRIBOR$_{t-1}$ * PROFIT$_{it}$	0.012***	0.001**	0.000	0.002***
	(0.0020)	(0.0004)	(0.0008)	(0.0005)
ΔGDP_t	0.064***	0.003	0.017***	0.003
	(0.0088)	(0.0043)	(0.0067)	(0.0058)
INTERCEPT	0.692***	0.020***	0.191***	0.052***
	(0.0025)	(0.0010)	(0.0017)	(0.0014)
R^2	0.09	0.03	0.12	0.02

Notes: Robust standard errors in parentheses. Significantly different from zero at the 90% (*), 95% (**), and 99% (***) confidence levels.

Table A3 Estimation Results: with Categorization
(number of observations: 312 394; number of firms: 56 637)

| Y_{it}	TODEBT	SHLOAN	SHTRADE	LDEBT
	(1)	(2)	(3)	(4)
3 MONTH PRIBOR$_{t-1}$	-0.008***	-0.001***	0.001	-0.004***
	(0.001)	(0.000)	(0.001)	(0.001)
SIZE$_{it}^{med}$	0.126***	0.022***	0.044***	0.017***
	(0.003)	(0.001)	(0.002)	(0.002)
3 MONTH PRIBOR$_{t-1}$ * SIZE$_{it}^{med}$	0.010***	0.001***	0.003***	0.001*
	(0.001)	(0.000)	(0.001)	(0.001)
SIZE$_{it}^{large}$	0.169***	0.035***	0.072***	0.023***
	(0.004)	(0.001)	(0.003)	(0.002)
3 MONTH PRIBOR$_{t-1}$ * SIZE$_{it}^{large}$	0.010***	0.003***	0.005***	0.001**
	(0.001)	(0.000)	(0.001)	(0.001)
AGE$_{it}^{med}$	-0.067***	0.006***	-0.016***	-0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
3 MONTH PRIBOR$_{t-1}$ * AGE$_{it}^{med}$	-0.011***	0.001*	-0.003***	0.000
	(0.001)	(0.000)	(0.001)	(0.000)
AGE$_{it}^{old}$	-0.116***	0.008***	-0.031***	-0.008***
	(0.002)	(0.001)	(0.001)	(0.001)
3 MONTH PRIBOR$_{t-1}$ * AGE$_{it}^{old}$	-0.003***	0.000	-0.003***	0.001*
	(0.001)	(0.000)	(0.001)	(0.000)
COLLATERAL$_{it}^{med}$	0.035***	0.012***	-0.001	0.012***
	(0.002)	(0.001)	(0.001)	(0.001)
3 MONTH PRIBOR$_{t-1}$ * * COLLATERAL$_{it}^{med}$	0.001	-0.001**	0.000	-0.001
	(0.001)	(0.000)	(0.001)	(0.000)
COLLATERAL$_{it}^{high}$	0.059***	0.032***	-0.023***	0.031***
	(0.003)	(0.001)	(0.002)	(0.001)
3 MONTH PRIBOR$_{t-1}$ * * COLLATERAL$_{it}^{high}$	-0.004***	0.001***	-0.001*	-0.002***
	(0.001)	(0.000)	(0.001)	(0.001)
PROFIT$_{it}^{med}$	0.004***	-0.001	0.004***	-0.003***
	(0.001)	(0.000)	(0.001)	(0.001)
3 MONTH PRIBOR$_{t-1}$ * PROFIT$_{it}^{med}$	0.012***	0.000	0.002***	0.002***
	(0.001)	(0.000)	(0.001)	(0.000)
PROFIT$_{it}^{high}$	-0.035***	-0.011***	-0.007***	-0.010***
	(0.001)	(0.000)	(0.001)	(0.001)
3 MONTH PRIBOR$_{t-1}$ * PROFIT$_{it}^{high}$	0.015***	0.001***	0.001**	0.004***
	(0.001)	(0.000)	(0.001)	(0.000)
ΔGDP_t	0.204***	-0.006	0.045***	0.005
	(0.010)	(0.004)	(0.007)	(0.006)
INTERCEPT	0.439***	0.010***	0.104***	0.035***
	(0.003)	(0.001)	(0.002)	(0.001)
R^2	0.09	0.03	0.11	0.02

Notes: Robust standard errors in parentheses. Significantly different from zero at the 90% (*), 95% (**), and 99% (***) confidence levels.

**Figure A4 The Effect of THREE-MONTH PRIBOR on External Financing Decisions
for Various Sets of Firm-Specific Characteristics: with Categorization**
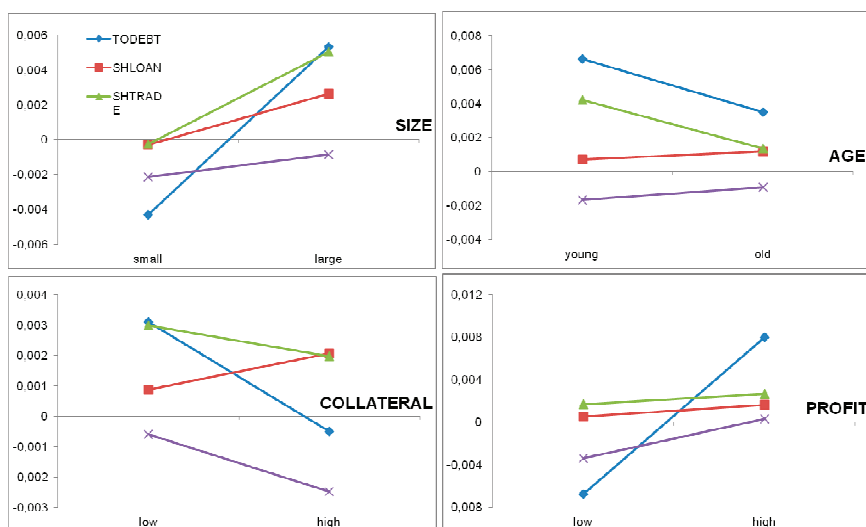
Appendix A3 Categorization Criteria for Firm-Specific Variables

Figure A5 Distribution of Firm-Specific Variables
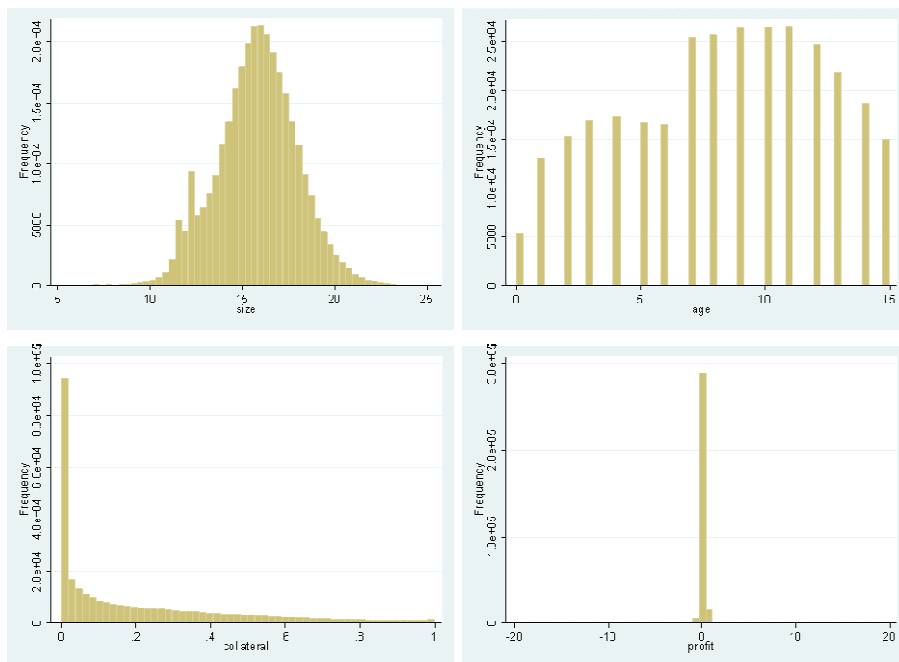
Table A4 Categorization Criteria and Summary Statistics for Different Groups

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
SIZE					
small	104 140	13.4	1.2	6.9	15.0
medium	104 102	15.8	0.5	15.0	16.7
large	104 124	18.1	1.2	16.7	25.4
AGE					
young	126 860	4.1	2.2	0.0	7.0
medium	105 211	9.5	1.1	8.0	11.0
old	80 323	13.3	1.1	12.0	15.0
COLLATERAL					
low	104 131	0.004	0.008	0.0	0.028
medium	104 130	0.126	0.069	0.028	0.265
high	104 133	0.528	0.198	0.265	1.000
PROFIT					
low	104 131	-0.091	0.398	-19.840	0.019
medium	104 130	0.059	0.025	0.019	0.110
high	104 133	0.280	0.376	0.110	19.183

REFERENCES

Acharya V, Naqvi H (2012): The Seeds of a Crisis: A Theory of Bank Liquidity and Risk-Taking over the Business Cycle. *Journal of Financial Economics*, 106(2):349–366.

Arellano M, Bond S (1991): Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies*, 58:277–297.

Bernanke B, Gertler M (1995): Inside the Black Box: The Credit Channel of Monetary Policy Transmission. *Journal of Economic Perspectives*, 9(4):27–48.

Boot AWA (2000): Relationship Lending: What Do We Know? *Journal of Financial Intermediation*, 9:7–25.

Bougheas S, Mizen P, Yalcin C (2006): Access to External Finance: Theory and Evidence on the Impact of Monetary Policy and Firm-Specific Characteristics. *Journal of Banking and Finance*, 30:199–227.

Ciccarelli M, Maddaloni A, Peydró J-L (2010): Trusting the Bankers: A New Look at the Credit Channel of Monetary Policy. *ECB Working Paper Series*, no. 1228.

CNB (Czech National Bank) (2011): *Analyses of the Czech Republic's Current Economic Alignment with the Euro Area*.
http://www.cnb.cz/miranda2/export/sites/www.cnb.cz/en/monetary_policy/strategic_documents/download/analyses_of_alignment_2011.pdf

Crespo-Cuaresma J, Égert B, Reininger T (2007): Interest Rate Pass-Through in Central and Eastern Europe: Reborn from Ashes Merely to Pass Away? *Journal of Policy Modeling*, 29:209–225.

Dell'Ariccia G, Marquez R (2006): Lending Booms and Lending Standards. *Journal of Finance*, LXI(5):2511–2546.

Égert B (2009): Monetary Transmission Mechanisms in Central and Eastern Europe: Surveying the Surveyable. *Journal of Economic Surveys*, 23(2):277–327.

Elsas R (2005): Empirical Determinants of Relationship Lending. *Journal of Financial Intermediation*, 14:32–57.

Elsas R, Krahnen J P (1998): Is Relationship Lending Special? Evidence from Credit Files in Germany. Journal of Banking and Finance, 22: 1283–1316.

Fidrmuc J, Horváth R, Horváthová E (2010): Corporate Interest Rates and the Financial Accelerator in the Czech Republic. *Emerging Markets Finance and Trade*, 46(4):41–54.

Geršl A, Jakubík P (2010): Relationship Lending in the Czech Republic. *Comparative Economic Studies*, 53(4):575–596.

Gertler M, Gilchrist S (1994): Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms. *Quarterly Journal of Economics*, 109(2):309–340.

Haan L de, Sterken E (2000): Capital Structure, Corporate Governance, and Monetary Policy: Firm-Level Evidence for the Euro Area. *De Nederlandsche Bank, Research Memorandum WO&E*, no. 637.

Haan L de, Sterken E (2006): The Impact of Monetary Policy on the Financing Behaviour of Firms in the Euro Area and the UK. *European Journal of Finance*, 12(5):401–420.

Harhoff D, Korting T (1998): Lending Relationships in Germany: Empirical Evidence from Survey Data. *Journal of Banking and Finance*, 22:1317–1353.

Horváth R (2006): Financial Accelerator Effects in the Balance Sheets of Czech Firms. *MPRA Paper,* no. 829.

Horváth R (2009): The Determinants of Interest Rate Margins. *Finance a úvěr-Czech Journal of Economics and Finance*, 59(2):128–136.

Horváth R, Podpiera A (2012): Heterogeneity in Bank Pricing Policies: The Czech Evidence. *Economic Systems*, 36(1):87–108.

Jiménez G, Ongena S, Peydró J-L, Saurina J (2012): Credit Supply and Monetary Policy: Identifying the Bank Balance-Sheet Channel with Loan Applications. *American Economic Review*, 102(5):2301–26.

Kashyap AK, Stein JC, Wilcox DW (1993): Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance. *American Economic Review*, 83(1):78–98.

Kashyap AK., Stein JC, Wilcox DW (1996): Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance: Reply. *American Economic Review*, 86(1):310–314.

Matousek R, Sarantis N (2009): The Bank Lending Channel and Monetary Transmission in Central and Eastern European Countries. *Journal of Comparative Economics*, 37(2):321–334.

Mizen P, Yalcin C (2002): Corporate Finance When Monetary Policy Tightens. *University of Nottingham Working Paper*, no. 03-1.

Oliner SD, Rudebusch GD (1996a): Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance: Comment. *American Economic Review*, 86(1):300–309.

Oliner SD, Rudebusch GD (1996b): Is There a Broad Credit Channel for Monetary Policy? *FRB of San Francisco Economic Review*, no. 1.

Petersen MA, Rajan RG (1994): The Benefits of Lending Relationships: Evidence from Small Business Data. *Journal of Finance*, 49:3–37.

Petersen MA, Rajan RG (1997): Trade Credit: Theories and Evidence. *Review of Financial Studies*, 10(3):661–691.

Pospíšil M, Schwarz J (2014): Bankruptcy, Investment, and Financial Constraints: Evidence from a Post-Transition Economy. *CNB* (Czech National Bank) *Working Paper*, no. 1/2014.

Prasad A, Ghosh S (2005): Monetary Policy and Corporate Behavior in India, IMF WP, no. 05/25.

Pruteanu-Podpiera AM (2007): The Role of Banks in the Czech Monetary Policy Transmission Mechanism. *Economics of Transition*, 15(2):393–428.

Sørensen CK, Werner T (2006): Bank Interest Rate Pass-Through in the Euro Area: A Cross Country Comparison. *ECB Working Paper Series*, no. 580.