

Banks' External Financing Costs and the Bank Lending Channel: Results from a SVAR Analysis

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Abstract

In this paper we evaluate if changes in banks' funding costs represent the deeper link between monetary policy shocks and the supply of bank loans. We identify heterogeneous responses in external financing costs of banks to theory consistent monetary policy shocks by estimating structural vector autoregressions across different bank groups. The monetary policy shock is identified with a combination of zero and sign restrictions. For the estimation we use data from the US, in which we combine bank balance sheet data from the Call reports with macroeconomic aggregates over the period from 1984Q1 to 2007Q3. The analysis provides empirical evidence that funding costs of banks increase for all subgroups of banks, but relatively more for undercapitalized and illiquid banks. Furthermore, the asymmetric reaction in banks' funding costs is most prominent for small banks. Therefore, our result support the interpretation of the empirical Bank Lending Channel literature that shifts in loan volumes of these specific group of banks after a monetary tightening are due to changes in loan supply.

Keywords: Bank Lending Channel, External Finance Premium, Structural Vector Autoregression, Sign Restrictions

JEL codes: E44, E52, G21

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1 Introduction

The banking sector is generally viewed as a central element of the monetary transmission mechanism and a large body of empirical literature demonstrates that monetary policy impacts upon the supply of bank loans (see e.g. Kashyap and Stein, 1995, 2000; Kishan and Opiela, 2000; Gambacorta, 2008; Gambacorta and Marques-Ibanez, 2011). While the traditional Bank Lending Channel (BLC) emphasizes bank reserves, Disyatat (2011) provides a formal reinterpretation of the BLC focusing on banks external financing premia and costs of funds (see also Bernanke, 2007). According to this view, the financial strength of a bank determines how its external finance premium responds to changes in monetary policy. And these changes in the external finance premium are finally passed onto borrowers, shifting the loan supply inwards.

Although the empirical literature typically motivates the analysis with reference to the traditional interpretation of the BLC, Disyatat (2011) points out that the analysis is flexible enough to also be consistent with a crucial role of funding costs rather than quantity constraints. Nevertheless, since funding costs are not explicitly analyzed, the question arises if the identification strategy and the interpretation of the results are indeed consistent with a strong focus on banks' funding costs. The purpose of this paper is to explore whether the financing costs of those banks in which the loan volumes react asymmetrically to monetary policy changes, respond accordingly.

Since monetary policy is unlikely to influence only loan supply, observed changes in loan volumes following monetary policy shocks are likely to be driven by supply as well as demand effects.¹ Consequently, the empirical literature faces an identification problem. A widely used approach to disentangle supply-related changes in loan volumes and changes in the demand for loans, originally proposed by Kashyap and Stein (1995), exploits the heterogeneity in the dynamics of loans volumes across banks. Specially, the standard identifying assumptions are that (i) policy shocks give rise to changes in loan demand which are symmetric across banks, whereas (ii) the response of loan supply depends on the banks ability to compensate policy induced fluctuations in the available funding and is therefore asymmetric. The standard results in this branch of the literature is that small, illiquid and undercapitalized banks tend to be more affected by monetary policy (see Kashyap and Stein, 1995, 2000; Kishan and Opiela, 2000,

¹A contractionary monetary policy shock, for instance, increases the interest rate and dampens firms' investment decisions, which ultimately, reduce economic activity. The higher costs of capital and the economic slow down decrease the demand for bank credit. This mechanism is commonly referred to as the Interest Rate Channel or Money Channel (see Kashyap and Stein, 1994; Bernanke and Gertler, 1995; Kishan and Opiela, 2000).

among many others). As long as the direct influence of monetary policy on borrowers does not systematically vary across these bank categories, then these heterogeneous responses are indicative of shifts in the loan supply curve.²

In this paper, we study whether banks that have been found to adjust their loan volumes relatively more to changes in monetary policy (that are small undercapitalized and small illiquid banks), face more pronounced responses in their external funding costs as well after a policy shock. In other words, we explore whether Disyatat’s (2011) claim hold that the standard identification of loan supply shifts and the derived results of the existing empirical BLC literature are consistent with his reformulation of the transmission mechanism. Therefore, our analysis provides empirical evidence if banks’ financing costs provide the deeper link between bank characteristics and the asymmetry of loan growth dynamics following a monetary policy shock. Additionally, we identify aggregated supply and demand shocks and evaluate if the logic from the BLC also translates to other real economic shocks (as suggested by Bernanke, 2007).

The only other studies explicitly analyzing banks’ financing costs in relation to the BLC are Gambacorta (2008) and Kishan and Opiela (2012). Gambacorta (2008) identifies BLC effects with cross-sectional differences in rates of demand deposits and short term credits. In contrast, we proxy the overall funding costs of banks, with banks’ interest rates on large certificate of deposits (CDs). As large CDs are not federally insured, our measure of banks’ funding costs incorporate the credit risk involved.³ Kishan and Opiela (2012) show that banks with stronger fundamental values face lower increases in their financing costs following monetary tightening. However, we focus on the findings and identification strategy of the existing BLC literature, and evaluate if policy induced responses of banks’ financing costs are consistent with the widely documented asymmetric responses in loan volumes.

In contrast to the vast majority of the existing literature on the BLC, which employs panel data methods to exploit the information contained in bank-level balance sheet data, we use vector autoregression (VAR) models.⁴ This approach has a number of advantages: First, we

²A more general alternative approach is to use bank credit register data. With detailed loan application records loan supply can be clearly distinguished from loan demand (see e.g. Jiménez et al., 2012; Jiménez et al., 2014; Khwaja and Mian, 2008). However these kind of data is not available for the US.

³Large CDs are bank obligations with a minimum value of \$100,000 and different maturities. In contrast to demand deposits, large CDs are non reservable deposits and furthermore, they are not federally insured (since their obligation value is above \$ 100,000). This implies that holders of large CDs face a default risk and claim a risk premium depending on banks’ financial health. This variable is widely used in the literature to capture the funding condition of banks (see Acharya and Mora, 2012; Kishan and Opiela, 2012; Demirgüç-Kunt and Huizinga, 2004; Maechler and McDill, 2006).

⁴Some exception exist: Bernanke and Blinder (1992) estimate a VAR and find that the dynamic responses of aggregated deposit and loan growth rates following a monetary policy shock are consistent with the theory of the traditional BLC. Buch et al. (2014b) and Dave et al. (2013) use a factor-augmented VAR and Carpenter and

are able to analyze responses to identified monetary policy shocks, rather than the reaction to a change in the short term interest rate, which are plausibly driven by a number of other shocks as well. Second, the VAR captures the interactions between macroeconomic variables and allows possible feedbacks between these variables. Thirdly, the dynamic responses of banks' financing costs to a monetary policy shock can be easily represented and nicely interpreted.

The interest rate on large CDs can be derived on the bank level from the Reports of Condition and Income (Call reports). Since we are interested whether financing costs heterogeneously respond to monetary policy shocks, we aggregate the bank level information for differently capitalized and liquid banks and estimate separate VARs.⁵ The specific bank groups exactly corresponds to the standard classification in the existing BLC literature.

We impose a combination of zero and sign restrictions to simultaneously identify monetary policy and aggregated supply and demand shocks (this approach is also used by Eickmeier and Hofmann, 2013; Jarociński, 2010). In this setting, a monetary policy shock can be exactly identified by imposing a block recursive-causal ordering (as suggested by Christiano et al., 1999). Since the causal order between monetary policy and banks' funding costs can be controversially discussed, for robustness purposes we also consider two alternative approaches, where we either reverse the causal order between these variables or allow bidirectional causality.

Our main finding is that banks' financing costs directly increase for all banks after a monetary policy shock, but significantly more for small undercapitalized and small illiquid banks. The existing empirical BLC literature shows that loan volumes of exactly the same bank groups respond more to policy shocks as compared to better capitalized and more liquid banks (see Kashyap and Stein, 2000; Kishan and Opiela, 2000). Consequently, the response of banks' external financing costs are consistent with the asymmetric response in loan volumes. Therefore our results provide empirical evidence that Disyatat's (2011) reinterpretation of the BLC is consistent with the existing standard identification of loan supply shifts. Furthermore, as banks' financing costs consistently respond with loan volumes to monetary policy shocks, our analysis underpins the interpretation of the empirical BLC literature that the asymmetric response in loan volumes are due to loan supply shifts.

Demiralp (2012) apply panel VAR estimations to identify heterogenous effects among bank lending after monetary policy shocks. However, these papers look at loan volumes, whereas we look at the cost of funds. Furthermore, researches have also applied VARs to assess the economic impact of the BLC on real activity (see Ashcraft, 2006; Ciccarelli et al., 2010) and its relative importance to credit shocks (see Milcheva, 2013).

⁵Den Haan et al. (2007) aggregate bank-level data as well, to evaluate the responses of different loan types following a monetary contraction in a VAR estimation (see also Buch et al., 2014b; Carpenter and Demiralp, 2012; Dave et al., 2013; Den Haan et al., 2011).

The paper is structured as follows: Section 2 summarizes briefly the theory of the BLC and describes the innovation of the new interpretation of the BLC and how this translates to our research question. In Section 3 we describe our empirical approach and the data set in more detail. Subsequently, Section 4 and 5 present our results and the applied robustness checks, respectively. Finally, in Section 6 we summarize the main findings.

2 Related Literature

The BLC, in its most traditional interpretation, holds that monetary policy exerts direct effects on loan supply through its influence on reserves, as banks' access to liquidity might be constrained due to an imperfect substitution between reservable- and non-reservable deposits. A monetary tightening, for instance, which decreases reserves of the banking sector and forces banks to substitute reservable deposits with other sources of non-reservable funding or, if banks are unable to fully do so, reduce loan supply (see Blinder and Stiglitz, 1983; Bernanke and Blinder, 1988, 1992; Kashyap and Stein, 1994). Thus, through binding reserve requirements, monetary policy has a rather direct effect on loan supply. As pointed out by Romer and Romer (1990), banks have a number of opportunities to raise funding which allows them to decouple loan supply from reservable deposits. However, under the assumption that investors of non-reservable deposits (i.e. uninsured certificates of deposit) face asymmetric information problems, the resulting agency costs alter the substitution process adversely (Bernanke and Blinder, 1992; Bernanke and Gertler, 1995). Depending on banks' credit worthiness, the increased funding costs limit banks' access to liquidity and thus reduce the loan supply accordingly.⁶ Therefore, the reduced loan supply dampens economic activity on top of the reduction in loan demand, causing an amplified effect of monetary policy on the business cycle (Bernanke and Gertler, 1995).

Along with the increase in market based funding, the narrow focus on quantity constraints, in the sense of reservable deposits constraining loans supply, has probably become less relevant over time (see Bernanke, 2007; Carpenter and Demiralp, 2012). A new interpretation of the BLC holds that monetary tightening reduces loan supply independently from changes in banks' demand deposits and the require to raise non-reservable deposits. According to Disyatat (2011), investors of uninsured deposits have a choice to hold banks' deposits or to invest in risk-free government bonds. A contractionary monetary policy shock increases banks' default risk due to

⁶The reduction of loan supply has real economic effects, as certain firms are bank credit dependent (see Bernanke and Blinder, 1988). This means, that although non-reservable liabilities are widely available, tightening monetary policy is expected to still result in a net reduction in loanable funds due to increased funding costs (Kashyap and Stein, 1994).

an increased credit risk of their borrowers (higher interest rate decreases the net worth of firms' balance sheets and their collateral). This in turn increases the opportunity costs of holding deposits and consequently banks that aim to retain their level of funds and loan supply, have to increase the interest rate accordingly (i.e. have to pay a risk premium). The higher financing costs are passed onto borrowers and reduce loan supply. Crucially, banks' default risk and the resulting financing costs depend on banks' capability to absorb a monetary contraction, which is determined by their capital strength.

Furthermore, Disyatat (2011) describes that effects on financing costs and loan supply amplifies through (i) an endogenous reduction of bank capital and (ii) an intensified perception of banks' credit risk following monetary tightening. How does this work in more detail? A change in the monetary policy rate alters banks' balance sheet strength due to the valuation of assets and the influence on interest margins and cash flows. Indirectly, banks' balance sheets are further affected by induced changes in borrowers' credit worthiness and dampening economic activity (Disyatat, 2011).⁷ These endogenous responses of banks' balance sheets due to monetary policy may be categorized as a separate channel, termed as Bank Balance Sheet Channel (see Jimenez et al., 2012; Van den Heuvel, 2002). This endogenous response of banks' funding costs seems even more important with the increasing market dependence of banks, since this has intensified the effects of interest rate changes and economic performance on banks' balance sheets (see Gambacorta and Marques-Ibanez, 2011; Disyatat, 2011; Adrian and Shin, 2010).

Concerning the risk perception of banks' investors, Disyatat (2011) notes that banks' capital costs may also increase due to an increased risk aversion (caused by moral hazard/adverse selection mechanism, search for yield arguments or expected changes in agents vulnerability to future economic shocks). Kishan and Opiela (2012) focus on the same aspect and provide a similar theory summarized in the so called Risk-Pricing Channel. Again, the expectations about banks' financial condition after a monetary policy shock cause an intensified risk perception endogenously. Importantly, while monetary policy may have no immediate effects on bank credit worthiness, the financing costs can still increase because the risk tolerance of investors instantaneously decreases with monetary tightening (Kishan and Opiela, 2012).

Hence, the "new" BLC implies that banks' funding costs react heterogeneously to a monetary policy shock depending on banks' financial strength and investors risk perception. Consequently, to identify BLC consistent loan supply effects, the new framework requires bank characteristics

⁷This indirect effect of monetary policy on banks' balance sheets is closely related to the so called Balance Sheet Channel or Borrowers' Net Worth Channel (see Bernanke and Gertler, 1995; Kishan and Opiela, 2000).

which determine how banks' financing cost endogenously respond to monetary policy. Although the empirical BLC literature motivate their analyses with reference to the traditional interpretation of the BLC, Disyatat (2011) notes that their identification strategy should be consistent with his reformulation. Since, banks which are assumed to substitute more difficultly between deposits after a monetary policy shock, are likely to be those banks, which face higher increases in their financing cost as well. To address our research question, we have to (i) measure the endogenous responses in banks' financing costs to a structural monetary policy shock and (ii) study if these reactions differ systematically across banks.

3 Data and Estimation

The empirical BLC literature shows that the growth rates of bank loans heterogeneously reacts among differently sized, capitalized and liquid banks (Kashyap and Stein, 1995, 2000; Kishan and Opiela, 2000, 2006; Gambacorta, 2005, 2008). With banks' asset size, the identification assumption seems likely to be violated, as differently sized firms demand bank credit asymmetrically and small banks have an over-proportional stack of small firms as creditors (Kashyap and Stein, 2000; Kishan and Opiela, 2000). In contrast the identification assumption holds more plausible with the distinction across financial characteristics. Therefore, we focus in our analysis on possible heterogenous responses in funding costs between banks with different capitalization and liquidity.

Banks are categorized as undercapitalized and illiquid, if they have a equity-to-asset ratio below 8%, or if they are below the median of the quarterly liquidity distribution, respectively. That is, these banks should reveal higher default risk after a policy shock and this increase in the risk premium is associated with a more pronounced reaction of the CD rate. According to Kashyap and Stein (2000) and Kishan and Opiela (2000) this is only true for small banks. Therefore, we study also the intersection of differently sized and capitalized (liquid) banks. As it is standard, we consider banks small if they are below the 95th percentile of the total asset distribution (see Kashyap and Stein, 1995, 2000; Kishan and Opiela, 2012). The exact categories are listed in Table 1.

[Insert Table 1 about here]

We proceed in several steps to quantify a possible heterogenous response of banks' funding costs in a SVAR estimation. First, we aggregate the bank-level information on financing

costs (CD rates) for each subgroups to obtain one representative time-series for each category. Subsequently, we calculate spreads between these aggregated CD rates as following:

$$\text{CD Spread}_t = \text{CD Rate}_{\text{weak},t} - \text{CD Rate}_{\text{strong},t},$$

where $\text{CD Rate}_{\text{weak},t}$ and $\text{CD Rate}_{\text{strong},t}$ are the aggregated CD rates of bank groups which are more or less susceptible to monetary tightening. Finally, we estimate separate VARs in which we include the spreads individually. According to the definition of the spread, the response in banks' funding costs is consistent with Disyatat's (2011) reinterpretation and the identified asymmetric responses in loan volumes whenever the spread reacts significantly positive to a monetary policy shock.

The CD spread reacts positively to an exogenous monetary contraction, if (i) financing costs of the weak bank group increase more as compared to the strong bank group, (ii) funding costs of the strong group do not react or (iii) decrease after policy tightening. Therefore, the CD spread captures the difference in the endogenous response of banks' external financing costs. In contrast, with a zero response of the CD spread, the documented asymmetries in loan volumes interfere with the new formulation of the BLC, as the response in bank's financing costs does not depend on financial characteristics endogenously.

3.1 SVAR and Identification

Consider a standard VAR:

$$X_t = \sum_{j=1}^2 A_j X_{t-j} + \epsilon_t, \quad (1)$$

where X_t is a vector of endogenous variables, A_j is a matrix of coefficients at lag j , and ϵ_t is a vector reduced-form residuals. X_t contains real GDP (RGDP), the GDP deflator (DEF), the federal funds rate (FFR) and depending on the particular estimation, on of the respective CD spread. The definition of the variables are provided in the next subsection. According to Akaike and Schwarz (Bayesian) information criterions we use 2 lags in our baseline estimation.

While our main emphasis focuses on the BLC, and consequently on the identification of monetary policy shocks, we also identify aggregate supply (AS) and aggregate demand (AD) shocks in addition to the policy shock. Since the new BLC relies heavily on the role of banks' funding costs, it appears plausible that non-policy shocks, as long as they give rise to changes in funding costs, exert an independent influence on loan supply (see Bernanke, 2007). Consider for instance an adverse aggregated demand shock. Standard macroeconomic models imply that economic slows down and that output as well as inflation decline. Along with this decline in

activity the demand for loans is also likely to decline. Nevertheless, since the shock will change interest rates, partly through the endogenous response of the central bank, it may also influence banks' cost of funds, and – ultimately – give rise to a shift in loan supply in addition to the change in loan demand. Similarly, with an aggregated supply shock, prices are expected to increase, which reduces money supply as well as increases the interest level. Again, beside the effects on loan demand, the change in the interest rates are likely to affect banks' financing costs and hence loan supply. In other words, the banking sector acts as a channel through which AD and aggregated supply shocks are transmitted.

To identify shocks, we use a combination of zero restrictions and sign restriction. Specifically, we identify the monetary policy using zero restrictions to implement a block recursive-causal ordering, as suggested by Christiano et al. (1999). The sign restrictions allow to identify aggregated supply and demand shocks simultaneously. For the policy shock we follow a standard Taylor Rule, in which monetary policy depends on real economic activity (RGDP and DEF) but influences the system only with a lag. Furthermore, banks' financing costs are assumed to depend on monetary policy but are not relevant for decisions of monetary authorities. With these assumptions, monetary policy shocks are precisely identified. The adverse AS (AD) shock is identified with a negative response of RGDP, a positive (negative) reaction of prices and a positive (negative) amplitude in the policy rate, respectively (Table 4 summarizes the identification approach). With this identification strategy we follow several recent studies which identify monetary policy in combination with aggregated supply and demand shocks (see Buch et al., 2014b; Gambacorta et al., 2014; Jarociński, 2010; Jarociński and Smets, 2008).

[Insert Table 4 about here]

We prefer to identify monetary policy with zero restrictions rather than sign restrictions (as suggested by Uhlig, 2005), since several issues remain vague with the latter approach. Although the identification via sign restrictions requires less restrictive assumptions, also less inference is possible (see Fry and Pagan, 2011). That is, the magnitude of the identified shock remains unknown, and therefore the magnitude of the responses cannot be interpreted as well. Furthermore, Fry and Pagan (2011) emphasize that structural shocks are only appropriately identified with sign restrictions, if they have a major impact on the system (see also Paustian, 2007, for Monte Carlo simulations). While this holds for the aggregated supply and demand shock it is well known in the literature that monetary policy are only minor sources of shocks.

While we impose zero restrictions to identify the policy shock in our baseline estimation,

we also present results based on two alternative identifications of the policy shock. In the second identification approach we combine zero and sign restriction to identify the policy shock. In particular, we delete one zero restriction to allow simultaneous interdependences between monetary policy and the CD spread. In the aftermath of the recent financial crisis monetary authorities targeted banks' funding possibilities heavily and since it is likely that banks' costs of funds may have influenced monetary policy also before the financial turmoil in 2007, we address this possible endogeneity issue with this alternative identification approach.⁸ However, if we drop the zero restriction between the federal funds rate and the shock of the CD spread, then the monetary policy shock is under-identified. Therefore we need additional restrictions. We closely follow Eickmeier and Hofmann (2013) and combine the remaining zero restrictions of the MP shock with additional sign restrictions. More precisely, we require that the impulse response of the FFR is positive for two periods and that the responses of RGDP and prices are negative in the subsequent period (see Table 5). Importantly, with this identification approach we face similar issues as under a pure sign restriction approach and therefore the obtained results from this identification strategy have to be interpreted carefully. Finally, we assume that monetary policy considers banks' financing costs explicitly but that banks' funding conditions cannot change immediately.⁹ The impulse response functions of these additional identification strategies are presented in the robustness Section 5.

[Insert Table 5 about here]

We estimate our model with Bayesian methods and assume an uninformative prior. By estimating the VAR with a flat prior and by assuming *iid* reduced form perturbation terms, we obtain a Multivariate Normal-Inverse-Wishart posterior distribution for the coefficients and the variance-covariance matrix (see Uhlig, 2005). We use this posterior distribution to simulate possible candidates satisfying our zero and sign restrictions. More precisely, first we jointly draw a set of models from the posterior distribution and a set of orthonormal matrix Q (where Q is derived recursively with the Gram-Schmidt process to incorporate our zero restrictions (see Arias et al., 2014)). Secondly we orthogonalize the impulse responses with Cholesky and subsequently multiply the orthogonal responses with the Q matrices to yield random factorizations. Finally we check if the resulting impulse responses fulfill the specified restrictions or not. We work

⁸Peek and Rosengren (2010) and Gambacorta and Marques-Ibanez (2011) emphasize that causality between the lending behavior of banks and monetary policy, potentially runs in both directions.

⁹Buch et al. (2014a) justify this delayed impact with the require to renegotiate existing contracts and the close customer relationships of banks.

through the whole set of models (in our case 1,000 models) and factorize each model with the whole set of Q s (we use 100 transformations for each model) and save all impulse responses that satisfy the restrictions.¹⁰

3.2 Data Description

For banks' balance sheet information, we use bank level data from the Reports of Condition and Income (Call reports), in which all US banks have to report their balance sheet and income statement, quarterly. The data is available from 1976Q1 until 2013Q2, but for the analysis we exclude data before 1984 and end our observation period with the outbreak of the recent financial crisis in 2007Q3 (1,092,347 bank quarters). We focus on the period of the Great Moderation, in order to avoid instability and structural breaks in the data set.

The imputed interest rate on jumbo CDs (CD rate) is calculated by dividing the quarterly interest earnings on time deposits of \$100,000 or more (RIAD4174 and RIADA517) with the quarterly averaged stock of these jumbo CDs (RCON3345 and RCONA514). The division yields a quarterly averaged interest rate and therefore has to be annualized by multiplying the fraction with four. The two series of interest earnings on large time deposits cumulate in each year and consequently are differentiated accordingly to obtain the revenues within each quarter. Furthermore, to categorize banks among the size, capital and liquidity dimension we obtain further data from the Call reports on total assets, equity capital and total securities. Except for the total asset variable, various time-series are required to form consistent indicators for equity and liquidity (see Den Haan et al., 2002). Table 2 list the individual series from the Call reports explicitly. The capital to asset ratio and the leverage ratio are calculated by dividing banks' equity capital and liquidity with total assets (Kashyap and Stein, 2000; Den Haan et al., 2002).

[Insert Table 2 about here]

To correct for data errors and outliers we applied several filters. Following Den Haan et al. (2002), our study considers only insured banks which are located in the US (1,040,066 bank quarters). Additionally, we delete observations with (i) negative jumbo CD expenses (5043 observations), (ii) zero interest earnings in the presence of a positive stock of large time deposits (5909 observations), and (iii) bank-quarters which are above 100 or below -100 percent of the equity-to-asset ratio (6 observations). Furthermore, extreme outliers are excluded from the analysis by quarterly winsorising the imputed interest rate at the 1st and 99th percentile (19329

¹⁰This algorithm follows closely Rubio-Ramrez et al. (2010) and Arias et al. (2014).

observations). Unfortunately, no data is available in the first two quarters of RIADA517. In Section 5 we interpolate for the missing values and check if they alter our conclusions.

The macroeconomic aggregates (RGDP, DEF, and the FFR) are derived from the Federal Reserve Economic Data (FRED) database. The data is seasonally adjusted (except the FFR) and RGDP, DEF are in log levels. Table 3 list the individual variables and summarizes their definition. The specific FRED data-codes are provided in the notes.

[Insert Table 3 about here]

4 Results

With our analysis we evaluate whether Disyatat’s (2011) claim holds, namely that his new interpretation of the BLC is consistent with the standard identification of loan supply shifts in the exiting empirical BLC literature. In other words, we analyze if the existing empirical results actually identify loan supply shifts in respect to the new BLC. To evaluate if banks’ external funding costs react consistently with their response of loan volumes, we estimate several VARs in which we include differently calculated CD spreads. Since the responses are from different VAR models, comparisons between the models have to be made carefully. Therefore, we only interpret qualitative differences across models with different CD spreads.¹¹

In respect of our primarily interest, firstly in Subsection 4.1, we present the impulse responses to monetary policy shocks and subsequently we discuss the responses to aggregated supply and aggregated demand shocks in Subsection 4.2 separately. The impulse response functions are only presented for median aggregated banks’ financing costs, as results are very similar for the mean aggregated data.¹² The error bands represent the 5th (16th) and 95th (84th) percentile of the restricted posterior distribution, respectively. For shocks which are identified via sign restrictions, we present both the point-wise median response (dotted line) as well as the *closest to median* response (solid line) (as suggested by Fry and Pagan, 2011).

4.1 Monetary Policy Shocks

Before we present the main results of this study, we analyze how the external costs of banks, measured by the CD rate, react to an exogenous monetary policy shock across all banks and all

¹¹Notably, the impulse responses of the various VAR estimations are relative homogenous among the macroeconomic aggregates and only differ in the CD spread (the median responses to monetary policy shocks of all different models are available upon request).

¹²The results of the mean aggregated data are enclosed in the Appendix.

subgroup of banks in our analysis.¹³ The motivation for the presentation of these results are twofold: Firstly, although we cannot evaluate significant differences among the responses in the CD rate, we can identify if monetary policy directly influences external financing costs among all subgroups of banks and secondly with these impulses in mind, the subsequent interpretation of the CD spreads becomes more intuitive.

[Insert Figure 1 about here]

Figure 1 shows the response of the the CD rate (aggregated over all banks) and the macroeconomic aggregates (RGDP, DEF and FFR) to a one standard deviation shock in monetary policy. Since the impulse responses look similar among all subgroups of banks we do not report them in the paper but provide these responses upon request. As expected RGDP declines after a monetary contraction (the response is only weakly significant). Similarly, DEF declines as well but only after two years. The response of FFR represents the monetary policy shock in our baseline specification.

Most importantly, the CD rate significantly increases for two years after an exogenous monetary policy contraction. This result provides strong empirical evidence in favor of the recent formulation of the BLC, namely that monetary policy has direct effects on banks' external funding costs. Furthermore, given the observed decreases in loan volumes after monetary tightening (see Bernanke and Blinder, 1992; Den Haan et al., 2007), our result show that this decline will be partly due to the increased funding coast of banks, which are passed onto borrowers and, finally shifts the loan supply curve inwards.

Notably, while the FFR declines gradually after the exogenous shock, the reaction of banks' financing costs is hump shaped: first the funding costs increase until they peak about one year after the shock. This delayed response implies that the funding condition for banks weaken further through endogenous feedback loops between variables in our model. This pattern is true for all subgroups of banks in our analysis. Therefore, if we subsequently discuss the responses of the CD spreads, we know that the responses of the differently categorized banks principally reveal the same sign.

[Insert Figure 2 about here]

¹³In particular, we analyze the responses among all, small, medium or large banks which are either categorized as under-, adequate-, well capitalized, illiquid, liquid or very liquid. The definitions of these groups follow directly from the literature (see Kashyap and Stein, 1995, 2000; Kishan and Opiela, 2000; Gambacorta, 2005) and are precisely describend in Section 3.

Now, after we have clarified that banks' external funding cost directly increase after monetary tightening, we evaluate if Disyatat's (2011) claim holds. More precisely, we test following an exogenous monetary policy shock, whether banks' funding costs consistently respond to the asymmetric reaction of loan volumes, which are documented in the literature across differently capitalized and liquid banks.

Therefore, we replace in the VAR model the CD rate with the CD spread which is firstly calculated between under- and well capitalized banks, and secondly between illiquid and very liquid banks. We follow the literature and categorize banks as under- or well capitalized banks if they have an equity to asset ratio of below 8% or above 10%, respectively and as illiquid or very liquid banks if they are below the median or above the 75th percentile of the liquidity to asset ratio distribution in each quarter.

In the first graph of Figure 2, we see the response of the CD spread between undercapitalized and well capitalized banks to a one standard deviation monetary policy shock. The funding costs of undercapitalized banks significantly increase more to monetary tightening as compared to well capitalized banks. This effect holds for about one year. The spread sharply increases during the first two quarters and declines in the second half of the year back to its pre-shock level. In terms of magnitude, an exogenous change in the policy rate of 50 basis points (one standard deviation) leads to 2.7 basis points higher funding costs of undercapitalized banks after one quarter as compared to well capitalized banks. In the second VAR estimation with the CD spread being calculated between illiquid and very liquid banks (second graph of Figure 2), we see a similar pattern in the response of the CD spread, but with less persistence. The spread peaks with 2.5 basis points already after one quarter in response to a standard deviation policy shock of 51 basis points and returns to its pre-shock level in the subsequent quarter.

From the empirical BLC literature we know that loan volumes of undercapitalized and illiquid banks are more responsive to monetary policy as compared to well capitalized and more liquid banks (Kashyap and Stein, 2000; Kishan and Opiela, 2000, 2006; Gambacorta, 2005, 2008). Our results show that indeed the financing costs of the exact same groups of banks respond more to monetary policy shocks as well. Hence, the groups which are already identified to reduce loan volumes relatively more to a monetary tightening are also those banks in which the financing costs increase most. This implies, that the existing identification of loan supply shifts, which is actually motivated by the traditional interpretation of the BLC, is consistent with the new framework of the BLC. In other words, our empirical analysis supports Disyatat's (2011) claim that the existing empirical findings translate to his reformulation of the BLC. Consequently our

results provide supportive empirical evidence that the asymmetric response of loan volumes of differently capitalized and liquid banks are due to changes in loan supply.

[Insert Figure 3 about here]

Finally we are interested if the asymmetric response of banks' external financing costs between differently capitalized and liquid banks, changes with banks' asset size. Previous studies show that capitalization and liquidity is only important for small banks to absorb monetary policy shocks (see Kashyap and Stein, 2000; Kishan and Opiela, 2000). Therefore we recalculate the CD spreads for differently sized banks: in particular for small ($< 95^{th}$ percentile of total assets), medium ($\geq 95^{th}$ and $< 99^{th}$ percentile of total assets) and large banks ($\geq 99^{th}$ percentile of total assets). To provide a more detailed picture, we additionally calculate the spreads between under- and adequate capitalized banks and between illiquid and liquid banks for each size group. The responses of these different CD spreads are shown in Figure 3 and 4.

In the first row of Figure 3 we see the asymmetric response of banks' funding costs between differently capitalized small banks. More precisely, the left graph shows the CD spread between under- and adequate capitalized small banks and the right graph shows the CD spread between under- and well capitalized small banks. In row two and three we see the same CD spreads for medium and large banks, respectively. For both CD spreads we clearly see, that the asymmetry is most pronounced for the small bank category. Hence, capitalization matters more for the response of small banks' financing costs as compared to medium and large banks. If we compare our results with the study of Kishan and Opiela (2000), we see that also in their analysis small undercapitalized banks respond more to monetary policy as better capitalized small banks. Consequently, the response of external financing costs and loan volumes among small and undercapitalized banks are consistent in respect to the new formulation of the BLC and therefore our results provide additional evidence that the asymmetric response in loan growth of these banks are due to changes in loan supply.

Notably, small undercapitalized banks respond also more to monetary policy as compared to adequate capitalized small banks. Hence, the asymmetric response between differently capitalized small banks is not driven by the comparison with the extreme group of well capitalized banks.

[Insert Figure 4 about here]

Figure 4 shows again CD spreads for the same size group of banks, but now the spreads are calculated between illiquid and liquid banks (left column), and between illiquid and very liquid banks (right column). Kashyap and Stein (2000) show that liquidity dampens the response of small banks' loan volumes to changes in monetary policy. Similarly, we see that the two CD spreads are only significantly different from zero in the small bank category. Hence, the higher decrease of loan volume of small and less liquid banks is consistent with the higher increase in their financing costs and therefore, our results support the interpretation of Kashyap and Stein (2000) that these changes are driven by loan supply shifts.

In summary, monetary policy has direct effects on banks' funding costs and furthermore, our results are consistent with existing empirical evidence in the BLC literature. Hence, our findings firstly supports Disyatat's (2011) claim, that the traditional identification is still valid in respect of his new interpretation of the BLC, and secondly our results underpin the interpretation of the empirical BLC studies that the asymmetric response of loan volumes between differently capitalized and liquid banks are due to loan supply shifts.

4.2 Aggregate Supply and Demand Shocks

Beside monetary policy shocks, aggregate supply and demand shocks plausibly influence banks' external financing costs, as they influence the interest level either through changes in prices or due to endogenous responses of monetary policy. Since we know now that changes in banks' funding costs are consistent with loan supply shifts, we are interested if aggregated supply and demand shocks influence banks' financing costs and therefore are potential sources of changes in loan supply as well. Put differently, we evaluate if the reaction of the external financing costs to other business cycle shocks is consistent with the logic from the BLC (as suggested by Bernanke, 2007).

In this subsection we do not estimate new VARs but show the impulse response functions from the previous estimations in respect to the identified aggregated supply and demand shocks.¹⁴ The impulse responses in Figure 5 correspond to the same VAR as the responses in Figure 1. From the responses in RGDP and DEF we see that although we restrict the two variables only on impact and the subsequent period to identify the aggregated supply and demand shocks, RGDP and DEF stay above or below zero, respectively, for at least 3 years.

¹⁴The only shock we do not present in this paper, is the residual shock from the CD rate or CD spreads, respectively, as they are not economically interpretable (the impulse responses to these shocks are available upon request).

[Insert Figure 5 about here]

The response of monetary policy (which is represented by the reaction of the FFR in our baseline identification) differs among aggregated supply and demand shocks. Since RGDP decreases and DEF increases after an aggregated supply shock, it is not clear a priori how monetary policy responds. As we see from the impulse response function, monetary policy considers price stability relatively more important as compared to the decline in output and therefore reacts contractionary to the shock. In contrast, with the aggregated demand shock, we see a clear expansionary response of monetary policy to the decline in output and prices.

Also the response of the CD rate is different for the two shocks. While the CD rate slightly increases after an aggregated supply shock, we see a significant negative response after an aggregated demand shock. Similar as with the policy shock, both CD rates react with a short delay in the same direction as the FFR (this is again true for all subgroups of banks). Consequently, banks' external financing costs are also directly influenced by aggregated demand shocks and partly by aggregated supply shocks. Hence, the logic from the BLC is likely to translate to these real economic shocks as well and therefore, changes in loan volumes may additionally be driven by shifts in loan supply. To the best of our knowledge, these are the first results which empirically support Bernanke's (2007) emphasis to interpret the BLC in a broader context.

Since the funding condition of banks significantly change more after an aggregated demand shock as compared to the supply shock, we expect effects on loan supply to be relatively more pronounced after the demand shock as well. Furthermore, as the response of the CD rate after the aggregated demand shock is of similar magnitude as compared with the response to the policy shock, changes in loan supply are potentially of similar magnitude as documented in the exiting empirical BLC literature.

[Insert Figure 6 about here]

Finally, we are interested whether the asymmetric response of banks' external financing costs are also present after aggregated supply and demand shocks. If the funding costs react heterogeneously, the standard identification approach from the BLC literature could also be applied to quantify loan supply shifts after aggregated supply and demand shocks.

Figure 6 shows the CD spreads from the two VARs, in which we calculate the spread between undercapitalized and well capitalized banks (left column) or between illiquid and very liquid banks (right column). In the first row we see the response of the two CD spreads to an one

standard deviation shock in aggregate supply. Although we see a slight positive response for both spreads in the first few quarters, they are not significantly different from zero. Therefore, differently capitalized and liquid banks do not heterogeneously respond to aggregated supply shocks and consequently, possible shifts in loan supply may not be captured with the standard identification approach.

The responses of the CD spreads to an aggregated demand shocks (second row) are negative in both cases and again more persistent for differently capitalized banks. In particular, after an aggregated demand shock, undercapitalized banks face lower financing costs for about one year as compared to well capitalized banks. Similarly, between the first and third quarter after the shock takes place, illiquid banks have lower funding costs as compared to very liquid banks. Hence, again undercapitalized and illiquid banks are more responsive to the exogenous shock. Accordingly, we expect loan volumes of the same group of banks to respond significantly more after an aggregated demand shock as compared to better capitalized and more liquid banks.

5 Robustness Checks

For robustness purposes we consider two additional identification strategies: first we follow Eickmeier and Hofmann (2013) and identify monetary policy with a combination of zero and sign restrictions. Subsequently, we change the block recursive-causal order, such that the monetary policy rate is now ordered last (i.e. RGDP, DEF, CD Spread, FFR). In the Appendix we present the same responses as in Section 4.1 with the two alternative identification approaches (Figures 7, 8 and 9).

The main differences of the second identification as compared to our baseline identification in response to a policy shock are: (i) that the response of the policy rate is less pronounced under the second identification approach and also the increase in the CD rate is relatively weak for all banks. (ii) While we get a similar response of the CD spread when it is calculated between under- and well capitalized banks, the CD spread between illiquid and very liquid banks only fluctuates around zero. (iii) Across the different size classes of banks, again we only see capitalization to influence the response of small banks' financing costs but with liquidity no heterogeneous responses are present. In summary, if we allow contemporaneous feedback between monetary policy and banks' funding costs, then liquidity is negligible for the response of banks' funding costs but capitalization still matters for small banks.

In contrast, if we look at the other extreme, namely that banks' funding costs are incorpo-

rated in the Taylor rule and that they are not influenced by monetary policy simultaneously, all conclusions from our baseline identification hold (also if we look at responses of CD spreads among differently sized banks). Hence, our results are robust against the exact order of the policy variable and banks' financing costs.

Furthermore, we apply several additional checks to assure the robustness of our results. To test if the results are driven by special subgroups, we re-estimate our models excluding bank observations with negative equity ratios ($n = 2,484$), zero liquidity ratios ($n = 4,703$) and bank-quarters in which a merger has occurred ($n = 10,780$). Furthermore, since we deal with quarterly data we repeat our analysis with 4 lags. We also vary the horizon of the sign restrictions from 0 to 3 periods. Finally, we interpolate missing data on the CD rate in the first two quarters of 1997. We derive the average mean within each quarter (using a regression with quarterly dummies over the whole observation period) and calculate the average weight for the first two quarter in respective to the average volume in quarter 3. Subsequently we multiply the cumulative stock of interest expenses in 1997q3 with the weights for the first two quarters in 1997 and derive 9561 observations for 1997q1 and 9609 observations for 1997q2 (for 92 and 93 observations in 1997q1 and 1997q2 we could not derive values because they have 0 expenses over the whole sample period).¹⁵ The results are robust against all these variations and are available upon request.

6 Conclusion

In this study we evaluate the response of banks' funding costs to an exogenous monetary policy shock. We test if the empirical findings of the existing BLC literature are consistent with the recent reinterpretation of Disyatat (2011), who emphasizes the role of banks' financing cost in the theory of the BLC. In contrast to the widely used micro panel approach, we evaluate the response of banks' funding costs in a SVAR model. This allows us to identify a theory consistent monetary policy shock. To study possible heterogeneous responses in banks' funding costs, we aggregate bank balance sheet data for specific groups of banks and estimate separate regression models.

We find that a structural monetary policy shock influences banks' external financing costs heterogeneously. Although all banks face an increase in their funding costs, they are relatively more pronounced for undercapitalized and illiquid banks as compared to better capitalized and more liquid banks. Furthermore, capitalization and liquidity especially matters for small banks.

¹⁵For the calculation we used banks which have data for the cumulated interest expenses on jumbo CDs in 1997q3 and which have at least 20 observations (using these filters, we finally interpolate data for 9686 banks).

Accordingly, as the empirical BLC literature identifies exactly the same groups of banks to significantly reduce their loan volumes, the responses of banks' funding costs and their loan volumes are consistent with Disyatat's (2011) reinterpretation of the BLC. This finding supports the claim that the identification approach of loan supply shifts of the existing BLC literature are consistent with the new reinterpretation of the channel. Therefore, our results supports the conclusion of previous research that policy induced changes in loan volumes of small undercapitalized and small illiquid banks are due to loan supply shifts.

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7 Table and Figures

Table 1: Applied bank categories

Name	Abbreviation	Definition
Size groups		
small	sm	$< 95^{th}$ percentile of total assets
medium	la	$\geq 95^{th}$ and $< 99^{th}$ percentile of total assets
large	la	$\geq 99^{th}$ percentile of total assets
Capitalization groups		
undercapitalized	uncap	$< 8\%$ of equity
adequately capitalized	adcap	$\geq 8\%$ and $< 10\%$ of equity
well capitalized	wecap	$\geq 10\%$ of equity
Liquidity groups		
illiquid	illiqu	$< 50^{th}$ percentile of liquidity
liquid	liqu	$\geq 50^{th}$ and $< 75^{th}$ percentile of liquidity
very liquid	vliqu	$\geq 75^{th}$ percentile of liquidity

Note: Equity and liquidity is defined as total equity and total securities divided by total assets, respectively. The definition of size and capitalization groups follows Kashyap and Stein (2000) and Kishan and Opiela (2000); the classification of the liquidity groups is based on the limits of the capitalization groups.

Table 2: Composition of the individual variables from the Call reports

Name	Code in Call reports	Start	End
Interest expenses	RIAD4174	1976Q1	1996Q4
on jumbo CDs ¹	RIADA517	1997Q3 ²	2012Q4
Quarterly average	RCON3345	1978Q3	1996Q4
of jumbo CDs ¹	RCONA514	1997Q1	2012Q4
Total assets ³	RCFD2170	1969Q2	2012Q4
Bank equity	RCFD3230 + RCFD3240 + RCFD3247	1976Q1	1989Q4
capital ⁴	RCFD3230 + RCFD3839 + RCFD3632 - RCFD0297	1990Q1	1993Q4
	RCFD3230 + RCFD3839 + RCFD3632 + RCFD8434	1994Q1	2012Q4
Liquidity ³	RCFD0400 + RCFD0600 + RCFD0900 + RCFD0380 + RCFD1350	1976Q1	1983Q4
	RCFD0390 + RCFD2146 + RCFD1350	1984Q1	1993Q4
	RCFD1754 + RCFD1773 + RCFD1350	1994Q1	2001Q4
	RCFD1754 + RCFD1773 + RCONB987 + RCFDB989	2002Q1	2012Q4

Notes: ¹Acharya and Mora (2012) uses these series to derive interest rates on large time deposits; ²officially this series starts in 1997Q1 but no data is available in the first two quarters; ³according to Kashyap and Stein (2000); ⁴following the definition from Den Haan et al. (2002); the individual series are: interest on time certificates of deposit of \$100,000 or more issued by domestic offices (RIAD4174), interest on time deposits of \$100,000 or more (RIADA517), quarterly average of time certificates of deposit in denominations of \$100,000 or more in domestic offices (RCON3345), quarterly averages of time deposits of \$100,000 or more (RCONA514), common stock (RCFD3230), surplus (RCFD3240), retained earnings (RCFD3247), undivided profits and capital reserves (RCFD3632), net unrealized loss on marketable equity securities (RCFD0297), net unrealized holding gains (losses) on available-for-sale securities (RCFD8434), US treasury securities (RCFD0400), US government agency and corporation obligations (0600), obligations of states and political subdivisions in the US (0900), all other bonds, stocks, and securities (0380), federal funds sold and all securities purchased under agreements to resell in domestic offices (1350), total investment securities (0390), total assets held in trading accounts (2146), held-to-maturity securities (1754), available-for-sale securities (1773), federal funds sold in domestic offices (B987), securities purchased under agreements to resell (B989).

Table 3: Macroeconomic aggregates

Variables	Definition
RGDP	Real gross domestic product (quarterly, seasonally adjusted, chained 2009)
DEF	Gross domestic product: implicit price deflator (quarterly, seasonally adjusted)
FFR	Effective Federal Funds rate (end of quarter, not seasonally adjusted)

Data source: ¹Federal Reserve Economic Data (FRED); the data codes on FRED for RGDP, DEF and FFR are, "GDPC1", "DEF," and "FEDFUNDS," respectively.

Table 4: Block recursive-causal ordering with sign restriction on impulse response functions (first identification)

	RGDP	DEF	FFR	CD Rate/Spread
AD^- Shock	< 0	< 0	< 0	nr
AS^- Shock	< 0	> 0	> 0	nr
MP^- Shock	0	0	> 0	nr
Shock 4	0	0	0	> 0

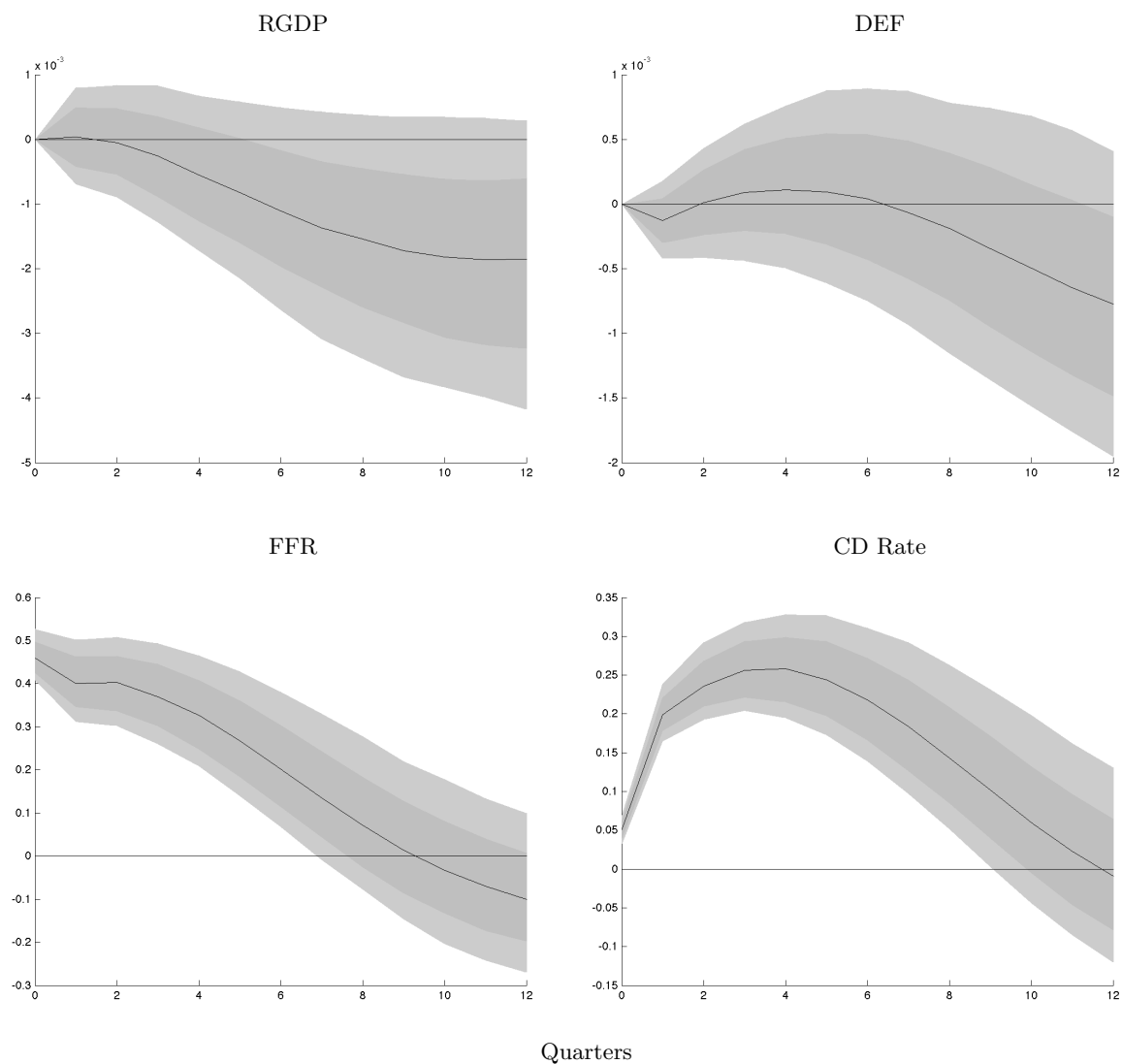
Note: no restriction (nr); sign restriction hold for impact and next period.

Table 5: Zero and sign restriction on impulse response functions (second identification)

	RGDP	DEF	FFR	CD Rate/Spread
AD^- Shock	< 0	< 0	< 0	nr
AS^- Shock	< 0	> 0	> 0	nr
MP^- Shock ¹	$0 \mid < 0$	$0 \mid < 0$	> 0	nr
Shock 4	0	0	nr	> 0

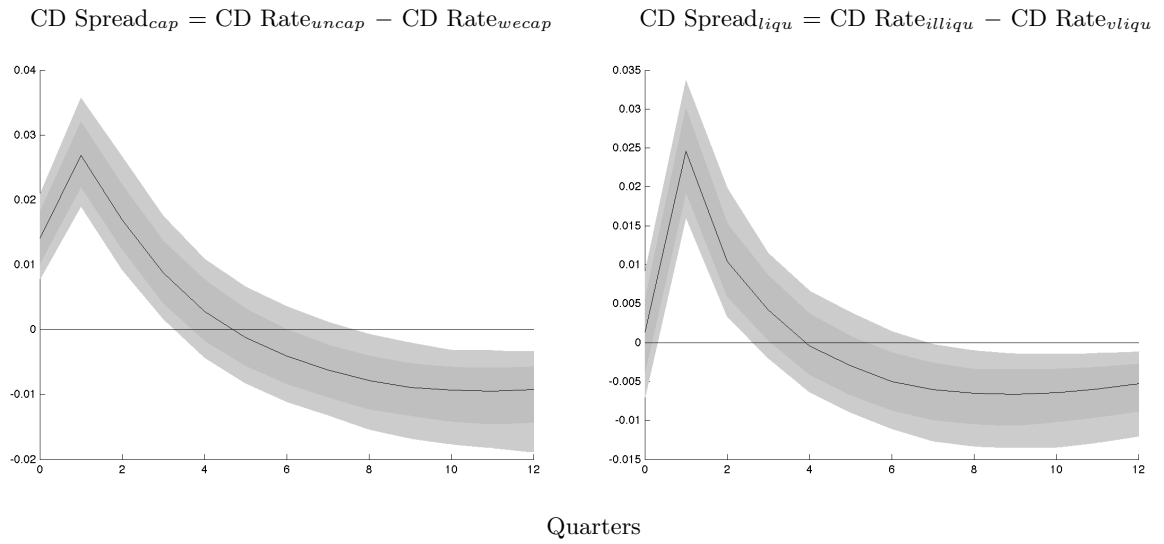
Note: no restriction (nr); sign restriction hold for impact and next period (¹only for subsequent period).

Figure 1: IRFs to a monetary policy shock (CD rate is aggregated over all banks)



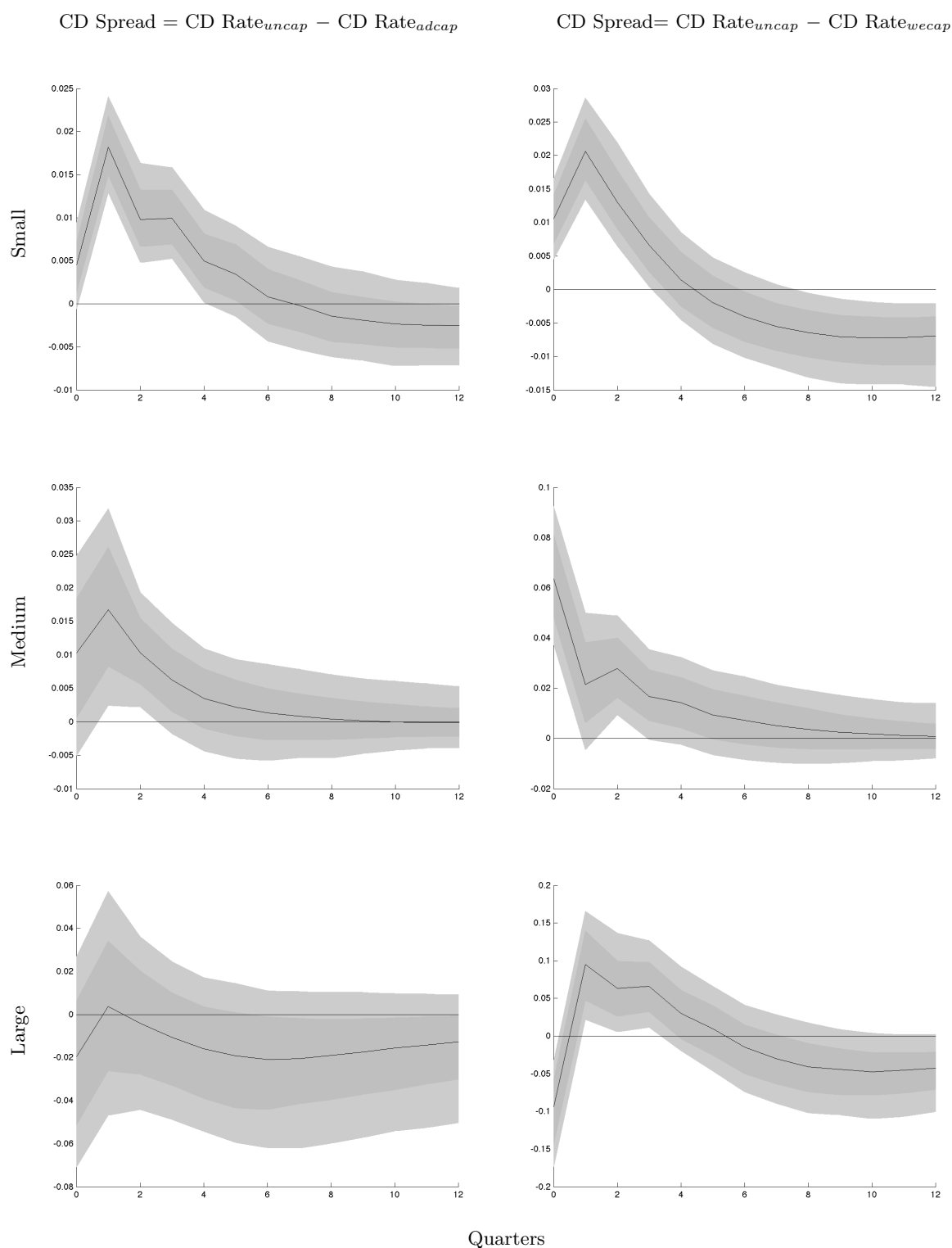
Notes: The VAR includes RGDP, DEF, FFR and CD rate (estimated with two lags; from 1984Q1 to 2007Q3; the first three quarters in 1996 with missing values were omitted); CD rate is aggregated with the median over all banks.

Figure 2: IRFs of CD spreads to a monetary policy shock



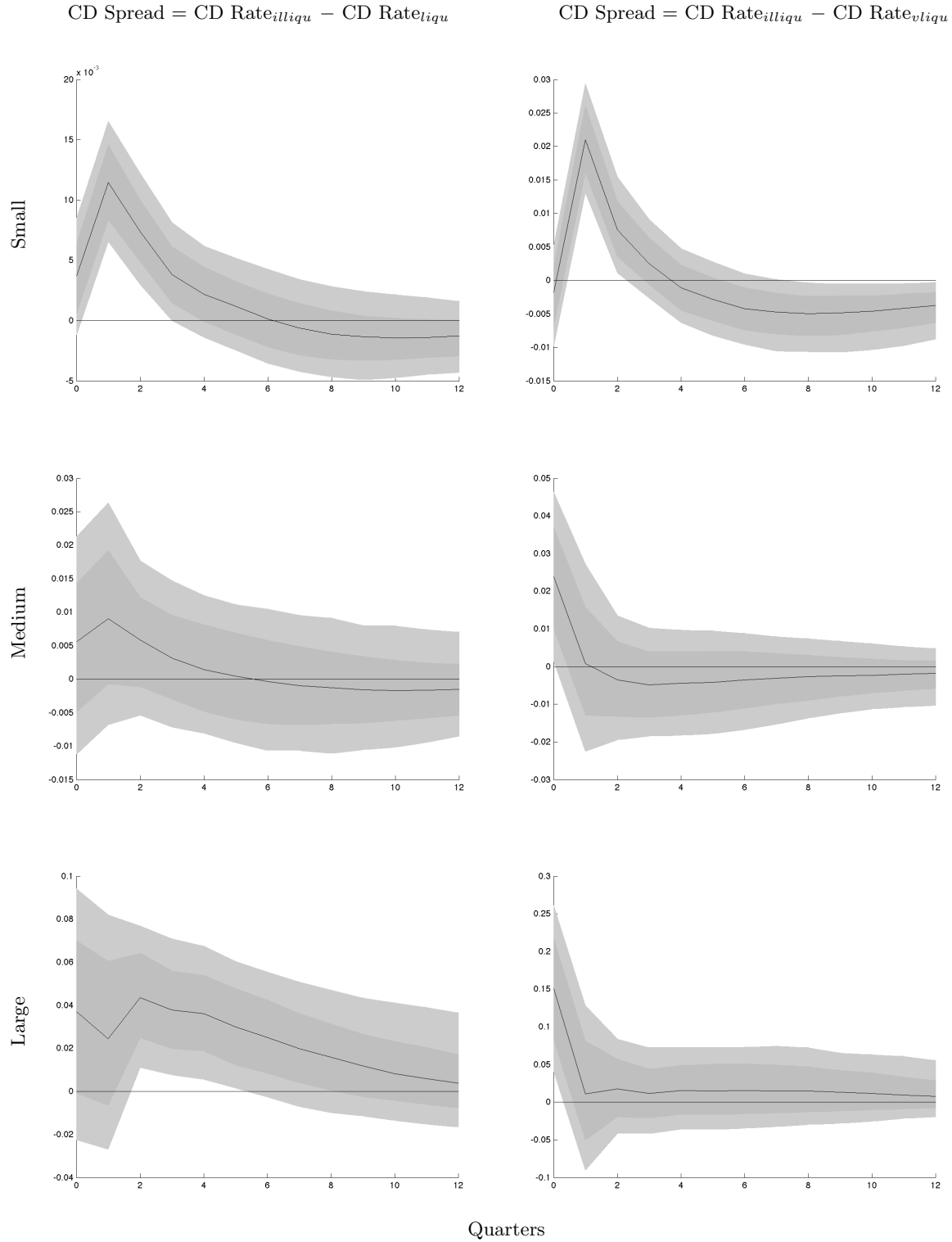
Notes: The VARs includes RGDP, DEF, FFR and either $CD\ Spread_{cap}$ or $CD\ Spread_{liqu}$ (estimated with two lags; from 1984Q1 to 2007Q3; the first three quarters in 1996 with missing values were omitted); the CD spread is calculated between undercapitalized (uncap) and well capitalized (wecap) banks or illiquid (illiqu) and very liquid (vliqu) banks.

Figure 3: IRFs of CD spreads to a monetary policy shock among different bank size classes



Notes: Each graph results from a separate VAR estimation. The rows correspond to the differently sized banks. For each banks size, we calculated the spreads between undercapitalized (uncap) and either adequate (adcap) or well capitalized (wecap) banks.

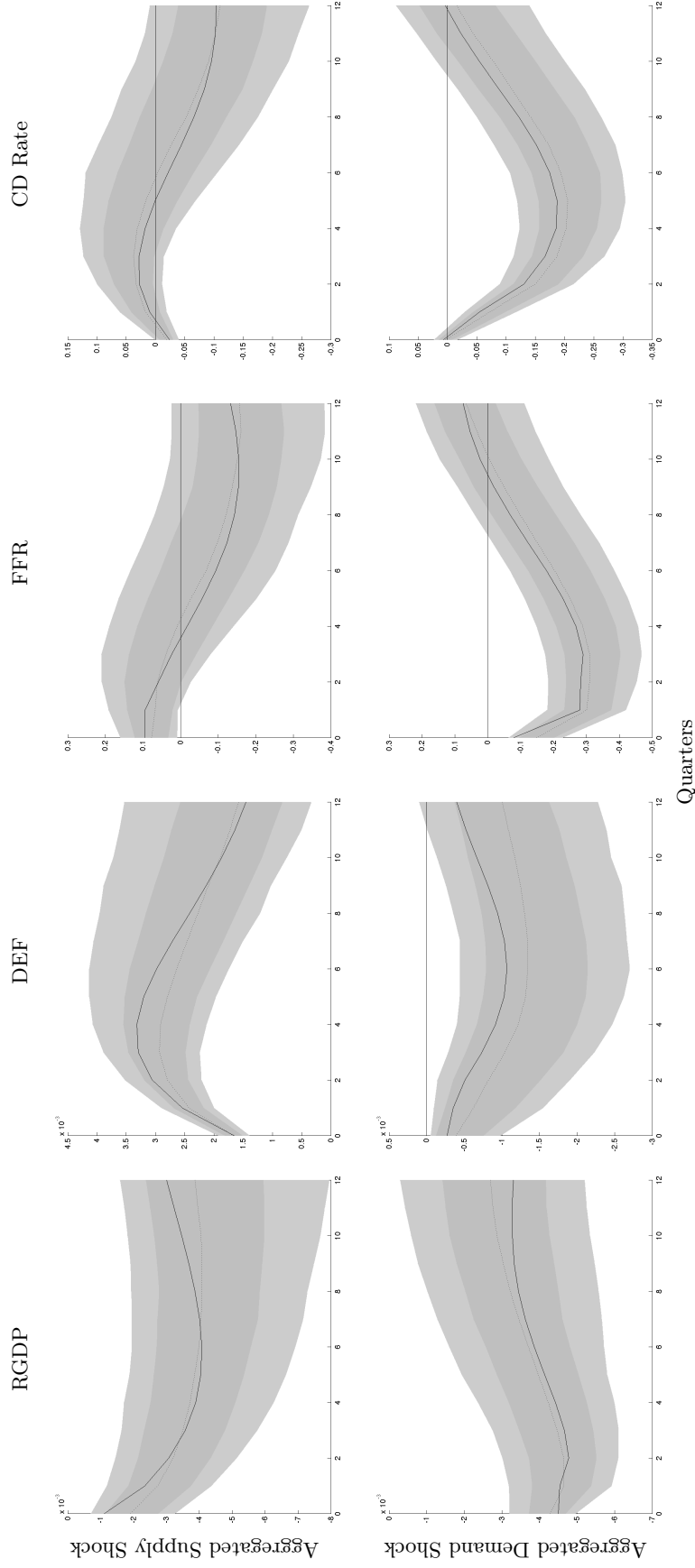
Figure 4: IRFs of CD spreads to a monetary policy shock among different bank size classes



Notes: Each graph results from a separate VAR estimation. The rows correspond to the differently sized banks. For each banks size, we calculated the spreads between illiquid (illiqu) and either liquid (liqu) or very liquid (vliqu) banks.

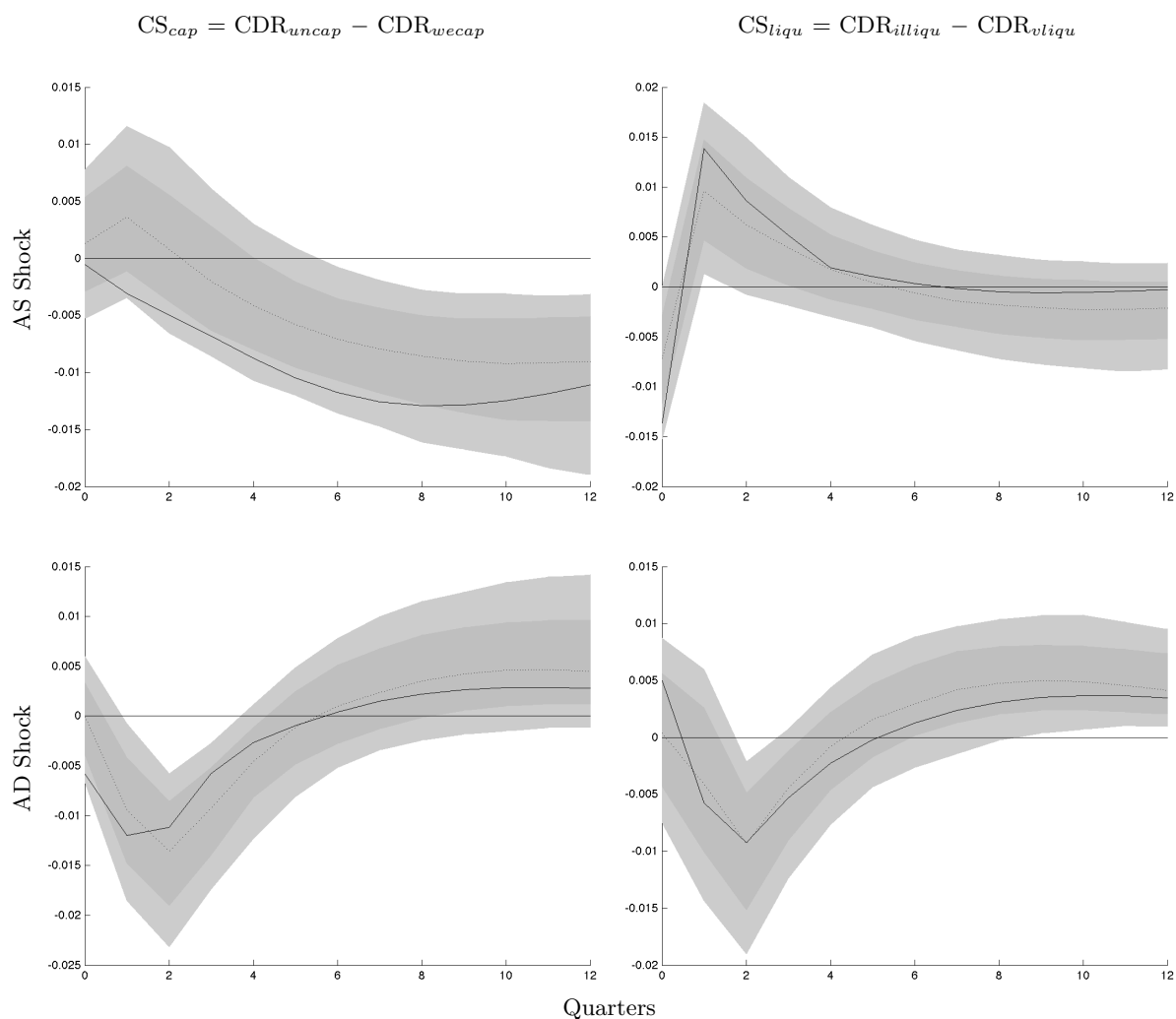
Appendix: Alternative Identification Approaches

Figure 5: IRFs of all variables in the VAR to an aggregated supply shock (first row) and an aggregated demand shock (second row)



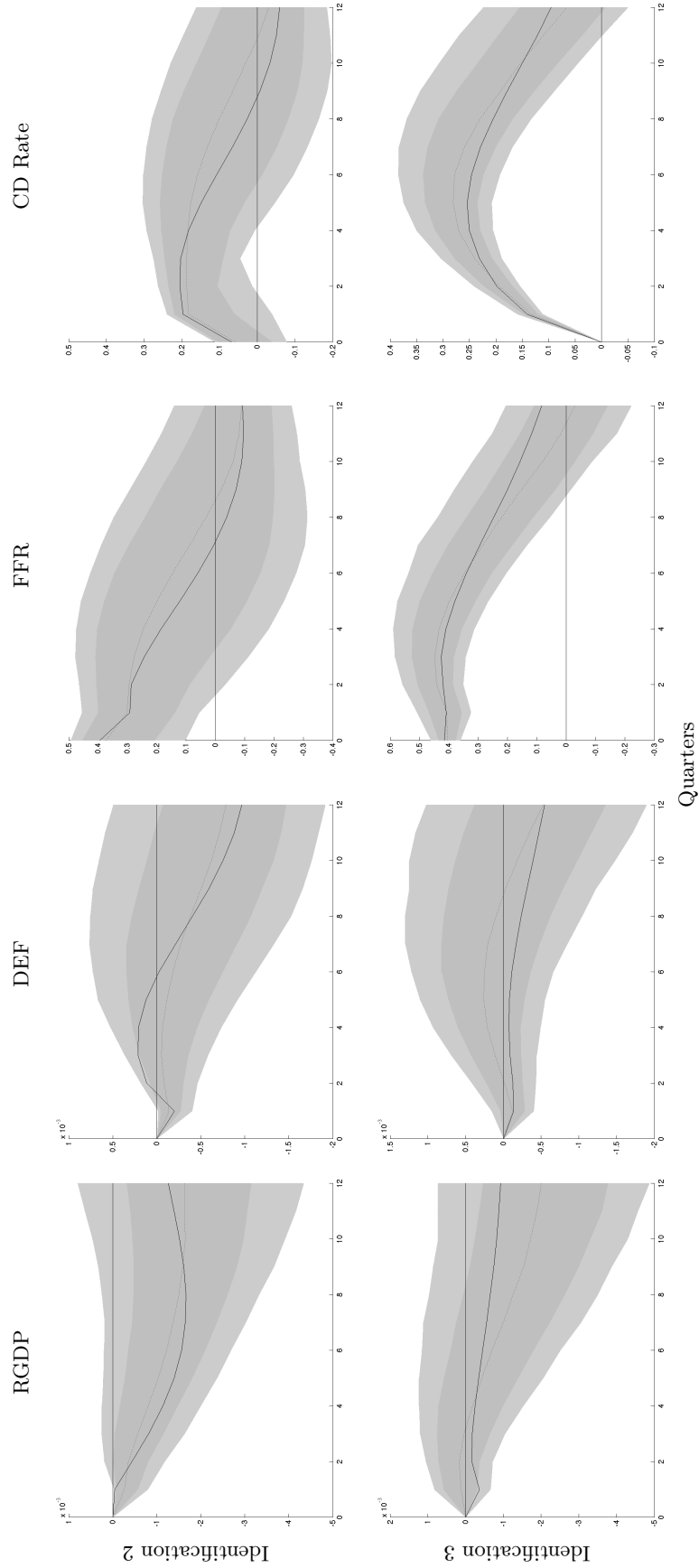
Notes: The VAR includes RGDP, DEF, FFR and CD rate (estimated with two lags; from 1984Q1 to 2007Q3; the first three quarters in 1996 with missing values were omitted); CD rate is aggregated with the median over all banks.

Figure 6: IRFs of the CD spreads to an AS shock (first row) and an AD shock (second row)



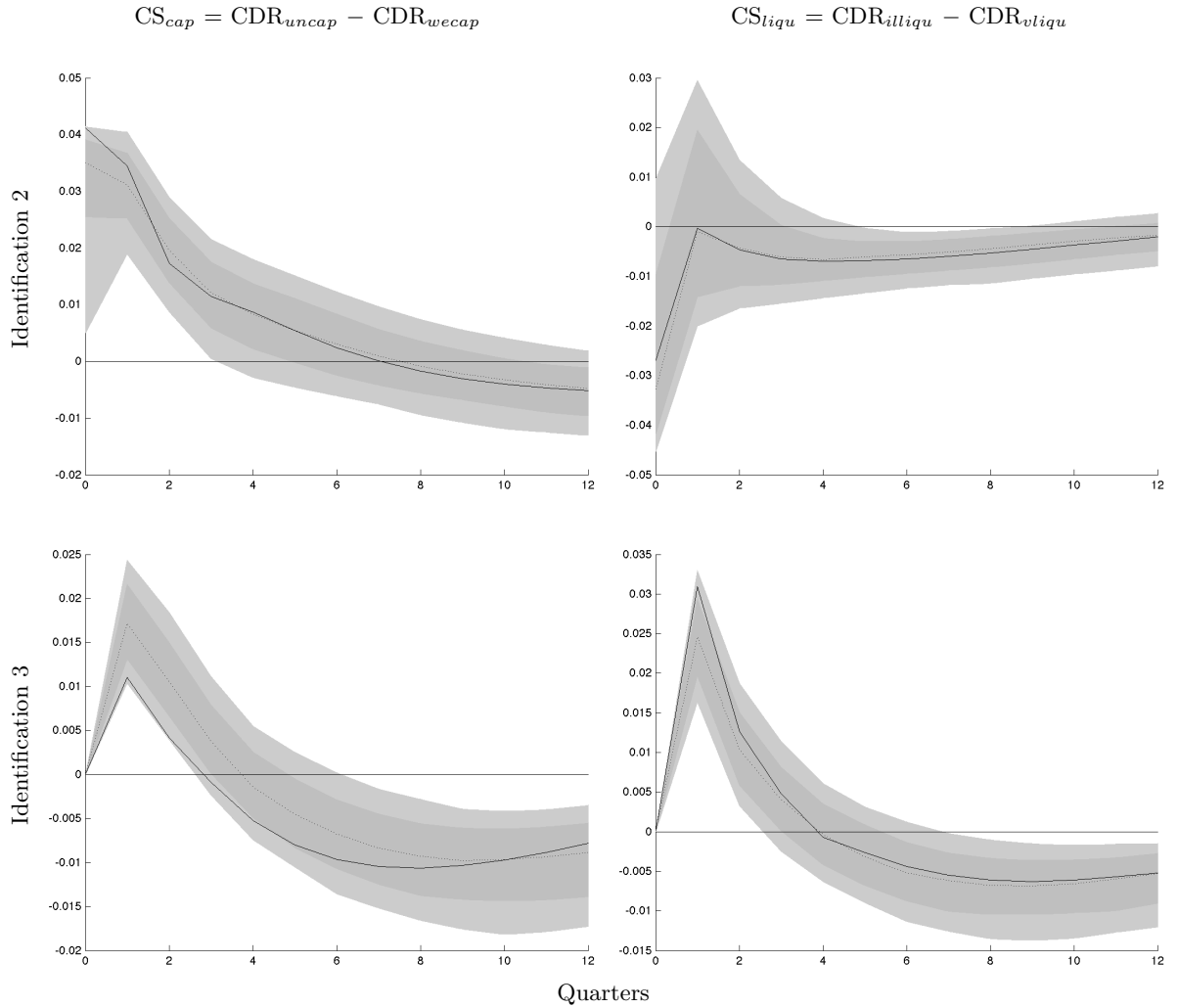
Notes: The VARs includes RGDP, DEF, FFR and either CS_{cap} or CS_{liqu} (estimated with two lags; from 1984Q1 to 2007Q3; the first three quarters in 1996 with missing values were omitted); CS is calculated between under-capitalized (uncap) and well capitalized (wecap) banks or illiquid (illiqu) and very liquid (vliqu) banks.

Figure 7: IRFs of all variables in the VAR to a monetary policy shock (CD-Rate is aggregated over all banks)



Notes: The VAR includes RGDP, DEF, FFR and CD rate (estimated with two lags; from 1984Q1 to 2007Q3; the first three quarters in 1996 with missing values were omitted); CD rate is aggregated with the median over all banks; identification 2: combination of zero and sign restriction for monetary policy shock; identification 3: zero restrictions with changed order (FFR is ordered last).

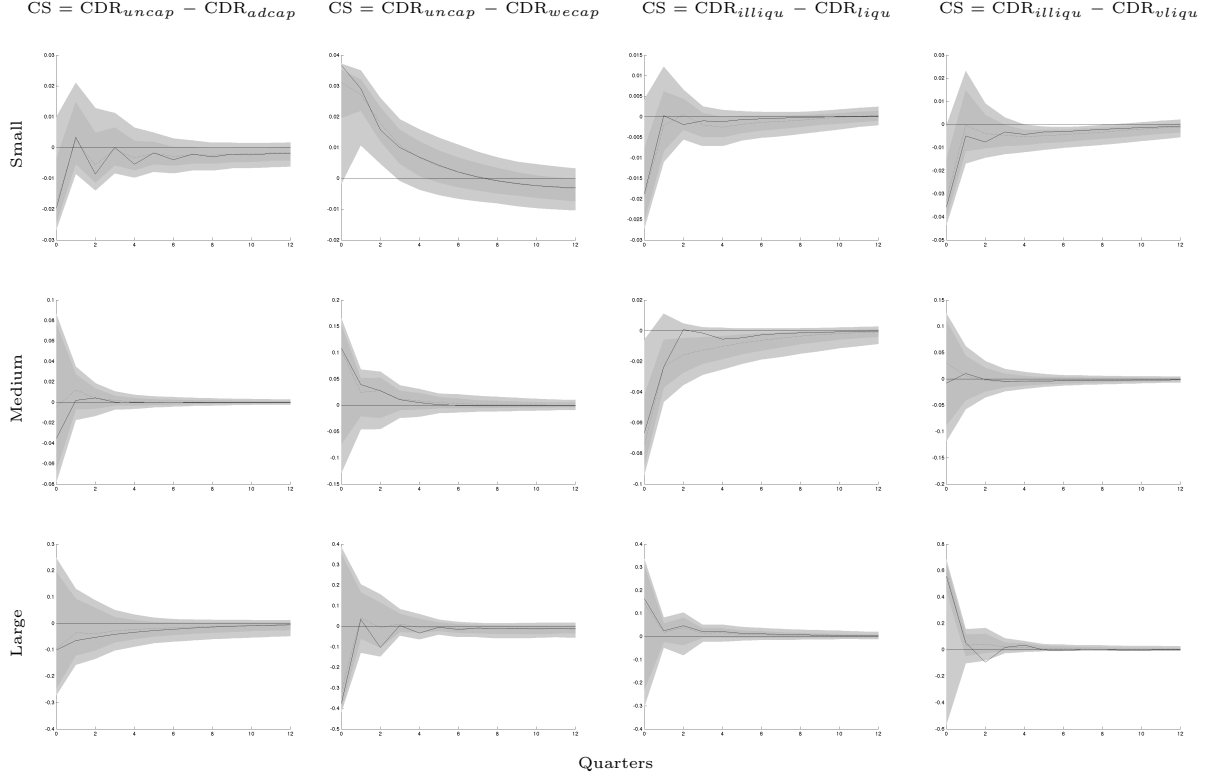
Figure 8: IRFs of the CS variable to a monetary policy shock (among the two different bank characteristics)



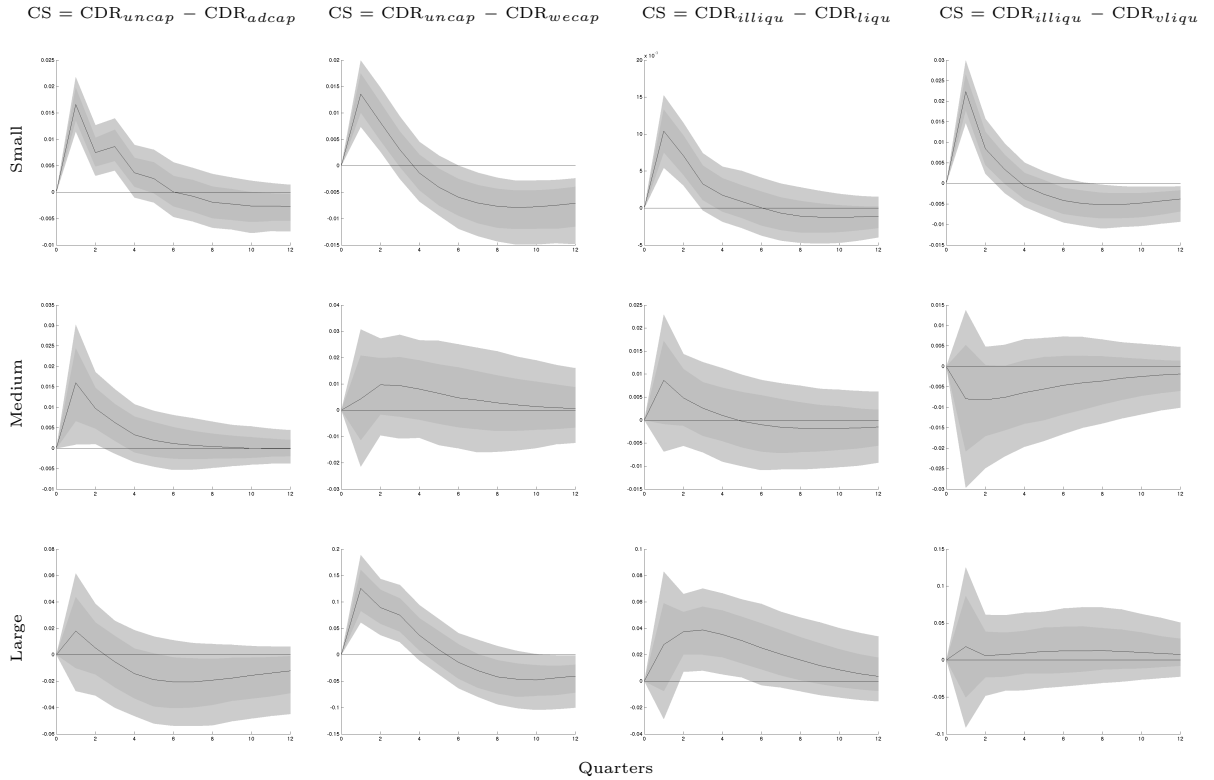
Notes: The VARs includes RGDP, DEF, FFR and either CS_{cap} or CS_{liqu} (estimated with two lags; from 1984Q1 to 2007Q3; the first three quarters in 1996 with missing values were omitted); CS is calculated between undercapitalized (uncap) and well capitalized (wecap) banks or illiquid (illiqu) and very liquid (vliqu) banks. Identification two corresponds to the combination of zero and sign restrictions and identification 3 identifies monetary policy with the alternative block recursive-causal ordering.

Figure 9: Response of the CD spread among different classes of banks (size constant; median ag.)

Identification 2: Zero and Sign Restrictions

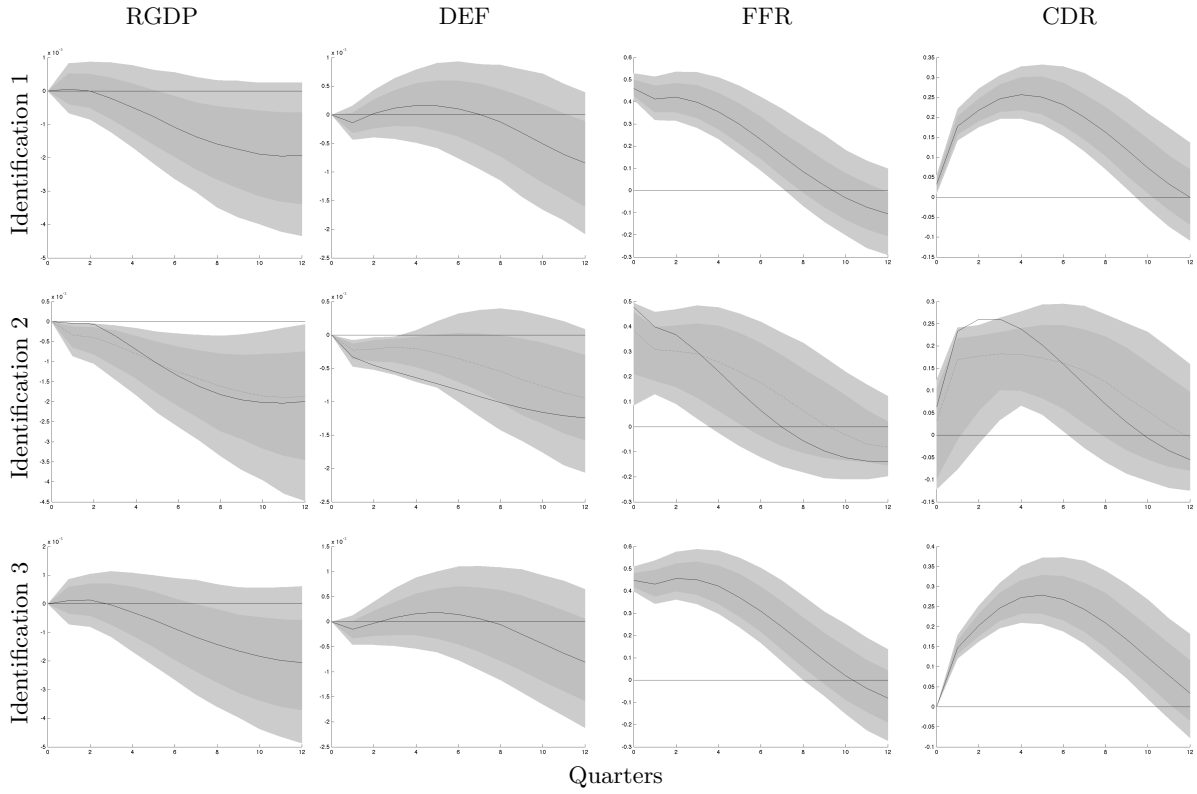


Identification 3: Block Recursive-Causal Ordering (changed order)



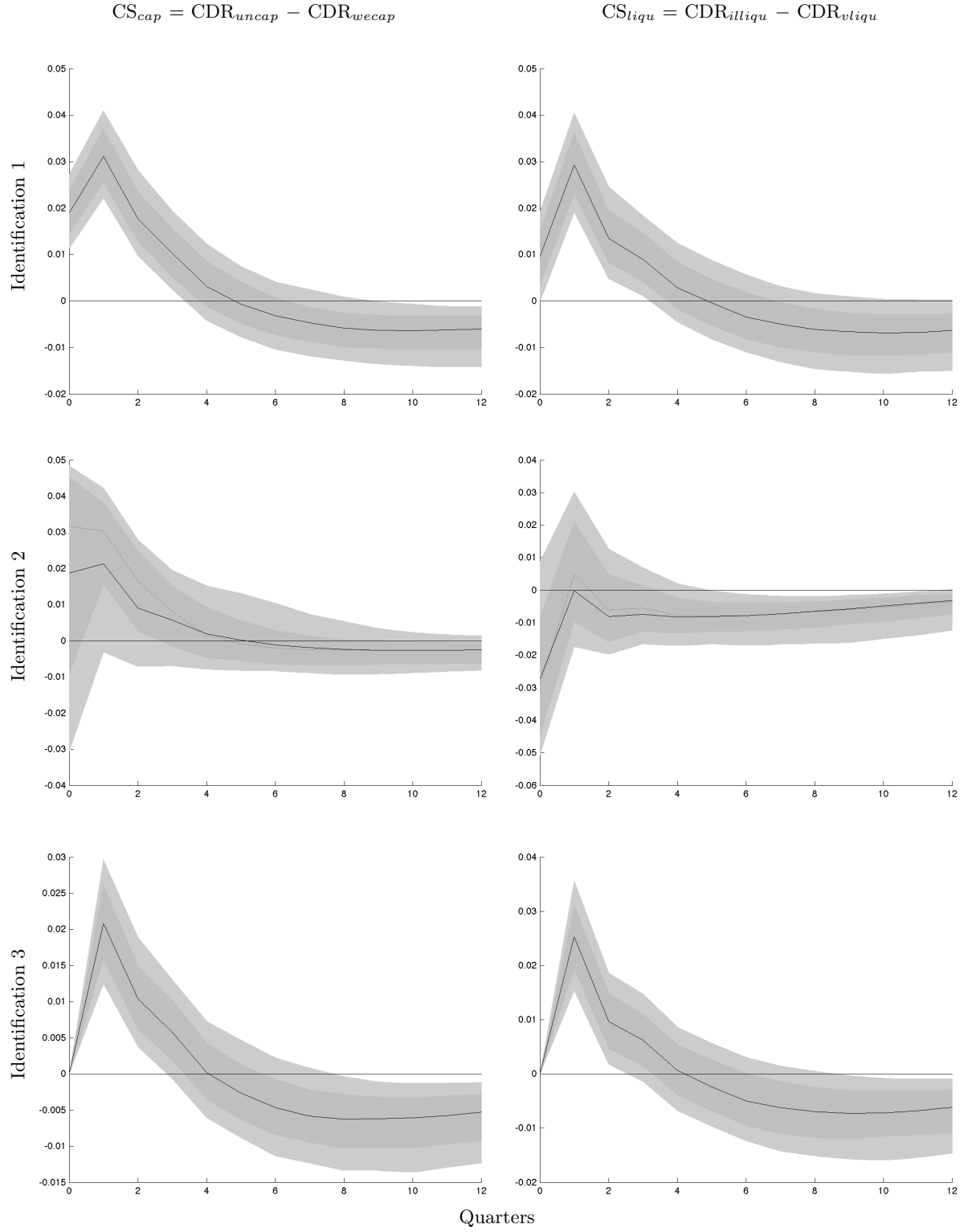
Appendix: Mean aggregated CDR

Figure 10: IRFs of all variables in the VAR to a monetary policy shock (CDR is aggregated over all banks)



Notes: The VAR includes RGDP, DEF, FFR and CDR (estimated with two lags; from 1984Q1 to 2007Q3; the first three quarters in 1996 with missing values were omitted); CDR is aggregated with the mean over all banks.

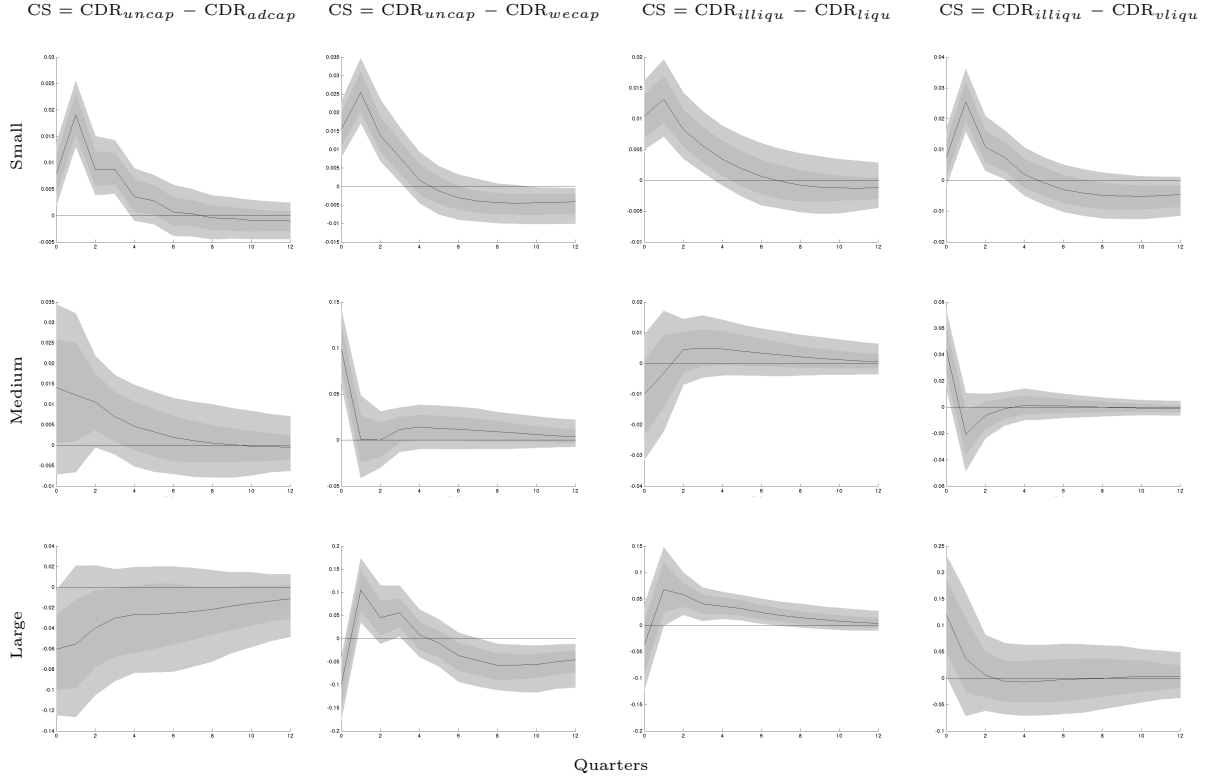
Figure 11: IRFs of the CS variable to a monetary policy shock (among the three different bank characteristics)



Notes: The VARs includes RGDP, DEF, FFR and either CS_{cap} or CS_{liqu} (estimated with two lags; from 1984Q1 to 2007Q3; the first three quarters in 1996 with missing values were omitted); CS is calculated between under-capitalized (uncap) and well capitalized (wecap) banks or illiquid (illiqu) and very liquid (vliqu) banks.

Figure 12: Response of the CD spread among different classes of banks (size constant; mean ag.)

Identification 1: Block Recursive-Causal Ordering



Identification 2: Zero and Sign Restrictions

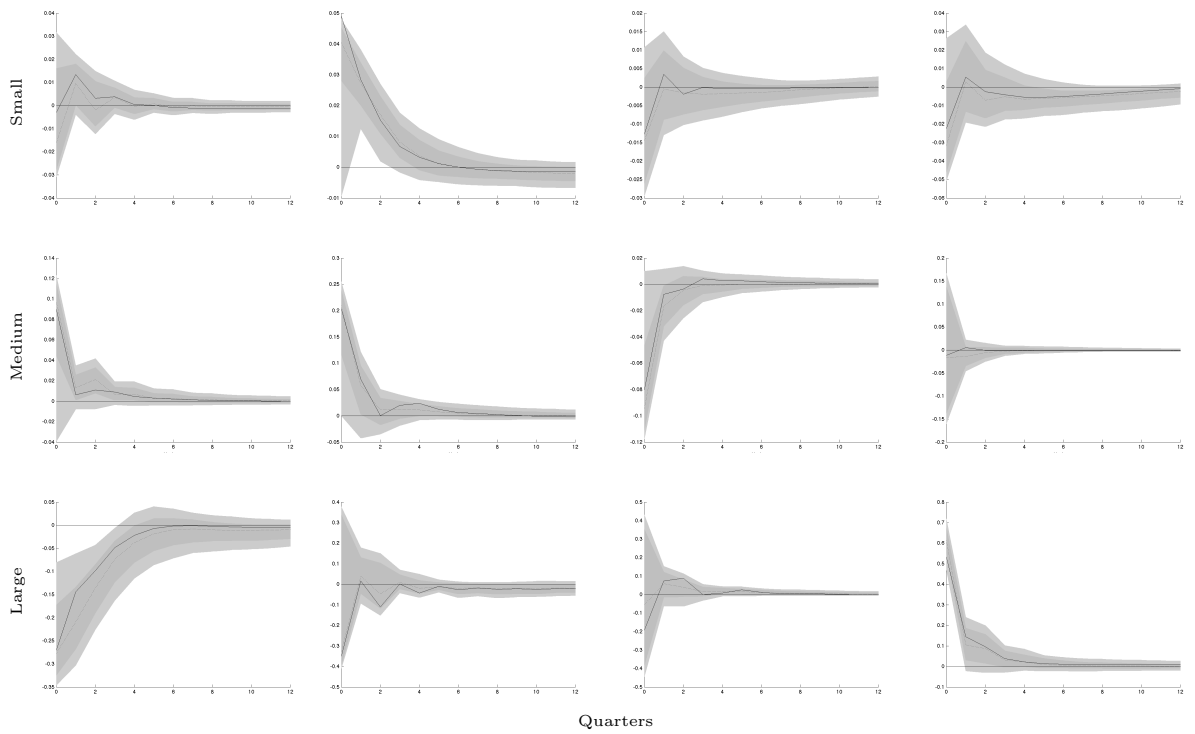


Figure 12: Continued

Identification 3: Block Recursive-Causal Ordering (changed order)

