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Bank capital and liquidity creation: Granger-causality evidence

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BANK CAPITAL AND LIQUIDITY CREATION GRANGER-CAUSALITY EVIDENCE

Roman Horváth, Jakub Seidler and Laurent Weill

In 2012 all ECB publications feature a motif taken from the €50 banknote

MACROPRUDENTIAL RESEARCH NETWORK

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This paper presents research conducted within the Macroprudential Research Network (MaRs). The network is composed of economists from the European System of Central Banks (ESCB), i.e. the 27 national central banks of the European Union (EU) and the European Central Bank. The objective of MaRs is to develop core conceptual frameworks, models and/or tools supporting macro-prudential supervision in the EU.
The research is carried out in three work streams: 1) Macro-financial models linking financial stability and the performance of the economy; 2) Early warning systems and systemic risk indicators; 3) Assessing contagion risks.
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Abstract

We examine the relation between capital and liquidity creation. This issue is interesting because of the potential impact on liquidity creation from tighter capital requirements such as those in Basel III. We perform Granger-causality tests in a dynamic GMM panel estimator framework on an exhaustive data set of Czech banks, which mainly includes small banks from 2000 to 2010. We observe a strong expansion in liquidity creation until the financial crisis that was mainly driven by large banks. We show that capital negatively Granger-causes liquidity creation in this industry, where majority of banks are small. But we also observe that liquidity creation Granger-causes a reduction in capital. These findings support the view that Basel III can reduce liquidity creation, but also that greater liquidity creation can reduce banks' solvency. Thus, we show that this reverse causality generates a trade-off between the benefits of financial stability induced by stronger capital requirements and the benefits of increased liquidity creation.

JEL Classification: G21, G28

Keywords: Bank capital, Liquidity creation, Basel III

Nontechnical Summary

This paper examines the relation between capital and liquidity creation, which is a comprehensive measure of a bank's overall ability to finance relatively illiquid assets with relatively liquid liabilities and thereby serve as a financial intermediary. We test the relation between bank capital and liquidity creation by using an exhaustive dataset of Czech banks from the Czech National Bank from 2000 to 2010. This way we propose a broad perspective on the interactions between capital and liquidity creation in the banking industry. In doing so, we are able to provide evidence on capital requirements limiting liquidity creation, which is highly relevant for appraising the economic implications of the capital requirements in the Basel III reforms.

We show, especially for small banks, that capital is found to negatively Granger-cause liquidity creation. However, we also observe that liquidity creation Granger-causes capital reduction. We thus support the view that there is a negative, bi-causal relation between capital and liquidity creation, which corroborates the importance of examining this causality.

Our findings have two policy implications for small banks. First, they suggest that the Basel III Accords might lead to reduced bank liquidity creation by introducing tighter capital requirements. Second, our findings support the view that greater liquidity creation may hamper bank solvency.

Overall, our primary conclusion is that there is a trade-off between the benefits of financial stability induced by stronger capital requirements and the benefits of greater liquidity creation. Therefore, any action in favor of one objective would deteriorate the other.

A possible caveat is that our findings might be dependent on our sample and might not be easily generalizable. However, the Basel III rules are planned to be implemented for a vast array of countries, including that examined here and others that are similar. In any case, to deepen our understanding of the relation between capital requirements and liquidity creation should occupy a high position on the bank regulation research agenda.

1 Introduction

Because of the recent financial turmoil, the Basel Committee on Banking Supervision has proposed new capital rules known as Basel III. Basel III is based on the conclusion that the financial crisis was rooted in the low solvency levels of banks' balance sheets. As a consequence, these rules introduce tighter capital requirements. In particular, the objective is to improve the resiliency of the banking industry: "A strong and resilient banking system is the foundation for sustainable growth, as banks are at the center of the credit intermediation process between savers and investors. Moreover, banks provide critical services to consumers (…)." (Basel Committee on Banking Supervision 2010, p.5).

Thus, the Basel Committee not only emphasizes the importance of banks' solvency, but liquidity creation as well. Banks function as key liquidity creators by financing relatively illiquid assets with relatively liquid liabilities. They thereby contribute to financing the economy and facilitating transactions between economic agents; or, to express it in Bank for International Settlements (BIS) terms, they contribute to credit intermediation and provide critical services to consumers. Yet, the Basel Committee seems to neglect the possibility that banks' solvency and liquidity creation might have a reverse causality.

Our aim in this paper is to examine both the effect of capital on liquidity creation and the effect of liquidity creation on capital. To the best of our knowledge, we are the first in the literature to take this approach. Using data from the U.S., Berger and Bouwman (2009) focus on the first effect and find that higher capital leads to less liquidity creation at small banks, while leading to greater or constant liquidity creation at large banks. In doing so, we are able to provide evidence on the potentially detrimental impact from capital requirements on liquidity creation that the regulatory authorities do not consider.

A negative impact from capital on liquidity creation suggests that greater capital requirements might hamper liquidity creation. In other words, there is a trade-off between the benefits of financial stability and the costs of lower liquidity creation to the economy. This trade-off might strengthen if liquidity creation is observed to have a negative effect on capital, because this effect suggests that greater liquidity creation by banks might have detrimental effects on banks' solvency. Reverse causality also supports the view that an optimal level of liquidity creation might exist.

Reciprocally, finding a positive impact from capital on liquidity creation provides support for the implementation of stronger capital requirements for banks in Basel III, because they would result in greater safety and in higher liquidity creation. Furthermore finding that

liquidity creation has a positive effect on capital means that greater liquidity creation can also contribute to banks' solvency and thus would show the existence of a virtuous circle in favor of tightening capital requirements.

Therefore, our research helps to assess the economic implications of the capital requirements in Basel III. The potential costs of these reforms have been assessed by international organizations. While Angelini et al. (2011) estimate for BIS that an increase of 1 percent leads to a 0.09 percent decline in output, an OECD study by Slovik and Cournède (2011) concludes that increased financing costs from following the new capital requirements reduce GDP growth by 0.05 to 0.15 percent annually. However, neither study explicitly considers the potential costs of reduced liquidity creation, which might lead to a reappraisal of the strengthening banks' capital requirements in Basel III.

The theoretical and empirical literature provides conflicting assumptions about the relation between capital and liquidity creation, both in terms of sign and the type of causality. Berger and Bouwman (2009) propose two opposing hypotheses regarding the impact of banks' capital on liquidity creation. Furthermore, the literature suggests mechanisms for the potential influence of liquidity creation on banks' capital that do not accord to the expected sign.

The concept of liquidity creation used in this paper is a rather comprehensive measure of a bank's overall ability to transform maturity in the economy (Berger and Bouwman 2009). Our measure comprises not only on-balance-sheet activities but also off-balance-sheet activities. Off-balance-sheet activities are relevant as a liquidity creation indicator, because many studies have highlighted the importance of these activities (e.g., Boot et al. 1993; Holmstrom and Tirole 1997; Kashyap et al. 2002).

We perform Granger-causality tests to check the sign and the type of causal relation between banks' capital and liquidity creation. We embed Granger-causality estimations in GMM dynamic panel estimators to address the econometric complications induced by the use of lagged dependent variables. We then follow recent empirical studies by using an exhaustive data set of Czech banks from the Czech National Bank (CNB) from 2000 to 2010. Our study is limited to a single country, as in these studies, because we require very detailed data (e.g., Podpiera and Weill 2008; Pruteanu-Podpiera, Weill and Schobert 2008, for Czech banks; Casu and Girardone 2009; and Fiordelisi et al. 2011, for European banks). Measuring liquidity creation requires this kind of data because balance-sheet items need to be classified to compute liquidity creation measures. As a consequence, cross-country databases such as

Bankscope cannot be used because the information provided is not sufficiently disaggregated.[1]

The Czech banking industry is an interesting case for our investigation. While it does not contain very large banks, it contains banks of various sizes with mainly small banks. Therefore, an investigation of this banking industry does not suffer from selection bias that might be the case for any study focusing on large banks or listed banks. Furthermore, the detrimental effects of new capital requirements for banks might be of particular importance for small banks, which face greater difficulties in increasing their capital. Therefore, an analysis of the impact of banks' capital on liquidity creation must include small banks. Indeed, in line with Berger and Bouwman (2009) we find that higher capital decreases liquidity creation especially for small banks.

The Czech Republic is a former transition country and is now an EU member. The vast majority of Czech banks are foreign-owned. Thus, results for this country can be generalized to countries with high levels of foreign bank ownership.[2] However, the results still provide insights that can be of interest in the policy debate, as foreign bank entry is an important debate in many emerging countries, results obtained for a banking industry that is largely owned by foreign investors are of special interest to these countries.

The use of Czech data also provides an opportunity to analyze the volume and evolution of liquidity creation in the Czech Republic over the last decade. We can then examine whether the amount of liquidity created by Czech banks is similar to what Berger and Bouwman (2009) found for the US. It will also improve information on the evolution of aggregate liquidity creation over time.

Our results suggest that a strong expansion in liquidity creation until the financial crisis was mainly driven by large banks. We find that capital negatively Granger-causes liquidity creation for small banks, while there is likely to be no such causality for large banks. We also observe that liquidity creation Granger-causes a reduction in capital. These findings support the view that Basel III can reduce liquidity creation in small banks, but also that greater liquidity creation can reduce banks' solvency. Thus, we show that this reverse causality

[1] For instance, Bankscope does not provide the disaggregation of loans by category or by maturity for the vast majority of banks, which is of course needed for the computation of liquidity creation measures. Moreover, even within countries, the classifications of demand deposits, savings deposits, and time deposits are not consistent across banks.

[2] Note that a large share of foreign bank ownership is common in Central and Eastern European countries. In addition to the Czech Republic, in Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Estonia, FYR Macedonia, Georgia, Hungary, Lithuania, Montenegro, Romania, and Slovakia foreign banks own greater than 80% of banks' assets. These figures come from EBRD Structural Change Indicators.

generates a trade-off between the benefits of financial stability induced by stronger capital requirements and the benefits of increased liquidity creation.

The remainder of this paper is structured as follows. In Section 2, we present the hypotheses and related literature and then describe recent changes in the Czech banking industry. Section 3 presents our method. Section 4 develops the results. We conclude in Section 5.

2 Background

2.1 Hypotheses

Opposing assumptions can be advanced regarding the relation between capital and liquidity creation. They diverge both in terms of the relation's sign and the type of causality.

Berger and Bouwman (2009) posit two hypotheses framing the causal link that moves from banks' capital to liquidity creation. The risk absorption hypothesis predicts that increased capital enhances the ability of banks to create liquidity. This hypothesis stems from two strands of the literature concerning the role of banks as risk transformers. Liquidity creation increases the bank's exposure to risk because banks that create more liquidity face greater losses when they are forced to sell illiquid assets to satisfy the liquidity demands of customers (e.g., Allen and Santomero 1998; Allen and Gale 2004). By contrast, more capital allows the bank to absorb greater risk (e.g., Bhattacharya and Thakor 1993; Repullo 2004).

But, the financial fragility hypothesis predicts that increased capital hampers liquidity creation (Diamond and Rajan 2001). Briefly, the financial fragility effect is an outcome of the following process. The bank collects funds from depositors and lends them to borrowers. Once a loan is issued, the bank has to monitor the borrower and collect loan payments. This process helps the bank obtain private information on its borrowers that gives the bank an advantage in assessing their profitability. However, this informational advantage creates an agency problem, whereby the bank might be tempted to extract rents from its depositors by demanding a greater share of the loan income. If depositors refuse to pay the higher costs, the bank threatens to curtail its monitoring or loan collection efforts. As depositors know that the bank might abuse their trust, they become wary of depositing their money with the bank. The bank is thus forced to demonstrate its commitment to depositors by adopting a fragile financial structure with a large share of liquid deposits. The result of this fragile financial structure is that the bank runs the risk of losing funding if it attempts to withhold depositors.

As such, the threat of bank runs mitigates the holdup problem that arises after the depositors have put their funds in the bank. Consequently, by allowing the bank to receive more deposits and finance more loans, financial fragility favors liquidity creation. As greater capital reduces financial fragility, it enhances the bargaining power of the bank and hampers the credibility of its commitment to the depositors. Thus, increased capital works to diminish liquidity creation.

However, we can also propose a mechanism through which the relation moves from liquidity creation to capital. The illiquidity risk hypothesis contends that greater liquidity creation increases the risk of illiquidity for banks because illiquid assets occupy a larger share of their total balance sheets. This larger share incentivizes banks to strengthen their solvency through increased capital, not only so that they can still have a relaxed access to external funding markets but also because capital acts as a buffer against risky liquidity creation. Therefore, greater liquidity creation should lead to higher levels of capital. This hypothesis is related to empirical works examining the impact of risk on banks' capital buffers (Lindqist 2004; Jokippi and Milne 2011).

2.2 Related literature

The literature on banks' liquidity creation remains scarce because its expansion is a recent development in the wake of Berger and Bouwman's (2009) pioneering article. Their paper makes a major contribution by suggesting a new method for measuring the liquidity created by banks. Berger and Bouwman propose a classification of all balance-sheet items as either liquid, semi-liquid, or illiquid. This classification applies to all items in a bank's assets, liabilities, equity, and off-balance-sheet activities. They then use four different measures of liquidity creation for each of the items. Two measures are based on a category classification of the balance-sheet items, while two measures are based on maturity. For each type, one measure includes off-balance sheet activities, while the other does not. The authors then assign weights to all of the items and compute the amount of liquidity created by each bank.

Berger and Bouwman (2009) use this method to measure liquidity creation in the US banking industry between 1993 and 2003. They find that liquidity creation increased substantially between 1993 and 2003, as the US banking industry created $2.8 trillion in liquidity in 2003. They find that the relation between capital and liquidity creation varies with size and depending on whether off-balance-sheet items are added to the liquidity creation measure. With measures that include off-balance-sheet items, the relation is positive for large banks, not significant for medium banks, and negative for small banks. With measures

excluding off-balance-sheet items, the relation is not significant for large and medium banks, and negative for small banks.

A handful of recent papers follow this study. Fungáčová et al. (2010) extend the debate by analyzing how a deposit insurance scheme affects this relation.[3] To do so, they study Russia. Russia provides a natural experiment to investigate this issue because a deposit insurance scheme was implemented there in 2004. Even if the deposit insurance scheme has effects, its implementation does not change the sign of the relation. They find a negative relation between capital and liquidity creation before and after the deposit insurance scheme. Moreover, they observe that the relation varies with size and ownership. It is significantly negative for small and medium banks and for private domestic banks, while the relation is not significant for large banks, foreign banks, and state-owned banks.

Berger and Bouwman (2010) analyze the impact of monetary policy on the aggregate liquidity creation by banks in the US. Analyzing the period from 1984 to 2008, they examine whether the impact differs between normal periods and financial crises, and whether the impact also differs according to bank size. They show that tightening monetary policy only reduces liquidity creation for small banks. This effect is weaker during financial crises. They also note that liquidity creation is somewhat higher prior to financial crises that suggests measures of aggregate liquidity creation have explanatory power in predicting crises.

Berger et al. (2012) investigate how regulatory interventions and capital injections influence risk and liquidity creation using a sample of German universal banks. They find that these interventions reduce both risk and liquidity creation. Rauch et al. (2011) analyze potential determinants of liquidity creation for a sample of German savings banks. They compare the influence of macroeconomic factors, including monetary policy and unemployment, with the bank-specific factors such as size or financial performance. They find some support for the impact of monetary policy; the tightening of monetary policy reduces liquidity creation. However, bank-specific factors do not seem to have any influence on liquidity creation. Additionally, Pana et al. (2010) examine the impact of bank mergers on liquidity creation for US banks. They report that mergers have a positive influence on banks' liquidity creation.

[3] See also Harding et al. (forthcoming) on the effect on banks' capital requirements and deposit insurance on banks' capital structure.

2.3 The evolution of the Czech banking industry

The banking industry occupies a dominant position in the Czech financial system and represents the most relevant channel of financial intermediation. While the depth of financial intermediation (measured as total financial sector assets to GDP) reached 156% at the end of 2010, the ratio of banking sector assets to GDP was nearly 115% according to figures from the CNB. The banking sector's large share of the overall financial system has been relatively stable in recent years (see Fig. 1). However, compared to Eurozone countries, the Czech financial sector remains relatively underdeveloped.

The 1990s was the first decade of a market-based banking sector. This decade was characterized by the deleveraging and cleaning of bank portfolios, which were primarily concentrated in the corporate sector. The loans in these portfolios were a legacy of the centrally driven economy and were of dubious quality because of the poor asset management during this period. The banking sector continued to undergo restructuring and privatization through 2001. As a result, approximately 97 percent of banking sector assets is currently owned by foreign capital, predominantly from other EU countries.

After the restructuring of the banking sector and in line with the solid performance of the Czech economy, banks' credit to the private sector grew substantially during the 2003 to 2007 period. Nonetheless, this relatively rapid credit growth – especially to the household sector – was primarily financed through local currency deposits, and banks had no incentive to offer foreign currency loans. Thus, the Czech Republic is one of a small number of countries in the Central and Eastern European region that neither experienced a boom in foreign currency lending nor relied on external (foreign) funding. The increased lending to households was primarily conducted in the local currency, which mitigated potential future risk from exchange-rate depreciation.

As a result, the performance of the Czech banking sector improved significantly after 2001, which is made apparent by high capital buffers (approximately 15% at the end of 2010) and a relatively small ratio (6.2% in 2010) of nonperforming loans. This performance also led to a relatively mild impact from the financial crisis in 2009 as no Czech bank needed government support.

The Czech banking sector is considered to be well funded because approximately 70% of its liabilities are created by client deposits. This funding also illustrates that the ratio of deposits to loans in the Czech Republic is among the highest in the EU, as observed in Fig. 2.

3 Method

3.1 Measures of banks' liquidity creation

We use data for all Czech banks during the period of 2000 to 2010 from the CNB. The data come from the balance sheets that the banks report to the Banking Supervision Department of the CNB. The data gives us an unbalanced panel of 31 banks with 3,821 monthly observations.

We compute two measures of liquidity creation. We follow Berger and Bouwman's (2009) procedure by classifying items on Czech banks' balance sheets as liquid, semi-liquid, or illiquid. Once all of the balance-sheet items are classified, we then assign them weights according to Berger and Bouwman's (2009) four measures of liquidity creation and calculate the measures by summing all weighed items. Their specifications classify all items except loans by combining information on both product category and maturity, and classify loans purely based on category or maturity ("cat" or "mat" measures), and include or exclude off-balance-sheet items ("fat" or "nonfat" measures).

We only use the classification based on maturity of items, as our data set provides detailed information that allows us to consider on- and off-balance-sheet items by maturity, not by category. Hence, in Berger and Bouwman's (2009) terminology, we consider the "mat fat" liquidity creation measure and the "mat nonfat" liquidity creation measure.[4] For the purposes of our analysis, we label these measures as broad and narrow liquidity creation respectively.

This broad measure of liquidity creation is our preferred one because it accounts for off-balance-sheet items that can also provide liquidity and is thus more comprehensive. Nevertheless, the narrow measure is relevant for our analysis, as it allows us to check the robustness of our conclusions. Table 1 gives a detailed description of the classifications.

[4] In contrast to their paper, we use "fully mat fat" and "fully mat nonfat" measures, that is, we classify all items (not just loans) by the remaining maturity.

3.2 The Granger-causality framework

To test the hypotheses on the relation between capital and liquidity creation, we use the Granger-causality framework. Thus, we estimate the following equations to examine their inter-temporal relation:

$$LiquidityCreation_{i,t} = f(Capital_{i,lag}, LiquidityCreation_{i,lag}, Z_{i,t}) + e_{i,t} \qquad (1)$$

$$Capital_{i,t} = f(LiquidityCreation_{i,lag}, Capital_{i,lag}, Z_{i,t}) + e_{i,t} \qquad (2)$$

where the subscript t denotes the time dimension, i represents the cross-sectional dimension across banks, Z represents the control variables, and $e_{i,t}$ is the error term. The *LiquidityCreation* is the ratio of liquidity creation to assets. We use the broad and narrow measures of banks' liquidity creation to shed light on the robustness of our results even though, as mentioned above, the broad measure is preferred because it includes off-balance-sheet items. The *Capital* is the ratio of banks' equity to total assets.

Equation (1) tests whether changes in capital temporally precede variations in liquidity creation, while equation (2) evaluates whether changes in liquidity creation temporally precede variations in capital. We use four lags that appear reasonable given the monthly frequency of our data. In their analyses of the causal relation between nonperforming loans and bank efficiency, Podpiera and Weill (2008) use three lags and Fiordelisi et al. (2011) use two, but both studies use yearly data.

We estimate an AR(4) process in which the Granger causality is by a joint test in which the sum of all of the lagged coefficients of the explained variable in question are significantly different from zero.[5] The addition of the lagged dependent variables to the predicting variables creates econometric problems induced by unobserved bank-specific effects and joint endogeneity of the explanatory variables. To address these issues, we use the system GMM estimators developed for dynamic panel models by Arellano and Bover (1995) and Blundell and Bond (1998). Podpiera and Weill (2008) and Fiordelisi et al. (2011) also use similar frameworks.

We add a series of control variables. The selection of the variables partly follows the work of Berger and Bouwman (2009) on US banks, as they also regress liquidity creation on capital by controlling for several factors. Nevertheless, we add additional control variables to account for the specific characteristics of the country under analysis and consider some potential

[5] Twelve lags are used in the robustness check, please see section 4.3.

determinants of capital to assets ratios, which was not a dependent variable for Berger and Bouwman.

We take various dimensions of risk into account using three variables: *Earnings Volatility*, defined as the standard deviation of the bank's monthly return on assets measured over the previous six months; *Credit Risk*, measured as the ratio of risk-weighted assets and off-balance-sheet activities divided by assets; and *Z-Score*, measured by the return on assets plus *Capital* divided by *Earnings Volatility*. We also control for *Nonperforming Loans* with the ratio of the nonperforming loans to total loans for two reasons. On the one hand, many Czech banks had portfolios with a sizeable amount of nonperforming loans because of the banking reforms implemented in the 1990s at the beginning of the period in our study. On the other hand, our study covers the recent financial crisis in which the share of nonperforming loans increased somewhat. The risk measures are not orthogonalized, because their correlation is low.

We consider *Size* that is measured by the log of total assets, and *Market Share* that is defined as the market share of total deposits for each bank. Because we use monthly data, we add *Inflation* and *Unemployment* to control for the macroeconomic environment. The macroeconomic data come from the Czech Statistical Office.

Unlike Berger and Bouwman (2009), we do not add a dummy variable for mergers and acquisitions, because there were very few during our sample period and the dummy would be largely correlated with the constant. Similarly, we do not add any variables that capture population density, as the Czech Republic is a rather small country and banks typically do not specialize geographically. Table 2 displays the summary statistics for all of the variables used in the estimations.

4 Results

This section displays our results. We first provide evidence on the volume and evolution of liquidity creation by Czech banks. We then develop estimations of the relation between capital and liquidity creation.

4.1 Analysis of liquidity creation

We study the volume and evolution of banks' liquidity creation. To do so, we provide liquidity creation measures for all banks. We also separately consider four categories of

Czech banks: large banks (with total assets of more than 200 billion CZK, approximately 11.3 billion USD), medium-sized banks (total assets between 50 billion and 200 billion CZK, approximately 2.8–11.3 billion USD), small banks (total assets less than 50 billion CZK), and building societies.[6] This decomposition allows us to draw conclusions about the roles that the different categories of banks play in liquidity creation. Table 3 provides the results for the liquidity creation measures over the sample period. They are also presented in Figs. 3 and 4 for the broad and the narrow liquidity creation measures, respectively. Several conclusions are apparent.

First, we observe a strong expansion of liquidity creation during the overall sample period. The aggregate volume of liquidity creation, when using the broad measure, increased in real terms from 357.1 billion CZK in 2000 (approximately 20.2 billion USD) to 1,293.8 billion CZK in 2010 (approximately 73.1 billion USD). The mean ratio of liquidity creation to assets more than doubles from 15% in 2000 to 33% in 2010. The same findings are observed when we use the narrow measure of liquidity creation.

These changes are in line with developments in the Czech banking industry. The high growth in liquidity creation in 2001 to 2003 was stimulated by the decline in interest rates to levels similar to those in the Eurozone following the successful disinflation. They were also driven by the consolidation of the banking industry, as larger banks are associated with greater liquidity creation. The growth peaked again at the onset of the global financial crisis. This peak is likely linked to high economic growth associated with considerable credit growth. Banks' prudence increased during the global financial crisis that contributed to halting the growth of liquidity creation. However, the crisis was not associated with a decline in liquidity creation. This development likely reflects the good financial health of the Czech banking sector, as banks that are in better shape have less incentives to reduce their credit supply. The positive financial situation of Czech banks is supported by the observation that, unlike in most EU countries, these banks did not benefit from any governmental support during the crisis. Stress tests also suggest that they were able to withstand the considerable negative shocks (Czech National Bank 2011).

Second, large banks contribute widely to liquidity creation. In 2000, large banks were responsible for 88% of total liquidity creation. Over the 2000s, their contribution to liquidity creation decreased somewhat but remained highly important: they represented 69% of total

[6] A building society is a special type of bank that provides home loans to households under specific conditions given in Act No. 96/1993 Coll., on Building Savings Schemes and State Support for Building Savings Schemes and its later amendments. Based on the volume of total assets, 4 building societies would be classified as medium-sized banks and one as a small bank.

liquidity creation in 2010. This reduction is a consequence of the increasing role of medium-sized banks and building societies in liquidity creation over time. Small banks created very little liquidity during the overall sample period. The key role of large banks in liquidity creation is in accordance with what Berger and Bouwman (2009) observe for the US banking industry. They show that large banks created 81% of total liquidity in 2003.

However, do large banks create more liquidity relative to their size? Namely, can large banks contribute more to liquidity creation in absolute terms, or might they create less liquidity in relative terms when considering their total assets? The analysis of the ratios of liquidity creation to assets confirms the predominant role of large banks in liquidity creation in relative terms. The mean ratios for large banks were 18% in 2000 and 39% in 2010 as compared with means for all banks of 15% in 2000 and 33% in 2010.

Third, comparisons for both liquidity creation measures show that off-balance-sheet items play a small role in liquidity creation. This role differs from the US situation described in Berger and Bouwman (2009): while off-balance-sheet items contribute approximately 50% to the banks' overall liquidity creation in the US, they only contribute approximately 10% in the Czech Republic. For example, building societies have almost no off-balance-sheet items, which reflects regulatory issues. Interestingly, off-balance-sheet items destroy rather than create liquidity in the Czech Republic. Nevertheless, it has to be acknowledged that the differences between our and Berger and Bouwman's (2009) results might be driven by differences in the methods used to calculate liquidity creation. For example, our approach classifies loan commitments with short maturities as liquid with a weight of -1/2 thus destroying liquidity. In contrast, Berger and Bouwman (2009) classify loan commitments of any maturity as illiquid, arguing that it is equally hard to get rid of a short-term loan commitment as a long-term loan commitment.

4.2 Regressions

We now turn to the regressions we run to investigate the sign and sense of causality between capital and liquidity creation. We focus our estimations on the broad measure of liquidity creation. Table 4 contains the results. The dependent variable is *Capital* or *Liquidity Creation.* We test two alternative specifications of the set of control variables by including or excluding both macroeconomic variables, *Inflation* and *Unemployment*, to examine their potential influence on the results.

We show that capital negatively Granger-causes liquidity creation, as the sum of the lagged variables for *Capital* is significantly negative for both models with *Liquidity Creation* as the dependent variable. This finding speaks in favor of the financial fragility hypothesis in which greater capital contributes to a deterioration in liquidity creation.

Berger and Bouwman (2009) also find a negative impact from capital on liquidity creation, but only for small banks. Our findings are in line with Berger and Bouwman (2009) because most banks in our sample can be regarded as small. In addition, our robustness checks in the following sub-section suggest that the negative impact is indeed caused by small banks only.

Our findings are also in accordance with the observations from Fungáčová et al. (2010) on Russian banks. The authors conclude capital has a significantly negative impact on liquidity creation.

When we study the reverse causality, we observe that liquidity creation Granger-causes a reduction in capital because the sum of the lagged variables for *Liquidity Creation* is significantly negative for both specifications with *Capital* as the dependent variable. In other words, greater liquidity creation leads to lower levels of capital. We can interpret this finding through a crowding-out effect in which increased liquidity creation is associated with increased deposits that crowd out capital. More generally, improved access to the depositor base reduces the incentives for bank managers to search for external funding, including capital.

This latter finding is of the utmost importance. First, it shows the importance of investigating the reverse causality between capital and liquidity creation that was previously ignored in the literature. Second, this bi-causal, negative relation between capital and liquidity creation stresses the existence of a trade-off for authorities between banks' solvency, with high capital levels, and liquidity creation.

In summary, our regressions show that there is a bi-directional link between capital and liquidity creation that is negative.

Turning to the analysis of the control variables, we observe that most control variables are not significant. One notable feature is the significantly negative coefficient for *Unemployment*. This coefficient means that greater unemployment deteriorates both capital and liquidity creation. This finding is in accordance with the fact that banks suffer from a reduction in solvency and create lower liquidity in troubled economic times.

4.3 Robustness checks

We perform alternative estimations to determine whether our findings are robust to the chosen measure of liquidity creation, to the period of study, and to the frequency of the data.

In the first robustness check, we rerun all estimations by using the narrow measure of liquidity creation. Thus far, we have focused on the broad measure of liquidity creation. However, the results might differ when off-balance sheet activities are excluded. Table 4 displays the results. Interestingly, they show a similar pattern in the relation between capital and liquidity creation. The total effect of capital on liquidity creation is again significantly negative, while we find the same conclusion for the total effect of liquidity creation on capital. The sums of the lagged variables for *Capital* when explaining *Liquidity Creation* and for *Liquidity Creation* when explaining *Capital* are still significantly negative. In other words, we again find evidence of negative Granger-causation in both directions between capital and liquidity creation

Thus, choosing to exclude off-balance-sheet items in the liquidity creation measures does not influence the relation between capital and liquidity creation. At first glance, this lack of influence might not seem to be a surprising result given the weakness of off-balance-sheet items in the aggregate liquidity creation in the Czech banking industry. However, the low volume of off-balance-sheet items at the aggregate level could obscure some strong differences across banks in which some have off-balance-sheet items that make a significant contribution to their liquidity creation activity. Furthermore, this result is important for emerging markets that commonly have a minor share of off-balance-sheet items in banking activities.

In a second robustness check, we test whether our results are contingent on the period of study, which includes the financial crisis. Even if the impact of the economic downturn on the relation between capital and liquidity creation is unclear, this major economic event might have influenced the behavior of banks. In their analysis of the relation between capital and bank performance, Berger and Bouwman (2012) show that capital can affect banks differently during financial crises and normal periods. To address this issue, we rerun all of our estimations but only include the period from 2000 to June 2007. Table 5 displays the results with the broad and the narrow liquidity creation measures, respectively. For the sake of brevity, we only report the sums of the lagged variables for capital and liquidity creation.[7]

[7] The results in Tables 5 and 6 are reported with macro controls. Results without macro controls are available upon request.

The results are similar. With one exception, we again observe significantly negative coefficients for the sum of the lagged variables for *Capital* when explaining *Liquidity Creation* and for *Liquidity Creation* when explaining *Capital*. The exception concerns the specification with the broad measure of liquidity creation. In that case, the sum of the lagged variables for *Capital* when explaining *Liquidity Creation* is negative but not significant (although with a *p*-value of 0.11). Thus, the finding of Granger-causation in both directions between capital and liquidity creation is also overall observed when we omit the financial crisis period from our sample. Similarly, we do not see any clear differences in terms of the size of the effect from capital on liquidity and vice versa. This finding might be because, unlike banks in many European countries, the Czech banks were not affected strongly or adversely by the crisis, and these banks maintained high capital adequacy at the pre-crisis levels (Czech National Bank 2011).[8]

In a third robustness check, we test whether our results are similar when using quarterly data rather than monthly data. The use of quarterly data might provide different results due to the periodicity of reporting and the longer time required for the impact of capital or liquidity creation on one another. Table 6 reports the results with the broad and the narrow measures of liquidity creation for the full sample and for the sample before the crisis. Again, we report the sums of the lagged variables for capital and liquidity creation only. The results remain largely unchanged.

In a fourth robustness check, we use 12 lags of capital and liquidity creation because our baseline regressions use monthly data. This is to check whether the four lags that are used in Table 4 are too restrictive. We report the results in Table 6.. The results are largely unchanged because the higher lags are not statistically significant.

Finally, in our fifth robustness check, we lag all control variables by one period, as they might affect capital and liquidity creation with a lag. The results are presented in Table 6. Again, they largely support our baseline findings.

We also analyze the subsample issues and examine whether the effect of capital on liquidity creation differs between small and large banks. Berger and Bouwman (2009) find that the negative effect from capital on liquidity creation is present only for small banks, and the effect is in fact positive for large banks (for medium banks it is nonsignificant). We divide our sample into two categories: the “large” banks (4 large and 4 medium banks according to the Czech National Bank classification and 4 building societies, which can be considered as medium banks according to their assets) and “small” banks (18 small banks according to the

[8] See Brewer et al. (2008) on why the capital ratios vary across countries.

Czech National Bank classification and 1 building society, which can be considered as small bank according to its assets). The correlation coefficients between liquidity and capital (as well as its lags) for both categories are negative but not significantly different from zero for the large-bank category. The corresponding correlation coefficient for small banks is approximately -0.17, which is statistically significant at the 1% level. However, this coefficient is only -0.02 for large banks. The regression results (not reported) suggest that there is no effect from capital on liquidity creation for large banks, but the results have to be taken with caution because the Arellano and Bond (1991) estimator is designed for the case of "small T, large N" and we have only eight banks in our large banks category (and T = 132). The results for small banks support our baseline findings but the results should be interpreted with caution. Ultimately, our subsample exercise results corroborate the findings of Berger and Bouwman (2009).

Overall, we find similar results even if the significance of the results is lower in some cases. The sum of the lagged variables for *Capital* when explaining *Liquidity Creation* is significantly negative in all estimations, which confirms our first finding. The sum of lagged variables for *Liquidity Creation* when explaining *Capital* is negative in all estimations, but it is not significant for the full sample. So the use of quarterly data rather than monthly data has a limited impact on our findings. It does not change our empirical support for the negative role of capital on liquidity creation, but it moderates our result on the negative role of liquidity creation on capital without contradicting it. Importantly, it should be noted that our sample primarily contains small banks and therefore, our findings are relevant mostly for small banks. Indeed, as one of our robustness checks in this sub-section shows, the negative impact of capital on liquidity creation is present for small banks only.

5 Conclusion

In this study, we investigate the relation between capital and liquidity creation by banks by examining the causality of this link. A handful of recent papers have analyzed the impact of capital on liquidity creation, but they do so without considering the potential for reverse causality. We do so by performing Granger-causality tests on an exhaustive data set of Czech banks that makes a detailed computation of liquidity creation measures possible. This computation also allows us to provide evidence on the volume and evolution of liquidity creation in a recently emerging market. The analysis of liquidity creation by Czech banks shows a strong expansion in liquidity creation during the overall sample period of 2000 to

2010 that was slowed but not halted by the financial crisis. Large banks are the primary contributors of liquidity creation, which is in accord with the observations of US banks by Berger and Bouwman (2009).

We show that capital negatively Granger-causes liquidity creation for small banks, which confirms the financial fragility hypothesis according to which greater capital hampers liquidity creation. However, we also observe that liquidity creation Granger-causes a reduction in capital. We thus support the view that there is a negative, bi-causal relation between capital and liquidity creation. This relation corroborates the importance of examining its causality.

Our findings have two policy implications for small banks. First, they suggest that Basel III might lead to banks' reduced liquidity creation by introducing tighter capital requirements. Second, our findings support the view that symmetrically greater liquidity creation might hamper banks' solvency. In other words, enhanced liquidity creation can have some detrimental consequences.

Overall, our primary conclusion is that there is a trade-off between the benefits of financial stability induced by stronger capital requirements and those of greater liquidity creation. Therefore, any action in favor of one objective might deteriorate the other. The derived lesson is that regulatory authorities should take this antagonistic relation into account when proposing banking regulations.

We are fully aware that our findings might be dependent on our sample dominated by small banks and might not be easily generalizable. However, Basel III is planned to be implemented for a vast array of countries, including the one examined here and others that are similar. Hence our conclusions are of interest to the regulatory authorities of banks. In any case, to deepen our understanding of the relation between capital requirements and liquidity creation should occupy a high position on the research agenda for the regulation of banks.

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Table 1 Liquidity classification of bank activities. This table presents the classification of the on- and off-balance-sheet items and the weights used for the calculation of the liquidity creation measures.

Assets		
Illiquid assets (weight ½)	*Semi-liquid assets (weight 0)*	*Liquid assets (weight -½)*
Financial assets held for trading with maturity greater than one year	Financial assets held for trading with maturity between three months and one year	Financial assets held for trading with maturity lower than three months
Financial assets designated at fair value through profit or loss with maturity greater than one year	Financial assets designated at fair value through profit or loss with maturity between three months and one year	Financial assets designated at fair value through profit or loss with maturity lower than three months
Available-for-sale financial assets with maturity greater than one year	Available-for-sale financial assets with maturity between three months and one year	Available-for-sale financial assets with maturity lower than three months
Loans and receivables with maturity greater than one year	Loans and receivables with maturity between three months and one year	Loans and receivables with maturity lower than three months
Held to maturity investments with maturity greater than one year	Held to maturity investments with maturity between three months and one year	Held to maturity investments with maturity lower than three months
Derivative-hedge accounting (positive fair value) with maturity greater than one year	Derivative-hedge accounting (positive fair value) with maturity between three months and one year	Derivative-hedge accounting (positive fair value) with maturity lower than three months
Other assets with maturity greater than one year	Other assets with maturity between three months and one year	Other assets with maturity lower than three months
		Cash and cash balances with central banks
Liabilities		
Illiquid liabilities (weight -½)	*Semi-liquid liabilities (weight 0)*	*Liquid liabilities (weight ½)*
Financial liabilities held for trading with maturity greater than one year	Financial liabilities held for trading with maturity between three months and one year	Financial liabilities held for trading with maturity lower than three months
Financial liabilities designated at fair value through profit or loss with maturity greater than one year	Financial liabilities designated at fair value through profit or loss with maturity between three months and one year	Financial liabilities designated at fair value through profit or loss with maturity lower than three months
Financial liabilities measured at amortized cost with maturity greater than one year	Financial liabilities measured at amortized cost with maturity between three months and one year	Financial liabilities measured at amortized cost with maturity lower than three months
Derivative-hedge accounting (negative fair value) with maturity greater than one year	Derivative-hedge accounting (negative fair value) with maturity between three months and one year	Derivative-hedge accounting (negative fair value) with maturity lower than three months
Other liabilities with maturity greater than one year	Other liabilities with maturity between three months and one year	Other liabilities with maturity lower than three months
		Deposits, loans and other financial liabilities vis-à-vis central banks
Off-balance-sheet items		
Illiquid items (weight ½)	*Semi-liquid items (weight 0)*	*Liquid items (weight -½)*
Commitments and guarantees given with maturity greater than one year	Commitments and guarantees given with maturity between three months and one year	Commitments and guarantees given with maturity lower than three months
Commitments and guarantees received with maturity greater than one year	Commitments and guarantees received with maturity between three months and one year	Commitments and guarantees received with maturity lower than three months

Table 2 Description of variables and summary statistics and the means and standard deviations for variables used in subsequent estimations.

Variable	Description	N	Mean	Std. Dev.
Liquidity Creation: broad measure	Ratio of liquidity creation (including off-balance-sheet items) to assets	4056	0.17	0.26
Liquidity Creation: narrow measure	Ratio of liquidity creation (excluding off-balance-sheet items) to assets	4056	0.19	0.19
Capital	Equity to assets	4056	0.08	0.11
Earnings Volatility	Standard deviation of monthly return on assets measured over the previous six months	3876	0.35	0.89
Credit Risk	Basel II risk-weighted assets and off –balance-sheet activities divided by assets	4056	0.41	0.41
Z-Score	Return on assets plus Capital divided by Earnings Volatility	3872	11.09	18.11
Nonperforming Loans	Share of loans in default for three months and more to total loans	4039	5.94	8.37
Size	Log of assets	4056	17.37	1.59
Market Share	Share of deposits in total deposits in the country	4092	0.03	0.07
Unemployment	Unemployment rate	4092	7.17	1.27
Inflation	Year-on-year change in consumer prices	4092	2.67	1.87

Table 3 Summary statistics on bank liquidity creation. This table displays the means of bank liquidity creation measures. Liquidity creation measures and assets are in billions of Czech crowns (CZK) and USD. LC/Assets is the ratio of liquidity creation to total assets. LC adjusted for inflation (Base 2005 = 100). N represents the number of banks. LC in USD is added for convenience; the 2011 average CZK/USD exchange rate of 17.7 is used.

			Broad measure			Narrow measure		
Mid-2000								
	N	Assets (USD bil)	LC (CZK bil)	LC (USD bil)	LC/Assets	LC (CZK bil)	LC (USD bil)	LC/Assets
All banks	31	128.6	357.1	20.2	0.15	378.1	21.4	0.16
Large banks	4	103.7	314.3	17.8	0.18	332.9	18.8	0.19
Medium banks	4	6.9	12.1	0.7	0.09	9.9	0.6	0.08
Small banks	18	4.6	8.7	0.5	0.1	12.6	0.7	0.15
Building societies	5	6.3	-11.3	-0.6	-0.09	-8.6	-0.5	-0.07
Mid-2006								
	N	Assets (USD bil)	LC (CZK bil)	LC (USD bil)	LC/Assets	LC (CZK bil)	LC (USD bil)	LC/Assets
All banks	31	162.3	897.4	50.7	0.28	911.8	51.5	0.29
Large banks	4	111.4	713.5	40.3	0.36	704.9	39.8	0.35
Medium banks	4	16.9	66.2	3.7	0.23	63.1	3.6	0.22
Small banks	18	6.7	0.3	0.017	0	18.4	1	0.15
Building societies	5	20.8	74.1	4.2	0.2	74.8	4.2	0.20
Mid-2010								
	N	Assets (USD bil)	LC (CZK bil)	LC (USD bil)	LC/Assets	LC (CZK bil)	LC (USD bil)	LC/Assets
All banks	31	219.5	1,293.8	73.1	0.33	1,350.6	76.3	0.36
Large banks	4	126.4	890	50.3	0.39	875.9	49.5	0.4
Medium banks	4	31.9	89.1	5	0.18	140	7.9	0.27
Small banks	18	12.9	-2.9	-0.2	-0.01	38.9	2.2	0.17
Building societies	5	26.1	203.3	11.5	0.52	215.7	12.2	0.47

Table 4 Granger-causality tests: estimations with the broad measure of liquidity creation and with the narrow measure of liquidity creation. We use the two-step system GMM estimator with Windmeijer's (2005) corrected standard errors (reported in brackets). The ***, **, and * indicate that p is less than 0.01, 0.05, and 0.1 respectively. The Sargan/Hansen test of the overidentifying restrictions for the GMM estimators is the null hypothesis that instruments used are not correlated with the residuals, and hence the overidentifying restrictions are valid. The Arellano–Bond (AB) test for the serial correlation is in the first differenced residuals. The null hypothesis is that errors in the first difference regression do not exhibit second-order serial correlation. The variables $Capital_{total}$ and $LiquidityCreation_{total}$ are the estimated coefficients for the test that the sum of lagged terms (for capital and liquidity creation, respectively) is not different from zero (*p*-values are reported in brackets).

	Broad measure				**Narrow measure**			
	Explained variable: LiquidityCreation		Explained variable: Capital		Explained variable: LiquidityCreation		Explained variable: Capital	
	(-1)	(-2)	(-3)	(-4)	(-1)	(-2)	(-3)	(-4)
$LiquidityCreation_{t-1}$	0.67***	1.03***	-0.01***	-0.01**	0.66***	0.52***	-0.01***	-0.01***
	(-0.19)	(-0.2)	(-0.002)	(-0.003)	(-0.18)	(-0.18)	(-0.003)	(-0.003)
$LiquidityCreation_{t-2}$	0.24	-0.585*	0.008***	0.01**	0.38**	0.25	0.002	0.003
	(-0.26)	(-0.35)	(-0.002)	(-0.002)	(-0.17)	(-0.2)	(-0.002)	(-0.002)
$LiquidityCreation_{t-3}$	-0.02	0.725**	-0.007***	-0.01***	-0.09	-0.11	0.003	0.002
	(-0.09)	(-0.29)	(-0.002)	(-0.001)	(-0.15)	(-0.19)	(-0.002)	(-0.002)
$LiquidityCreation_{t-4}$	0.09	0.25	-0.003**	-0.0002	-0.1	0.01	-0.002	-0.0002
	(-0.18)	(-0.32)	(-0.001)	(-0.001)	(-0.15)	(-0.19)	(-0.003)	(-0.003)
$LiquidityCreation_{total}$	0.98***	1.42***	-0.01***	-0.01***	0.85***	0.67***	-0.01**	-0.01**
	(0)	(0)	(0)	(0)	(0)	(0)	(-0.01)	(-0.01)
$Capital_{t-1}$	0.06	-0.02	0.65***	0.72***	-0.22	-0.22	0.61***	0.68***
	(-0.29)	(-0.28)	(-0.03)	(-0.04)	(-0.19)	(-0.19)	(-0.02)	(-0.05)
$Capital_{t-2}$	-1.22	1.1	0.12***	0.10**	-1.18	-2.29	0.07***	0.05
	(-1.58)	(-1.46)	(-0.03)	(-0.04)	(-1.22)	(-1.84)	(-0.02)	(-0.03)
$Capital_{t-3}$	-2.94**	-5.31**	-0.02	-0.10***	-0.44	-2.23**	-0.05*	-0.07**
	(-1.33)	(-2.25)	(-0.02)	(-0.04)	(-1.25)	(-1.14)	(-0.03)	(-0.03)

Capital$_{t-4}$	-2.84***	-2.71**	-0.04	-0.14**	-3.04***	-3.36***	-0.07	-0.08
	(-0.92)	(-1.12)	(-0.06)	(-0.06)	(-1.07)	(-1.23)	(-0.06)	(-0.05)
Capital$_{total}$	-6.94***	-6.94***	0.71***	0.58***	-4.88*	-8.10**	0.56***	0.58***
	(-0.01)	(-0.07)	(0)	(0)	(-0.02)	(-0.02)	(0)	(0)
NPL	-0.00167	-0.003**	-0.0002***	-1.20E-06	-5.20E-06	-0.001	-0.0003***	-8.1E-05**
	(-0.0016)	(-0.001)	(-6.4E-05)	(-4.3E-05)	(-0.0008)	(-0.001)	(-6.3E-05)	(-3.4E-05)
Credit risk	6.10E-05	1.10E-05	-3.2E-05***	-1.50E-05	7.30E-05	5.30E-05	-3.9E-05***	-1.40E-05
	(-0.0001)	(-0.0001)	(-7.5E-06)	(-1.0E-05)	(-6.3E-05)	(-8.2E-05)	(-1.0E-05)	(-1.1E-05)
Z-score	8.03E-05	-0.0002*	1.29E-05***	1.7E-05***	-8.8E-05**	-0.0002***	3.80E-06	1.6E-05***
	(-9.7E-05)	(-0.0001)	(-4.5E-06)	(-4.7E-06)	(-3.9E-05)	(-5.2E-05)	(-4.5E-06)	(-4.6E-06)
Earnings Volatility	0.002	-0.0004	-0.001*	-0.001**	-0.001	0.001	-0.002***	-0.001**
	(-0.002)	(-0.003)	(-0.001)	(-0.001)	(-0.002)	(-0.002)	(-0.001)	(-0.001)
Market share	0.3	-1.046	-0.03	-0.03	0.74	0.37	-0.04	-0.12
	(-1)	(0.992)	(-0.13)	(-0.11)	(-0.98)	(-0.96)	(-0.11)	(-0.17)
Size	-0.10***	-0.14***	-0.05***	-0.03***	-0.10***	-0.12***	-0.05***	-0.05***
	(-0.04)	(-0.04)	(-0.01)	(-0.01)	(-0.03)	(-0.04)	(-0.004)	(-0.01)
Unemployment		-0.01**		-0.002***		-0.01**		-0.002***
		(-0.01)		(-0.001)		(-0.01)		(-0.0005)
Inflation		-0.0005		0.0002		0.003**		0.0003***
		(-0.001)		(-0.0002)		(-0.002)		(-0.0001)
Constant	2.31***	3.08***	0.89***	0.47***	1.88***	1.99***	0.89***	0.89***
	(-0.74)	(-0.93)	(-0.11)	(-0.16)	(-0.55)	(-0.68)	(-0.07)	(-0.14)
Observations	3821	3821	3821	3821	3821	3821	3821	3821
Sargan test	11.76	10.3	20.86	13.61	20.34	6.99	20.16	17.75
AB test AR(1)	-1.39*	-2.17**	-2.18***	-2.29***	-1.26*	-1.20**	-2.29***	-2.51***
AB test AR(2)	-0.11	0.86	-0.79	-0.77	-0.22	-0.34	-0.61	-0.01

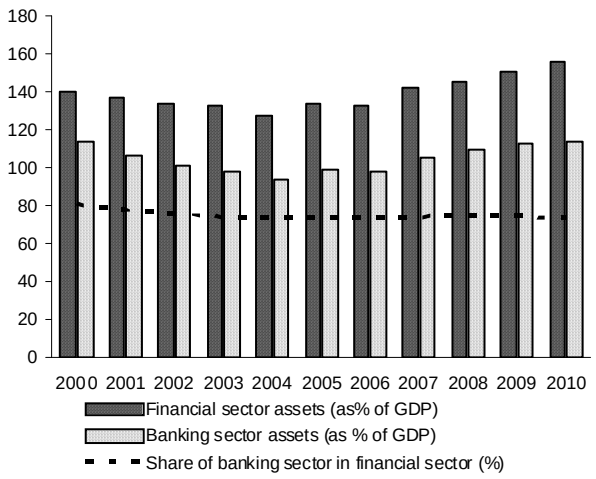
Table 5 Granger-causality tests: estimations with the broad and narrow measure of liquidity creation before the crisis**.** We use the two-step system GMM estimator with Windmeijer's (2005) corrected standard errors (reported in brackets). The ***, **, and * indicate that *p* is less than 0.01, 0.05, and 0.1 respectively. The Sargan/Hansen test of the overidentifying restrictions for the GMM estimators is the null hypothesis that instruments used are not correlated with the residuals, and hence the overidentifying restrictions are valid. The Arellano–Bond (AB) test for the serial correlation is in the first differenced residuals. The null hypothesis is that errors in the first difference regression do not exhibit second-order serial correlation. The variables $Capital_{total}$ and $LiquidityCreation_{total}$ are the estimated coefficients for the test that the sum of lagged terms (for capital and liquidity creation, respectively) is not different from zero (*p*-values are reported in brackets).

	Broad measure		**Narrow measure**	
	Explained variable: LiquidityCreation	Explained variable: Capital	Explained variable: LiquidityCreation	Explained variable: Capital
$LiquidityCreation_{total}$	0.88***	-0.01***	1.11***	-0.01**
	(0.00)	(0.00)	(0.00)	(-0.02)
$Capital_{total}$	-4.82	0.72***	-9.27***	0.65***
	(-0.11)	(0.00)	(-0.01)	(0.00)
Bank controls	YES	YES	YES	YES
Macro controls	YES	YES	YES	YES
Constant	1.57**	0.59***	2.98***	0.75***
	(-0.68)	(-0.14)	(-0.72)	(-0.11)
Observations	2526	2526	2526	2526
Sargan test	12.7	17.1	10.44	19.11
AB test AR(1)	-2.07**	-2.37**	-6.16***	-2.05**
AB test AR(2)	0.6	0.01	1.47	-0.86

Table 6 Granger-causality tests: robustness check with the quarterly data, with 12 lags for monthly data, and with the lagged control variables. We use the two-step system GMM estimator with Windmeijer's (2005) corrected standard errors (reported in brackets). The ***, **, and * indicate that *p* is less than 0.01, 0.05, and 0.1 respectively. The variables $Capital_{total}$ and $LiquidityCreation_{total}$ are the estimated coefficients for the test that the sum of lagged terms (for capital and liquidity creation, respectively) is not different from zero (*p*-values are reported in brackets).

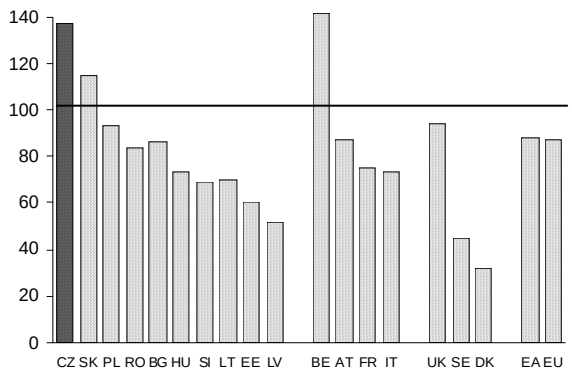
	Quarterly data		**12 lags for monthly data**		**Lagged control variables**	
	Explained variable: LiquidityCreation	Explained variable: Capital	Explained variable: LiquidityCreation	Explained variable: Capital	Explained variable: LiquidityCreation	Explained variable: Capital
Estimations with the broad measure of liquidity creation, full sample:						
$LiquidityCreation_{total}$	0.38***	-0.01	0.90***	-0.01***	1.30***	-0.02***
	(0.00)	(-0.15)	(0.00)	(0.00)	(0.00)	(0.00)
$Capital_{total}$	-0.05***	0.90***	-0.10*	0.94***	-6.89**	0.93***
	(0.00)	(0.00)	(-0.07)	(0.00)	(-0.03)	(0.00)
Bank controls	YES	YES	YES	YES	YES	YES
Macro controls	YES	YES	YES	YES	YES	YES
Estimations with the narrow measure of liquidity creation, full sample:						
$LiquidityCreation_{total}$	0.13***	-0.01	0.93***	-0.01*	0.80***	-0.02***
	(0.00)	(-0.92)	(0.00)	(-0.08)	(0.00)	(0.00)
$Capital_{total}$	-0.04***	0.92***	-0.10***	0.91***	-5.61**	0.93***
	(0.00)	(0.00)	(0.00)	(0.00)	(-0.02)	(0.00)
Bank controls	YES	YES	YES	YES	YES	YES
Macro controls	YES	YES	YES	YES	YES	YES
Estimations with the broad measure of liquidity creation before the crisis:						
$LiquidityCreation_{total}$	0.08***	0.01	0.89***	-0.01	0.46***	-0.04***
	(0.00)	(-0.42)	(0.00)	(-0.11)	(0.00)	(0.00)
$Capital_{total}$	-0.02***	0.98***	-0.12***	0.91***	-2.83**	0.96***
	(0.00)	(0.00)	(0.00)	(0.00)	(-0.02)	(0.00)
Bank controls	YES	YES	YES	YES	YES	YES
Macro controls	YES	YES	YES	YES	YES	YES
Estimations with the narrow measure of liquidity creation before the crisis:						
$LiquidityCreation_{total}$	0.01***	-0.01	0.96***	-0.01*	0.37***	-0.04***
	(0.00)	(-0.20)	(0.00)	(-0.08)	(0.00)	(0.00)
$Capital_{total}$	-0.01***	0.95***	-0.18***	0.95***	-1.15	0.95***
	(-0.05)	(0.00)	(0.00)	(0.00)	(-0.24)	(0.00)
Bank controls	YES	YES	YES	YES	YES	YES
Macro controls	YES	YES	YES	YES	YES	YES

Fig. 1 Financial and banking sector assets



Source: CNB

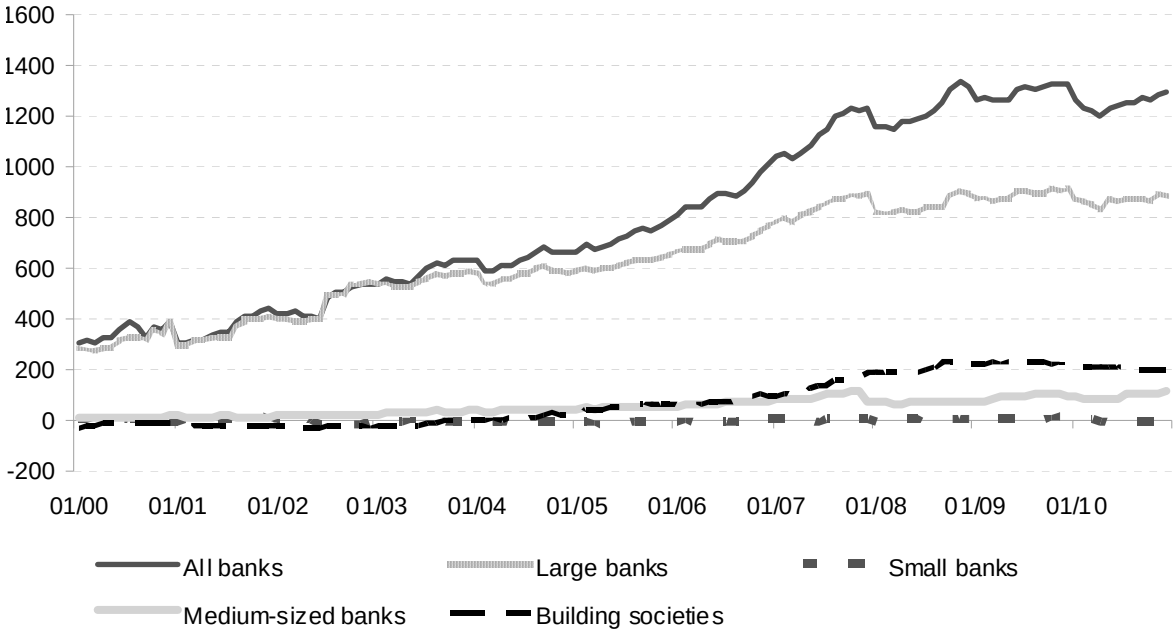
Fig. 2 Ratio of deposits to loans granted in selected EU countries



Source: ECB

Note: EA = Euro Area; EU = average for all EU countries.

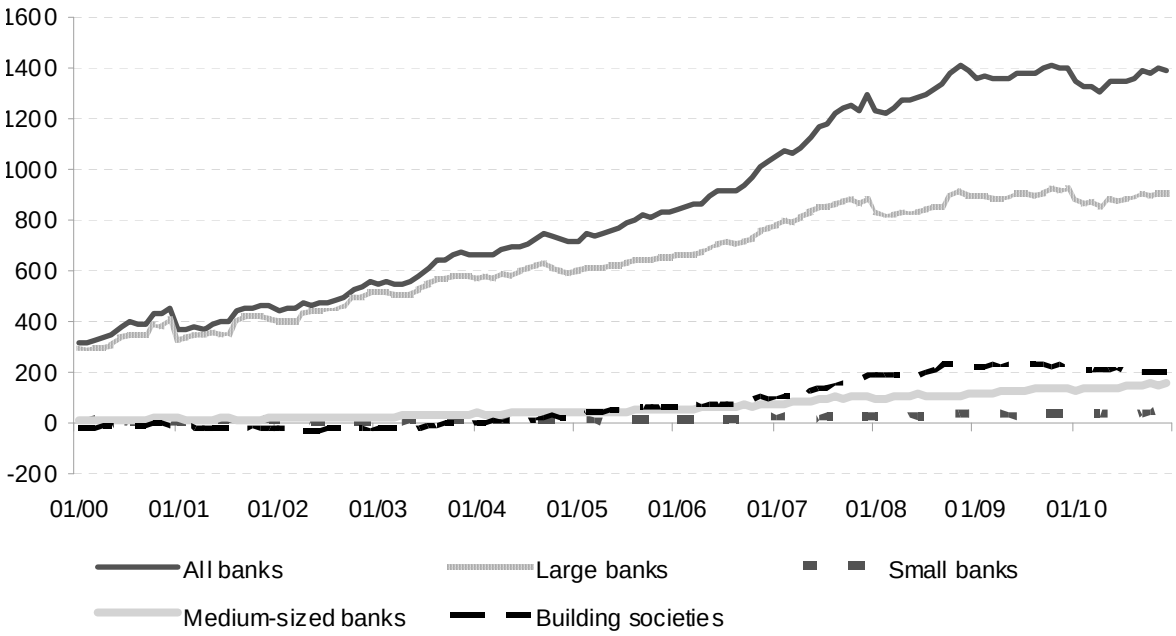
Fig. 3 Bank liquidity creation (broad measure)



Source: CNB, authors' calculations

Note: The series are adjusted for inflation (Base 2005 = 100) and are in billions of Czech crowns. X-axis = month/year.

Fig. 4 Bank liquidity creation (narrow measure)



Source: CNB, authors' calculations

Note: The series are adjusted for inflation (Base 2005 = 100) and are in billions of Czech crowns. X-axis = month/year.