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Financial Stability and Monetary Policy
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EDITORIAL

The importance of analysing the interactions between financial stability and monetary policy and its effects on macroeconomic fluctuations has risen substantially during the current financial crisis. This edition of the Research Bulletin is focused on five articles which analyse these interactions from various angles. The first article examines the effect of tighter macroprudential and monetary policies on output. According to this research, in comparison to monetary policy, macroprudential policy may be less costly, as it has less adverse effects on bank earnings. The second article examines to what extent financial frictions matter for macroeconomic fluctuations. The results suggest that the effect of financial frictions on macroeconomic fluctuations is sizeable only when financial stress is sufficiently high. The third article focuses on the relation between central bank finances and inflation. The article concludes that central bank losses are unlikely to represent a threat to price stability. The fourth article examines whether low monetary policy rates may increase commercial banks' risk-taking. It finds that too low an interest rate may lead to a build-up of long-term risks to financial stability, but a lower interest rate during the life of a loan reduces its riskiness. The fifth article examines the interactions between bank capital and bank liquidity creation. The results indicate that greater capital requirements are beneficial for financial stability but may have an adverse effect on bank liquidity creation.

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IN THIS ISSUE

Financial Frictions, Bubbles and Macroprudential Policies[1]

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Policy instruments directed at combating financial instability became highly demanded following the last global financial crisis, when the latter, originally a purely financial problem, evolved into a severe worldwide recession. One of the challenging questions is the extent of the real implications of macroprudential policies, i.e. ones that fight systemic risks in the financial system. Past generations of macro models had difficulties answering this question, as they posited orderly financial market functioning, paying limited attention to improperly functioning financial intermediaries as a source of financial shocks. Factors that impair efficient pricing of household and corporate liabilities (such as information asymmetry, agency, imperfect competition and institutional design) are well-known from the theory of financial intermediation, so the time has come to compare the relative economic importance of various financial frictions in a setting compatible with the conventional macroeconomic modelling universe.

According to my approach, one can begin to tackle this task with the help of a model featuring imperfect financial intermediaries in a production economy. I consider a joint debt-equity market equilibrium with (partially insider) equity and debt financing of physical capital. For this economy, three types of financial frictions are introduced. The first type involves imperfectly substitutable equity and debt markets for risky and opaque producers, leading to lender-borrower informational disparity. The second friction arises from banks that have a non-zero market power over borrowers. The possibility of biased public beliefs/prejudiced economic sentiment as a source of asset bubbles constitutes the third type of friction. I investigate the relative importance of these frictions and macroprudential intervention for the probability of default (PD), loss given default (LGD) and aggregate economic activity (investment and output). I discuss a two-period setup, but a multi-period generalisation would not present a conceptual problem.

To capture financial shock absorption by the real economy, I consider pricing physical capital as the commodity underlying liabilities, such as equity, debt and collateral, created to finance production. An alternative, exploited by the majority of dynamic stochastic general equilibrium models with a financial sector (cf. Bernanke et al., 1999, Christiano et al., 2008, or Covas and Fujita, 2010), has to rely on the formal workings of slack versus binding finance constraints in individual consumption and investment optimisation problems. However, under this approach, the DSGE-with-financial-sector literature is forced to overlook vital ways in which financial stability contributes to economic performance. This is because price movements are a powerful – and nearly indispensable – way of accounting for the so-called cross-sectional side (Borio, 2003) of financial turmoil.

[1] This article is based on Derviz (2011, 2012).

One of my objects of interest is public sentiment, so often invoked when asset price misalignments are discussed, as a factor behind real investment decisions and output. I analyse the role of incorrect sentiment about the distribution of total factor productivity across borrowers. Sentiment is identified with biased prior public beliefs. Firms send unbiased signals to the public about their average productivity level. However, each firm's public signal is noisy because the firm-specific productivity type and the aggregate disturbance cannot be reported separately. Therefore, updating a prior belief may reduce the bias somewhat, but will never completely eliminate it. In such a situation, I say that there is (prejudiced) public sentiment. Not surprisingly, prior prejudice affects equilibrium equity prices, lending rates, bank credit, investment volumes and output. In the chosen two-period setup, this belief-share demand connection can be considered as the nucleus of an endogenous equity bubble. Even in two periods, the model includes basic elements of the credit cycle effect, as optimistic beliefs support inflated equity prices, which, in the role of collateral, inflate credit demand, and so forth. A proper multi-period extension of this construction would have the familiar attributes of self-fulfilling price expectations and a sudden correction the moment improved information becomes available. The shorthand "bubble", instead of the more accurate "sentiment-driven risk mispricing", should be acceptable in this context as long as it is recognised that, regardless of the number of periods in the model, a bubble is generally understood as a self-validating asset price distortion due to non-fundamental factors.

As the main application, I study a policy tool designed to counteract systemic credit risk. Specifically, I look at the impact of additional (and convexly growing) regulatory capital charges on banks that lend to firms with low relative equity. The formal definition was inspired by Angelini at al. (2012). Although the true advantages and disadvantages of such policy instruments are fully revealed only in a dynamic model, I am nevertheless able to gauge the basic qualitative consequences of the said policy for economic fundamentals within each period. This is made possible by uniting the features of a usual model of production with financial friction effects.

An immediate and obvious consequence of the presence of the said macroprudential instrument in my model is a reduction of leverage on the producer side, since the costs of borrowing become more directly driven by the debt-equity ratio. An equally intuitive downside of enacting the macroprudential policy is a significant increase in lending rates for all borrowers, leading to a tangible output loss. The latter effect obtains because the most risky borrower segment, that is, the one targeted by the policy, is also the one with the highest ex ante performance. Macroprudential capital surcharges mean that those borrowers experience a disproportionate increase in the price of credit by comparison with the low-productivity segment. The said effect is supported by an additional transmission channel through physical capital markets: after an initial increase in the lending rate, banks have to raise the rate even higher because physical capital as collateral has become cheaper. This mechanism is at work regardless of either the sign or the size of the possible equity bubble. In more detail, I find that

• macroprudential capital surcharges on banks are successful in reducing LGD and marginally alleviate the real economy implications of correcting biased public sentiment;

• macroprudential tightening fails to reduce PD and leads to an economic contraction of the same order as the LGD reduction;

• macroprudential tightening results in downward pressure on equity (physical capital) prices and a modest reduction of leverage; this result might explain why policymakers find macroprudential restrictions to be such an attractive strategy in dealing with credit bubbles; however, output losses are a warning that the costs may exceed the benefits; in short, macroprudential policy is more successful at alleviating the symptoms of a bubble than at curing the underlying disease;

• a monetary policy tool aimed at the same equity bubble mostly affects the bank profit side and has very little effect on the producer/borrower side. It is slightly better at reducing default frequency than the macroprudential tool, but is slightly worse when it comes to lowering the average loss given default. The aggregate implications of monetary and macroprudential policies are strongly aligned and may be difficult to separate empirically; however, ceteris paribus, macroprudential tightening is more advantageous for banks. This is because monetary tightening uniformly increases financing costs for everyone (banks and firms), whereas macroprudential tightening allows banks to pass increased funding costs on to firms more easily.

As already mentioned, the outcomes provided by the model are heavily influenced by the mutually reinforcing reactions to shocks by equity and debt markets. This mutual reinforcement also helps explain why investment and output are so sensitive to small changes in the capital surcharge rate. A further observation worthy of more research is that the convex macroprudential capital charge on bank loans reduces equilibrium fragility. In other words, it helps investors coordinate on an equilibrium mix of equity and debt financing in situations in which equilibria do not exist in the absence of this instrument. In my model, this is particularly likely to occur when firm productivity types are distributed very unevenly or when public economic sentiment is highly biased.

Since macroprudential regulation in its current form affects only lenders, it has no direct influence on the aspects of borrower behaviour related to limited liability. However, the adverse aggregate consequences of investment decisions by producers who are indifferent between varying degrees of insolvency (i.e. who do not distinguish between the “dead” and “deader” states of a firm that is unable to repay a loan) are more pronounced than the consequences due to the absence of a macroprudential response to a bubble. This came out of the experiments I conducted with a modified “proportional liability” borrower regime. These experiments also produced reduced default rates for the most risky borrowers, compared to the pure limited liability case. Accordingly, one can conjecture that policies able to replicate downside risk on the borrower side are likely to be the next fundamental challenge for financial regulation. More generally, there seem to be limits, in terms of economic activity and ex ante welfare costs, to promoting financial stability through policies directed at credit providers. At the same time, policies with the same ultimate objective of systemic risk containment, but directed at credit consumers, continue to be largely unexplored (let alone exploited). My results indicate that the potential benefit gained by reorienting from regulating credit supply to educating credit demand may be worthwhile, notwithstanding numerous implementation difficulties.

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Monetary Policy Implications of Financial Frictions in the Czech Republic[2]

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Having witnessed the consequences of the financial crisis for the real economy, we try to evaluate the relevance of macro-financial linkages in the case of the Czech Republic. We focus on the interest rate spread as a key factor that makes monetary authority actions ineffective at times of adverse risk conditions and limited interest rate pass-though.

Specifically, in the case of the Czech Republic, the financial crisis hit the economy via a slump in foreign demand. The lowered policy rates were not entirely transmitted into interbank rates and on into bank interest rates. These remained at pre-crisis levels and banks were reluctant to loosen their credit conditions since they needed to compensate for increasing default rates at that time. This increased interest rate spread, which we measure as the difference between interbank market rates and bank interest rates[3] is one of the key factors weakening the effectiveness of monetary policy in reviving the economy. Understanding the implications of financial frictions for economic dynamics is the main focus of the paper.

It turns out that the financial accelerator approach (see Bernanke et al., 1999) constitutes a channel through which recent events can be explained. Our paper therefore follows this approach. We try to explain recent events by relying on a model of Christiano et al. (2011 – CTW, for short), which assumes financial frictions in the bank lending channel besides the traditional standard macroeconomic channels, of which the exchange rate matters the most in the case of a small open economy. This model was originally developed for the Swedish economy, so we first adjust the model structure to fit the Czech specifics. Second, we estimate the model using so-called Bayesian techniques. Lastly, we describe the dynamics of the model variables as a response to a financial shock. Also, we carry out a pair of forecast exercises to reveal the differences in forecasting behaviour between the model with and without a financial frictions block.

Banks in this model do not have an active role because they only function as intermediaries. Entrepreneurs are risk-taking agents who borrow from a bank and invest in capital. Upon successful investment, they profit from a positive return on capital net of the bank loan and interest. Entrepreneurs also face shocks to their return on capital, which can either increase or reduce the final return on capital. The model also features the costly state verification approach, in which banks face costs in determining whether defaulted clients really have gone bankrupt and thus are unable to pay back their loans. Unlike in the original Swedish estimation, the Bayesian

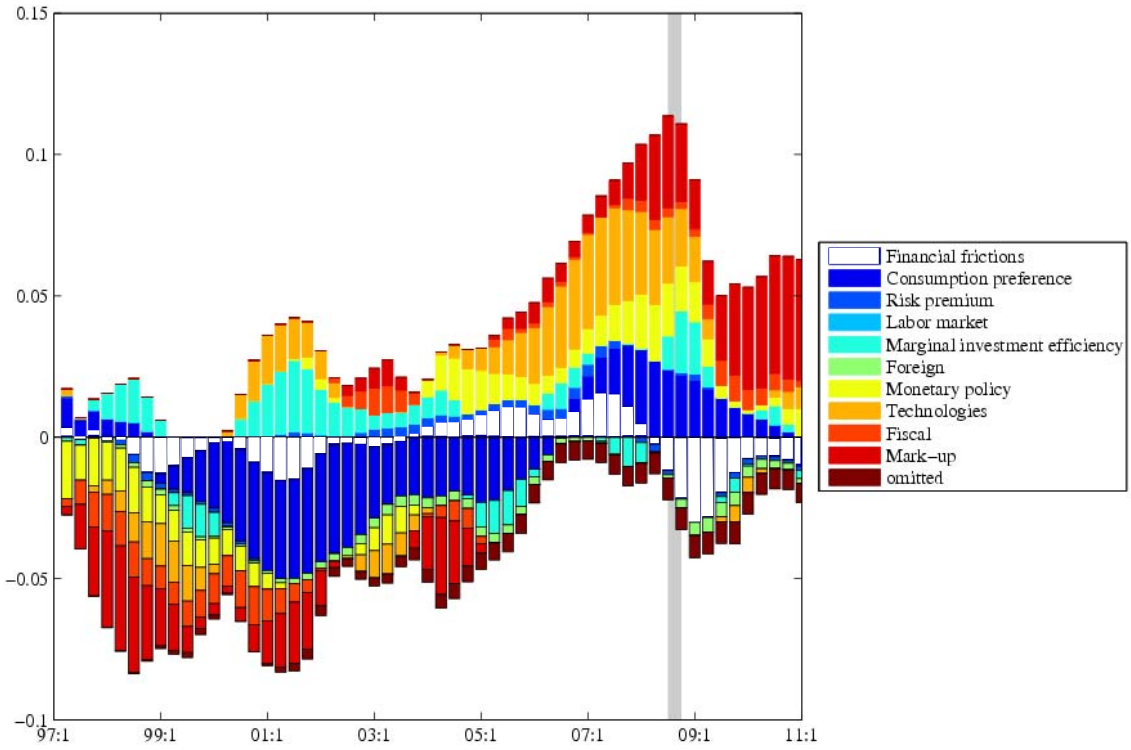
[2] This article is based on Ryšánek et al. (2011).

[3] It is not easy to choose a single measure of the interest spread. Ryšánek et al. (2011) provide a discussion on this issue.

estimation of the parameter measuring banks' monitoring costs indicates that banks lose roughly 1/3 of the amount that they would otherwise receive in the absence of monitoring costs. This proportion is lower than in the Swedish case.

To uncover whether financial frictions help to explain a substantial portion of the business cycle in the Czech Republic, we use our model and construct ex post decomposition graphs for relevant model variables (see scaled GDP[4] shock decomposition in Figure 1 – the shaded grey area in the graph marks the beginning of the economic downturn due to the financial crisis). The effect of financial frictions on economic fluctuations does not stay constant over time. The importance of financial friction for macroeconomic fluctuations increases during periods of high interest rate spreads, while its implications are limited at times when the interest rate spreads are relatively low. This can be best seen from the shock decomposition of relevant endogenous variables, as financial shocks do not dominate for the most of the time, but increase in magnitude hand in hand with the economic crisis of 2009. This is especially true in the case of real investment together with real imports, due to the fact that a significant portion of investment is imported into the Czech Republic.

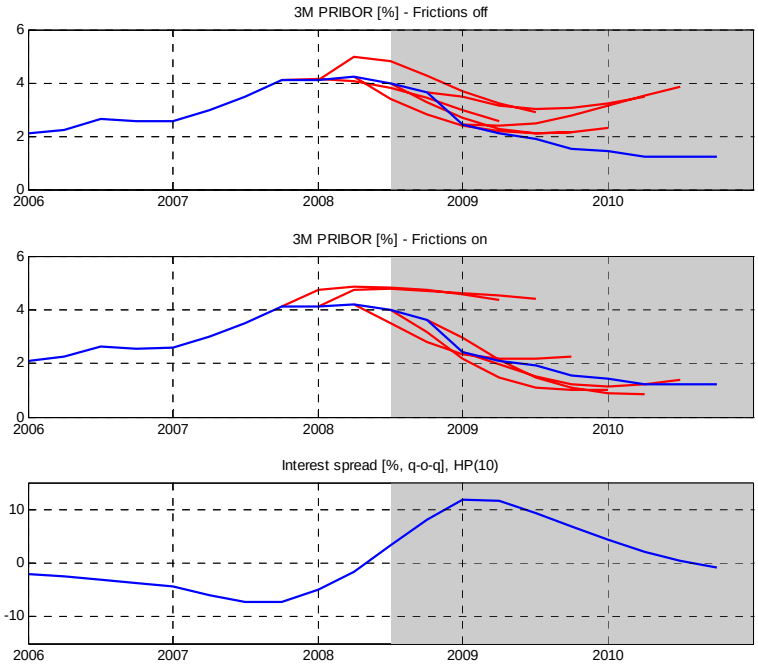
Figure 1. Scaled GDP shock decomposition – shaded area marks period of economic downturn.



[4] Scaled GDP is the trend-adjusted level of GDP.

To explore the influence of financial frictions, we conduct a pair of experiments to reveal the extent of macro-financial linkages in the Czech Republic. First, we run pre-crisis forecasts with the CTW model with and without financial frictions. Next, we compare these two versions of our model with the actual development of the interest rate. The results suggest that the monetary authority should react faster with policy rate cutting when financial frictions are taken into consideration. Second, we investigate whether the effects of financial frictions are time dependent. On a series of recursive forecasts we demonstrate that the effect of financial frictions seems to be limited at times when the interest rate spread is relatively low, since the CTW model with and without frictions shows similar behaviour (Figure 2). The difference in the forecasting power between these two models becomes significant as the interest rate spread increases.

Figure 2. Recursive forecast exercise – shaded area marks period of rising interest spread



The potential use of this paper in policy analysis is twofold. First, the forecasting process of the Czech National Bank could be enhanced with the use of a satellite model which explicitly takes into consideration financial frictions based on the empirical findings that we propose. Second, such a model could serve as a tool for generating adverse scenarios during stress testing of commercial banks' credit portfolios.

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Does Central Bank Financial Strength Matter for Inflation? [5]

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Do central banks' finances affect their policy performance? This question has been relevant for several central banks in catching-up economies – including the Czech National Bank – that have experienced negative equity. More recently it has become topical for advanced economies, too, as their central banks have increased their financial exposures considerably due to anti-crisis measures.

The answer to this question is neither easy nor uncontroversial. There are numerous historical examples – typically associated with quasi-fiscal operations – when central bank financial weakness has become so serious that the pursuit of monetary policy objectives has been clearly affected. Nonetheless, for most central banks, financial losses or even negative equity have no direct implications. As a monopoly issuer of money, a central bank can hardly become illiquid in the domestic currency. Central banks are also typically not subject to standard bankruptcy procedures, and zero is thus not a legally binding constraint for their equity. Finally, the right to collect seigniorage means that central banks' financial strength typically goes beyond their equity. There are thus countries – such as Chile, the Czech Republic, Slovakia, Israel, Mexico and Thailand – that have successfully achieved low inflation irrespective of their negative central bank equity.

However, it is argued that central banks' finances could have an impact on their policies due to soft considerations, such as political independence and reputation. A government may try to limit the autonomy of a loss-making central bank, as the losses do have long-term fiscal implications and their origins may be viewed as controversial. To avoid such negative consequences, a central bank may abstain from potentially loss-generating activities, or try to improve its finances by allowing higher inflation once the losses have occurred.

The empirical evidence on this subject is unfortunately very scarce. One notable exception is the paper by Klüh and Stella (2008). The authors found a relatively stable and robust negative relationship between central bank financial strength and inflation, but at the same time suggested that only a relatively strong impairment of the central bank's balance sheet would result in a significant worsening of inflation performance. Another recent contribution is by Adler et al. (2012), who suggest that central bank financial strength can be a statistically significant factor explaining large negative interest rate deviations from a forward-looking Taylor rule.

In our own paper, we extend the analysis of Klüh and Stella (2008), providing an in-depth robustness check of their results. First of all, we use a broader and more recent data sample covering 105 countries worldwide between 2002 and 2009. Second, we enrich the set of variables approximating the financial strength of central banks. Third, we use alternative control variables and employ econometric techniques better suited to a panel data set-up. Fourth, in some of our

[5] This article is based on Benecká et al. (2012).

estimates, we explore whether the strength of the relationship between central bank finances and inflation outcomes depends on the degree of legal central bank independence.

To cope with the accounting and economic difficulties of finding a suitable proxy for central bank financial strength, and as a robustness check, we use four alternative measures, referring both to central banks' balance sheet situation and to their profitability:[6]

1. **The ratio of equity to total assets (ETA)**, which indicates the relative proportion of a central bank's assets financed by its own resources.

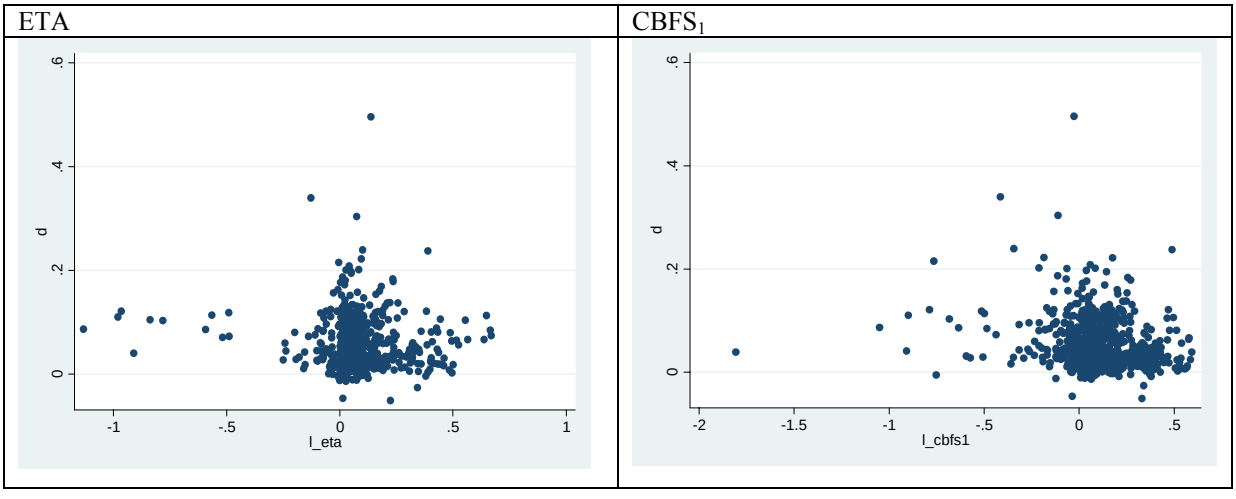
2. **"Broadly-defined" capital to total assets ($CBFS_1$)** as in Klüh and Stella (2008), providing a more comprehensive definition of financial strength compared to ETA, as it also contains "other items net", which reflect – inter alia – specific accounting and reporting practices.

3. **The ratio of net non-interest bearing liabilities (NNIBL) to total assets**, which is given by equity plus the difference between other non-interest bearing liabilities and non-earning assets (including fixed assets), divided by total assets. This is a measure of financial strength that should capture the overall earning potential of a central bank, including seigniorage.

4. **The return on average assets (ROAA)**, which is the commonly used profitability measure.

Figure 1 provides the first look at the empirical link between (two out of the above four) central bank financial strength variables and a rescaled measure of inflation *d*.[7] The scatter plots show that there is no apparent relationship between the financial strength ratios and the measure of inflation *d*. In the case of ETA, high inflation outcomes appear even in countries with positive central bank equity, while there are some counties with negative equity and modest inflation rates. It is true, however, that in countries with a negative equity ratio at or beyond -0.5, inflation is usually elevated. Concerning the $CBFS_1$ measure, the results again do not show any clear correlation between central bank finances and inflation. In particular, the correlation is only weakly and insignificantly negative at around -0.25. There are countries that have achieved modest inflation rates even with a significantly adverse balance sheet situation. A similar level of negative correlation exists between NNIBL (not shown here) and the rescaled measure of inflation *d*. The analysis also suggests no relationship between ROAA and inflation.

Figure 1. Financial strength indicators (lagged by one year) and inflation (*d*)



[6] As a fifth measure we also used the return on average equity (ROAE), but it was insignificant in all estimates and is thus not reported here. We used the BankScope database as our key data source, except for the Klüh and Stella (2008) measure of financial strength, $CBFS_1$, which was computed using data from the IMF's IFS database.

[7] Defined as $d=\pi_t/(1+\pi_t)$, where π_t is the annual inflation rate.

Source: BankScope, IFS, own calculations (pooled samples; 2002–2009)

A more reliable analysis of the relationship between central bank financial strength and inflation, however, needs to control for the impact of other variables on inflation. Following Calderon and Schmidt-Hebbel (2008), we employed a range of control variables, which in most cases turned out to be statistically significant, with the results being quite stable for alternative models. The global price of oil was found to have a substantial effect on inflation worldwide with the expected positive sign. The level of economic development lowers inflation, and so does financial account openness. Introducing a fixed exchange rate regime tends to lower inflation. The impact of inflation targeting goes in the same direction and is even stronger.

The results for the central bank financial strength measures using four different estimation techniques are summarised in Table 1. The alternative techniques were used as a robustness check and to deal with some crucial econometric issues (unobserved country characteristics, non-normality, heteroscedasticity and autocorrelation of residuals, reverse causality).

Table 1. Econometric analysis of the link between central bank financial strength and inflation

	Financial strength measure			
Econometric technique	$CBFS_1$	NNIBL	ETA	ROAA
Pooled OLS	☑	☑	–	–
Panel fixed effects	–	☒	☒	☒
PCSE with a common AR(1) term	– / ☑	–	–	–
System GMM	–	–	–	☑

Notes: ☑ denotes a significantly negative (i.e. worse financial strength results in higher inflation) coefficient; ☒ denotes a significantly positive coefficient; – denotes an insignificant coefficient.

As can be seen, the empirical results for the link between central bank financial strength and inflation are not as robust as suggested by the earlier literature. Starting with the pooled OLS method for the sake of comparability with Klüh and Stella (2008), the two broader measures of central bank financial strength – $CBFS_1$ and NNIBL – have the expected significantly negative coefficients, while the other two indicators (ETA and ROAA) are not statistically significant. Moreover, when accounting for unobserved country characteristics using the panel data fixed effects estimations, the results become counterintuitive. The coefficient for $CBFS_1$ is not significant, while the other three measures of financial strength have significantly positive coefficients, probably due to the reverse causality problem. When we improve the estimation method using a panel-corrected standard error (PCSE) estimator with a common autoregressive term, none of the financial strength indicators seem to play a significant role.[8] Finally, when we account for endogeneity with the System GMM method, only the coefficient for ROAA is (weakly) statistically significant with the intuitive negative sign.

Overall, there is no financial strength indicator that has a significantly negative coefficient for all econometric techniques. In general, the explanatory power of the central bank financial strength indicators for inflation appears weak, with the control variables playing a more important role.

[8] With a slightly modified set of control variables, $CBFS_1$ became significant at the 10% probability level.

We also tested the hypothesis that a higher degree of central bank independence (CBI) could shield the monetary authority from the political-economy consequences of its financial performance and thus weaken the link between central bank financial strength and inflation. However, only the interaction term NNIBL/CBI turned out to be statistically significant in the pooled OLS regressions. The analysis thus provides only weak support for the idea that more independent central banks might be able to care less about their balance sheets in pursuing their policy goals.

Finally, we analysed the potential non-linearity of the investigated relationship between central bank financial strength and inflation. For two measures of balance sheet strength ($CBFS_1$ and NNIBL), we found that only a strong balance sheet impairment has an upward effect on inflation in the OLS estimates, in line with the conclusions of Klüh and Stella (2008). At the same time, the expected significantly negative relationship is found only for countries with relatively high inflation rates and low central bank independence. Using the System GMM method, ROAA (and to some extent also ETA) is associated with significantly higher inflation only when it gets very weak.

To sum up, we find that the link between central bank financial strength and central bank performance in containing inflation is either absent, or weak and not robust. Other inflation determinants play a more important role. Our findings thus contrast with the existing literature on this issue.

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Monetary Conditions and Banks' Behaviour in the Czech Republic[9]

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One of the factors often mentioned as a cause of the recent financial turbulence has been the relaxed monetary policy of major central banks, which might have increased financial institutions' appetite for risk. Because of imperfect information, incomplete contracts and imperfect bank competition, it is a widely held idea that monetary policy may affect loan supply (the so-called credit channel of monetary policy). In particular, expansionary monetary policy may increase bank loan supply either directly (the bank lending channel) or indirectly by improving borrower net worth and, hence, by reducing the agency costs of lending (the balance sheet channel – see Bernanke et al. 1996, or Matsuyama, 2007). Recent theoretical work shows that changes in short-term interest rates may also affect risk-taking by financial institutions. This effect has been labelled the "risk-taking channel" of monetary policy following Borio and Zhu (2007) and can be considered a salient and distinguishable part of the credit channel too (Diamond and Rajan, 2006; Stiglitz and Greenwald, 2003).

Borio and Zhu (2007) advocate that the policy rate may affect the risk tolerance of banks due, for example, to the presence of "sticky" targets for rates of return. Banks targeting rigid rates of return would reach out to riskier borrowers to recoup their drop in profits at times of monetary expansion. Dell'Ariccia and Marquez (2006) suggest that lower interest rates decrease financing costs, thus banks' motivation to screen borrowers declines, which in turn may result in them accepting riskier applicants. Another reason could be a reduced threat of deposit withdrawals at times of excess liquidity, as in Diamond and Rajan (2006). Lower interest rates generate more liquidity in the banking sector, which provides less of an incentive for depositors to withdraw and more of an incentive for banks to finance risky projects. Other theoretical contributions linking interest rates and risk-taking behaviour include Hellman et al. (2000), Stiglitz and Greenwald (2003) and Rajan (2006). However, some of them lead to conflicting theoretical implications, so that the impact of short-term interest rates on risk-taking is ultimately a critical empirical question.

As to the empirical investigations of the impact of monetary policy on bank risk-taking behaviour, Ioannidou et al. (2007) and Jiménez et al. (2008) provide empirical evidence on the

[9] This article is based on Geršl et al. (2012).

link between monetary policy rates and banks' risk-taking behaviour using micro-level data from credit registers in Bolivia and Spain respectively. Both studies find that in the short run a lower short-term interest rate augments banks' appetite for risk, while the medium-term effect is a decrease in credit risk for existing bank portfolios. In the longer term, however, the former effect dominates, so that the two effects jointly yield a net increase in the risk incurred. The analysis of Bolivian banks' appetite for risk is differentially developed in Ioannidou et al. (2009), where the authors additionally explore the pricing of credit risk.

Our study follows the methodology of Jiménez et al. (2008), using loan-level data on non-financial corporations in the Czech Republic from the credit register operated by the Czech National Bank (CNB). We pose two main and distinct research questions that relate the monetary policy stance and bank risk-taking. First, we examine whether lower interest rates promote more lending to borrowers with a riskier past. However, such behaviour does not necessarily reflect a change in risk appetite, as it could be attributed to higher current net worth of previously riskier borrowers and could thus be partly indicative of the existence of a balance sheet channel. Second, we thus investigate whether lower interest rates encourage banks to incur more risk by accepting borrowers with a higher probability of default. In addition to these two main questions, we test whether all types of banks are equally affected by the monetary policy stance. In this vein, we also study the impact of the interest rate conditioned on bank characteristics such as balance sheet liquidity, capital adequacy and lending strategy diversification. Again, neither the theoretical literature nor the available evidence suggests a clear relationship between liquidity, capital and loan portfolio diversification on the one hand and risk-taking on the other hand.

The dataset constructed to answer the research questions is based on a random sample of 3% of corporate borrowers that obtained a new loan between October 2002 and January 2010. This amounts to more than 200,000 loan-period observations. The monthly data on loan characteristics (including information on whether loans are past due) are taken from the credit register of the CNB. This data is subsequently matched with information on borrowers taken from the Magnus database maintained by CEKIA, which are mostly at annual frequency. We also employ monthly bank-level data originating from the CNB's internal database. Finally, aggregate data such as GDP growth, interest rates, the exchange rate and inflation are used from the macroeconomic databases of the CNB, the Czech Statistical Office and the ECB.

The key explanatory variable of interest is the short-term interest rate. There are several options to choose from. A good candidate is the CZEONIA overnight interest rate, as it is a weighted average of O/N rates on trades executed in a given day and, as such, reflects real money market trading among Czech banks, unlike PRIBOR rates, which are reference rates based on banks' quotations and not real trades. Moreover, the O/N segment is the most liquid part of money market trading. However, in order to properly capture the effect of the monetary conditions on credit risk both on the date of loan origination and during the life of individual loans, we have to control for potential reverse causality and endogeneity of the monetary conditions represented by CZEONIA. CZEONIA, mirroring the official 2W repo rate of the CNB, may itself strongly depend on the level of credit risk in the banking system, as the central bank might react to worsening economic conditions and an increase in bad loans in banks' portfolios by decreasing the official CNB repo rates. Furthermore, if we happen to ignore controls correlated with both the Czech monetary stance and Czech banks' risk-taking, our analysis would suffer from omitted variable inconsistency. Thus, we use the euro area rate EONIA as an instrument, or alternatively

a proxy, for CZEONIA. The tests applied confirmed that EONIA is a valid instrument for CZEONIA, reflecting the strong correlation between these two rates as discussed above.

The first research question is addressed within the probit framework. We estimate the likelihood that a borrower with observable past non-performance obtains a new loan, conditioning on selected bank, loan, firm and macroeconomic variables. Among those explanatory variables, the interest rate prior to loan origination is of primary interest to us. We treat all firms with overdue loans six months prior to new loan origination as borrowers with a bad credit history and, thus, ex-ante riskier. The results suggest somewhat surprisingly that expansionary monetary policy encourages Czech banks to grant fewer loans to borrowers who exhibited a recent bad credit history prior to loan origination. The results also indicate that larger banks, ceteris paribus, are less prone to lend to firms with a recent bad credit history, as are banks holding more liquid assets or banks with higher than average non-performing loan ratios. The estimation output suggests that less leveraged banks (i.e. more capitalised banks) are likely to grant loans to borrowers with a risky past.

A possible explanation of the link between low interest rates and lower probability of granting loans to borrowers with a riskier past might be the specific time period for which the analysis is done. The rises and falls of money market rates (mirroring the CNB repo rate) between 2002 and 2010 happened under different conditions which were probably not taken fully into account by the control variables. In the expansionary period of 2002–2004, the major domestic banks had just been cleared of non-performing assets and started to refocus their business on household loans. In this sub-period, corporate loans were declining and banks were not keen on providing new loans to corporations with a bad credit history despite the monetary expansion, effectively decreasing their risk-taking. The monetary expansion in 2007–2009 was a reaction to the global economic crisis and the economic recession in the euro area, again a period when banks were not keen on financing risky borrowers. In the period of monetary tightening 2005–2007, which was itself a reaction to accumulating inflation pressures due to the strong economic and credit boom in those years, banks strengthened their risk-taking owing to both competitive pressures and overall optimism in the economy, relaxed their lending standards and fuelled the credit boom even further, despite increases in money market rates. These structural factors are likely to have produced the puzzling positive relation between interest rate levels and banks' appetite for risk.

As to the second research question, a survival analysis is applied and duration models of loan defaults estimated. The duration analysis enables us to capture the changing conditions over the loan life and examine the impact of the monetary policy stance on the riskiness of new loans as well as its effect on the existing loan portfolio. Such a treatment emphasises that there is a dynamic element to loan performance and that defaults differ at different points of the loan "life". Therefore, our hazard rate models comprise not only the interest rate measured prior to loan origination, but also the interest rate prior to loan default or maturity.

Our survival analysis indicates that expansionary monetary conditions promote risk-taking among banks. At the same time, a lower interest rate reduces the riskiness of outstanding loan portfolios. The impact of monetary policy on risk-taking varies with bank profiles. The negative association between bank risk appetite and liquidity shows that banks accumulating liquid assets tend to be more prudent and grant less hazardous loans. Neither the effect of portfolio

diversification nor the capital position of individual banks proved to be significant in the duration models.

The results of our analysis offer important policy lessons for the macroprudential policy of central banks, which – ideally – need to take into account the consequences of the monetary policy stance regarding bank risk-taking.

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Banks' Capital and Liquidity Creation: Granger Causality Evidence[10]

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Recent financial turmoil has led the Basel Committee on Banking Supervision to propose new capital rules, commonly known as the Basel III reforms, which, among other things, introduce tighter capital requirements to improve the resilience of the banking industry.

Our research contributes to assessing the economic implications of the increased capital requirements in the Basel III reforms. The potential costs of these reforms have been assessed by international organisations. For instance, a BIS study by Angelini et al. (2011) estimates that an increase of 1 percentage point in capital requirements leads to a 0.09 percent decline in output, and an OECD study by Slovik and Cournède (2011) concludes that increased financing costs from following the new capital requirements reduce GDP growth by between 0.05 and 0.15 percentage point annually. However, neither study explicitly considers the potential costs of reduced liquidity creation.

Liquidity creation 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. Thus, the higher capital requirements imposed by Basel III may have a negative impact on liquidity creation by the banking sector and reduce the ability of the banking sector to finance the economy and facilitate transactions between economic agents. Furthermore, this concept of liquidity creation accounts for both the on- and off-balance sheet activities of banks. Therefore, this new liquidity creation measure is used instead of other indicators that only capture a bank's lending activity (e.g. the credit-to-total-assets ratio).

The literature on bank liquidity creation remains scarce and follows Berger and Bouwman's (2009) pioneering article. Their paper makes a contribution by suggesting a new method for measuring the liquidity created by banks. They propose a classification of all balance sheet items as liquid, semi-liquid and illiquid. This applies to all items in a bank's assets, liabilities, equity and off-balance sheet activities. The authors then assign weights to all of the items and compute the amount of liquidity created by each bank.

In our paper, we compute the volume of liquidity creation for Czech banks using a comprehensive data set from the Czech National Bank from 2000 to 2010. We largely follow the methodology of Berger and Bouwman (2009).

[10] This article is based on Horváth et al. (2012).

We observe a strong expansion of liquidity creation in the Czech banking sector during the full examined period. The aggregate volume of liquidity creation, when using both the on- and off-balance sheet item measures, increased in real terms from CZK 357.1 million (approximately USD 20.2 million) in 2000 to CZK 1,293.8 million (approximately USD 73.1 million) in 2010. The ratio of liquidity creation to assets more than doubled from 15% in 2000 to 33% in 2010.

Using our liquidity creation measure, we study the interactions between capital and liquidity creation in the Czech banking industry using Granger causality tests. We show that capital negatively Granger-causes liquidity creation. However, we also observe that liquidity creation Granger-causes capital reduction. We thus support the view that there might be a negative, bi-causal relation between capital and liquidity creation, which corroborates the importance of examining this causality. 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.

The Czech Republic is a former transition country and is now an EU member. The vast majority of Czech banks are foreign-owned. Thus, the results found for this country can be generalised to countries with high levels of foreign ownership of banks (as is typical in many Central and Eastern European countries) rather than to other countries.

Our findings have two policy implications. First, they suggest that the Basel III Accords may lead to reduced bank liquidity creation by introducing tighter capital requirements. As a result, these new rules may contribute to the creation of alternative economic difficulties by reducing liquidity creation, i.e. financial intermediation by the banking sector, which may slow economic growth by reducing the amount of available financing. Second, our findings support the view that excessive 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 those of greater liquidity creation. Therefore, any action in favour of one objective would deteriorate the other. We are fully aware that our findings may be dependent on our sample and may not be easily generalisable. However, the Basel III rules increasing capital requirements are planned to be implemented for a vast array of countries, including the one examined here and others that are similar. In any case, the task of deepening our understanding of the relation between capital requirements and liquidity creation should occupy a high position on the bank regulation research agenda.

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Call for Research Projects 2014

The CNB Economic Research Department will announce the regular Call for Research Projects 2014 on **15 April 2013**, follow the link: http://www.cnb.cz/en/research/research_projects/

Information Meeting for Prospective Authors of CNB Research Projects will be held in the Czech National Bank's Commodity Exchange (Plodinová Burza) building on **Monday, 13 May 2013 at 14.00**.

CNB Research Open Day

The ninth CNB Research Open Day will be held in the Czech National Bank's Commodity Exchange (Plodinová Burza) building on **Monday, 13 May 2013**. This half-day conference will provide an opportunity to see some of the best of the CNB's current economic research work, to learn about the CNB Call for Research Projects 2014 and to meet CNB researchers informally.

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