THE INTERACTION OF MONETARY AND MACROPRUDENTIAL POLICIES IN THE PURSUIT OF THE CENTRAL BANK'S PRIMARY OBJECTIVES

Jan Frait, Simona Malovaná, Vladimír Tomšík

This article is concerned with the interaction of monetary and macroprudential policies at different stages of the financial and business cycle. We focus on identifying related channels of transmission of the two policies and potential feedback between them. Our methodology allows us to obtain information from large number of variables and thus provides a comprehensive picture of the potential impacts of a monetary easing and a macroprudential tightening. The analysis reveals that in some situations monetary policy and macroprudential policy can come into conflict in the pursuit of their objectives. It is therefore crucial to coordinate them and seek an optimal policy mix based on a detailed assessment of the economic outlook.

1. INTRODUCTION

Monetary policy based on inflation targeting has proved to be very effective in combating inflation since it was first introduced in the 1990s. Following the economic and financial crisis of 2008–2013, however, many monetary economists and central bankers have started to ask whether the main postulates of this form of monetary policy should be revised and supplemented. Research in the fields of monetary economics and financial stability has started to concentrate much more on (re-)testing theories that try to explain the formation of economic and financial crises in terms of changes in the dynamics of monetary and credit variables, most notably bank loans (Aikman et al., 2014).[1]

In the textbook monetarist monetary policy framework, lending is predicated on the existence of deposits. Banks face a relative shortage of bank liquidity and can obtain additional liquidity from the central bank, usually in open market operations. In this framework, the central bank's ability to restrict banks' access to liquidity implies control of the amount of loans. Since loans are the main source of money, liquidity management should deliver control of inflation in the long run. However, the modern world differs greatly from the era when this framework came into being. Changes in the functioning of financial systems have eroded central banks' ability to control credit growth by managing liquidity (McLeay et al., 2014). Lending itself has started to deliver the necessary deposits. Quantitative easing and extensive purchases of foreign assets by central banks have created a large set of countries whose banking systems operate in conditions of "excess" liquidity. This access to central bank liquidity tools means that banks no longer face significant lending constraints. Such constraints are now meant to be created by macroprudential policy in addition to capital and liquidity regulation.

The incorporation of macroprudential policy into the framework for the functioning of central banks reflects a worldwide shift in the understanding of the duties of central banks. As an integrated monetary and supervisory authority since 2013, the CNB is formally responsible for implementing the objectives of both financial stability and price stability. To this end, it employs macroprudential policy tools, microprudential supervisory tools and, where necessary, regulation. As monetary policy and macroprudential policy both affect the functioning of the entire financial sector and thus of the economy as a whole, when configuring these policies the CNB has to take into account how they interact and make sure they are coordinated. The right policy mix depends on the intersection of two different cycles – the business cycle and the financial cycle.

This article is concerned with the coordination of monetary and macroprudential policies from the perspective of their real effects and their interaction at different stages of the financial and business cycle. It first defines the relationship between the two policies, focusing on identifying related transmission channels and similarities in transmission mechanisms. It then discusses the need to coordinate the two policies given the risks associated with credit growth and demand-side developments. This discussion is supported with a simulation of the effects of a monetary policy easing, a macroprudential tightening and an increase in house prices using data from the Czech economy.

1 Economic theory offers several explanations of why credit growth can exceed GDP growth at certain stages of the business cycle. A survey of these explanations is given, for example, in Mandel and Tomšík (2015).

2. THE RELATIONSHIP BETWEEN MONETARY POLICY AND FINANCIAL STABILITY POLICIES

In the early 2000s, academic economists and central bankers generally agreed that monetary policy tools should be deployed to deliver price stability while microprudential regulation and supervision should be used to achieve financial stability (Bernanke, 2002). It was also thought that the central bank should respond to financial market and asset market developments only insofar as they affected inflation. In response to the financial crisis, a consensus emerged that macroprudential policy tools needed to be added to the traditional approaches of microprudential regulation and supervision. It was also accepted that price stability alone was not enough for maintaining financial stability. In this context, there was renewed discussion about whether the central bank should take the risks to financial stability into account in its monetary policy tools even when the current forecast does not indicate any risks to price stability over the monetary policy horizon (Frait et al., 2011; Woodford, 2012). A full consensus on this issue has not been reached so far. However, this article does not seek to answer this question and focuses instead on macroprudential and monetary policy coordination.

The need for such coordination is based on the observation that monetary and macroprudential policy tools are not independent, as they affect both the monetary and credit conditions via their effect on credit growth.[2] In some situations the two can come into conflict because of a need for them to work in opposite directions, while in other situations it may be desirable for them to act in the same direction. This makes it necessary to analyse their interactions at different stages of the financial and business cycle and to coordinate them where appropriate (Borio, 2014; IMF, 2013).

Monetary and macroprudential policy coordination is superfluous in pre-crisis general equilibrium models, as such models contain no financial frictions, asymmetric information and non-linearities. In such a framework, it is optimal for the monetary authority only to react to macroeconomic developments by changing the monetary conditions. In reality, though, macroprudential policy tools cannot eliminate all the frictions, shocks and imbalances that exist in financial markets. In this situation, the financial conditions are also important for monetary policy-makers (Woodford, 2012; Adrian and Liang, 2014).

Financial market conditions have been partially incorporated into general equilibrium models in response to the financial crisis. In these models, it is the job of monetary policy to control the risk-free interest rate and that of macroprudential policy to control the credit risk premium (Baillu et al., 2012). However, these models remain highly stylised and necessarily abstract from many important economic linkages and transition mechanisms. Consequently, they cannot fully capture the interactions between monetary and financial conditions and the simultaneous effects of monetary policy on financial stability and of macroprudential policy on macroeconomic developments. In addition, the short period of use of macroprudential tools in advanced countries means there is limited empirical evidence on their effectiveness and side-effects.

The models central banks currently use to analyse macroeconomic developments, formulate monetary policy recommendations and simulate changes in monetary conditions work primarily with the interest rate and exchange rate channels of the transition mechanism (Tovar, 2008; Franta et al., 2014). However, anything that affects the availability and price of credit also affects credit growth and thus also monetary policy transmission. Changes to monetary policy tools hence also act via the credit demand and supply channels, the asset price channel and the risk-taking channel (for details, see Égert and MacDonald, 2009).

The *bank lending channel* acts via the bank credit supply. It is based on a mechanism whereby the monetary authority influences the cost of financing and banks' access to funding sources. As the monetary policy rate decreases, so do banks costs' of raising funds on the money market. As a result, banks can lend more – and more cheaply – to households and firms. Households and firms that might have been rated as too risky before the monetary policy easing now have access to credit. The *bank capital channel* has a similar effect – easier monetary policy increases banks' profitability, leading to higher capitalisation and a greater ability to lend.

The *balance sheet channel* acts through asset prices and affects the ability of households and firms to obtain credit. A decrease in interest rates leads to an increase in the prices of assets that can be used as collateral when applying for a loan (Bernanke and Gertler, 1989). This reduces the mark-

2 Macroprudential policy affects the capital market conditions as well as the credit conditions, i.e. the overall financial conditions. However, given the banking sector's dominant role in the Czech financial sector, this article focuses for simplicity on the credit conditions.

up that borrowers have to pay for external financing. The resulting increased demand for credit gives rise to an acceleration in credit growth and subsequently also in consumer and investment demand.[3]

Through the *asset price channel*, lower monetary policy rates lead to a rise in asset prices, thereby increasing the perceived wealth of households. This, in turn, is reflected in higher household consumption. In the case of firms, equity prices go up, implying a reduced cost of corporate capital for investment financing (the "Tobin's q" effect).

In recent years, economists have been devoting considerable attention to the *risk-taking channel*, which focuses on the behaviour of financial institutions. In the short run, a monetary policy easing enhances the stability of banks, as low interest rates improve the overall quality of their loan portfolios.[4] In the long run, however, low rates can give banks a greater incentive to expand their balance sheets and invest in more risky assets in an effort to attain their original target rates of return equal to their original interest margins (Diamond and Rajan, 2012). This occurs through higher lending coupled with softer lending conditions (Borio and Zhu, 2008). In the long run, cutting policy rates to very low levels affects loan quality as well as quantity (Maddaloni and Peydró, 2013).[5] Banks' liability-side risks also increase. The proportion of market-based funding with compressed risk premia goes up, as does the amount of maturity transformation (Adrian and Shin, 2010; Adrian and Liang, 2014).

The complexity of the transition mechanism means that changes in the key monetary policy tool, the short-term interest rate, can act simultaneously via various channels differing in strength according to the current position of the economy in the financial and business cycle, the structural characteristics of the financial system and other characteristics of the economy. Changes in credit conditions can also affect certain transmission mechanisms. By contrast, a change in the cyclical component of the macroprudential conditions affects not only the lending conditions, but also the monetary conditions via the lending and asset price channels. A tightening of a macroprudential tool will affect the price and availability of credit. This can impact on the balance sheets of households and firms and subsequently on demand in the economy.

Under certain conditions, conflicts can arise between monetary policy pursuing an inflation target on the one hand and credit stability on the other. Let's look at some examples. First, low and stable inflation and resulting low nominal interest rates can paradoxically lead to a situation where banks and their clients start perceiving risks as being low on average. A relaxation of lending standards and a reduction in risk premia lead, ceteris paribus, to a rise in the prices of financial and real assets used as collateral. These processes produce an acceleration in credit growth, which can potentially result in overleveraging of the economy when the perceived low risk turns out to be just an illusion. So, under certain conditions, price stability can foster financial instability.[6]

Second, an interest rate cut in response to disinflationary pressures can fuel asset price bubbles. The economy may be exposed to a positive supply shock due, for example, to technological progress or lower global commodity prices. Alternatively, an economic recovery may prompt foreign investors to significantly and positively revise their view of the outlook for the domestic economy, causing its currency to appreciate. The inflation forecast will fall below the inflation target and the inflation-targeting central bank will respond by cutting policy rates. A potential side-effect of the combination of optimistic growth forecasts, a strong currency and falling interest rates is growth in prices of financial and real assets and the subsequent emergence of self-fulfilling expectations, which can give rise to speculative bubbles.

Third, in a small open economy with high cross-border capital mobility, misplaced expectations about the stability of the domestic currency can be a source of conflict between inflation targeting and financial market stability. Imagine a situation where the central bank raises its policy rates in an attempt to stop inflation rising above the target in the future. With interest rates on domestic currency loans rising, borrowers may redirect part of their demand to "cheaper" foreign loans. If, however, the foreign currency strengthens

3 This phenomenon has long been known and is referred to in the literature as the financial accelerator.

4 Easing monetary policy by cutting short-term interest rates also supports the profitability of banks. Banks' funds tend to have shorter maturities than their assets. A reduction in rates therefore leads to a rapid decrease in funding costs relative to asset yields.

5 The financial crisis also confirmed the assumption that the sustainability of such changed balance sheets is conditional on interest rates being low. If a crisis occurs, rates will have to be kept low or cut even further to maintain banks' ability to lend to the private sector.

6 For example, a monetary policy easing will reduce interest rates on house purchase loans. This will support construction and investment in housing. Growth in house prices can further boost consumer demand via the wealth effect. However, if households gradually take on too much debt and overestimate their ability to service their loans after interest rates go up, they and their banks will become vulnerable.

significantly, unhedged borrowers will see their debt service costs increase and many of them may default. The Hungarian economy has been hard hit by the materialisation of this risk in recent years. Likewise, the sharp appreciation of the Swiss franc in early 2015 has hurt borrowers in Croatia, Poland and Austria.

3. MONETARY POLICY AND MACROPRUDENTIAL POLICY: RIVALS OR TEAMMATES?

A fierce debate on the interaction of monetary and macroprudential policies erupted in 2013 in connection with the accommodative monetary policy being pursued by the Federal Reserve, the ECB and the Bank of England coupled with a strong recovery in property markets and some financial market segments. Many commentaries were published on the contribution of the sustained easy monetary conditions to inflated prices of houses and some other assets, the greatly increased activity on the corporate bond market, inadequate risk assessment and the compression of yields on debt securities (BIS, p. 3; IMF, pp. 6–8; ECB, p. 37). The prevailing conclusion of this debate is that the potential undesirable effects of easy monetary policy on the risks to financial stability can be largely mitigated by applying suitable macroprudential tools in good time. However, concerns have been voiced that more aggressive use of such tools could neutralise the effects of accommodative monetary policy and foster deflationary pressures. This risk is also indicated by the simulation of the effects of an increase in the capital adequacy ratio contained in the next section.

The existence of a potential conflict between monetary and macroprudential policies, the strength of that conflict, and the optimum policy mix for minimising it, all depend on which phase of the financial and business cycle the economy is in (Borio, 2014) and on what sorts of shocks the economy is currently exposed to. These factors determine the strength of the relative risks associated with credit growth on the one hand and demand-side developments on the other. Table 1 describes suitable combinations of responses of the two policies. At first glance, these combinations may seem logical and uncontroversial. Sometimes that is indeed the case, but at other times it can be very hard to decide on the right mix in reality. If the economy is starting to climb out of recession and emerge from a banking crisis, easing both policies works in a single, common direction, since inflation pressures and risk-taking are both at a low level. The easy monetary policy does not compress risk premia and does not encourage excessive risk-taking. If the economy is in a phase where credit growth is accelerating and financial imbalances are starting to form, maintaining easy monetary policy may initially help further improve the current financial risk indicators (primarily by reducing the default rate), but may simultaneously generate latent risks that could later manifest as a sharp deterioration in loan portfolio quality (see Frait and Komárková, 2012, p. 17). Both policies should be kept neutral, or one of them – macroprudential policy – should be tightened.

The policy combinations in Table 1 should be regarded as dominant, but not always optimal and attainable. Other combinations may be desirable or necessary in some circumstances. At times of weak demand and falling leverage, a macroprudential policy easing will tend to bolster the transmission of easy monetary policy, help eliminate overly pessimistic expectations and stabilise the financial sector, and foster economic recovery. However, this effect is

TABLE 1

INTERACTION OF POLICIES AT DIFFERENT STAGES OF THE FINANCIAL AND BUSINESS CYCLE

		Inflationary pressures		Disinflationary pressures	
		Strong demand	Weak demand	Strong demand	Weak demand
Rapid credit growth and rising asset prices	Monetary pol.	Tightening > IT	Tightening	Easing< IT	Easing
	Macroprud. pol.	Tightening	Tightening	Tightening	Tightening
Decline in credit and falling asset prices	Monetary pol.	Tightening	Tightening < IT	Easing	Easing> IT
	Macroprud. pol.	Easing	Easing	Easing	Easing

Source: CNB
Note: Some combinations are unlikely. The symbols > IT and < IT denote monetary policy responses that are, respectively, stronger and weaker than those needed to attain the inflation target. Green boxes = policies complement each other. Red boxes = policies potentially conflict. Combinations where inflation is close to the target, loans are growing at a reasonable rate and asset prices are at normal levels are not shown in the table, as in these cases the responses of the two policies will be moderate and will not interact significantly.

contingent on the financial sector being in relatively robust health at the time. If the sector is very weak, a macroprudential policy easing could undermine confidence in its stability and will not be accommodative in its effect.[7] In such case, failure to fulfil the macroprudential policy objective reduces the extent to which monetary policy can attain its objectives. The right response may thus be to tighten macroprudential policy by taking action to enhance the capital adequacy of banks, as this will safeguard the functioning of the monetary policy transmission mechanism.

From the conceptual perspective, there is no doubt about the need to coordinate the two policies in such a situation (Shakir and Tong, 2014). From the practical point of view, however, it will be very difficult for the monetary authority to decide, especially if the two policies are conducted by different authorities. This is due to different probabilities of failure to fulfil the two main objectives (Adrian and Liang, 2014). It is highly likely that the macroeconomic forecast will imply failure to hit inflation target in the short run, whereas at any given moment in time systemic risk will have the potential to materialise in the medium run only. The monetary authority's natural response will thus be to prioritise the inflation target. Preference is unlikely to be given to the financial stability objective, as this would require a consensus that the risk of a future financial crisis has exceeded a critical level. No such consensus was reached before the recent financial crisis. On the contrary, the rising systemic risks were downplayed. It is the difference between expected risks and merely potential vulnerabilities that makes the two types of policy often very difficult to coordinate in practice.

A specific problem arises when the recovery is more sustained and output is near its potential but the inflation pressures are very weak and interest rates therefore stay very low. If this situation persists, credit growth is likely to recover and demand for risky assets will increase, leading to growth in their prices. The USA and some other advanced countries started to get into a similar situation in 2013–2014. From the conceptual perspective, the right response is to partially tighten macroprudential policy, as there is an increasing risk of households and firms becoming overleveraged and the financial sector becoming more vulnerable. If this step is ineffective, the monetary policy authority may be faced with the dilemma of whether to support the achievement of the financial stability objective by preventively tightening the monetary conditions at the cost of missing the inflation target in the short run. Should central banks under certain conditions really abandon their inflation target and switch to some mode of financial or credit stability "targeting"?

As mentioned in section 2, there is no consensus among economists on whether the central bank should "lean against the wind", i.e. whether it should take the risks to financial stability into account in its monetary policy tools even when the current forecast does not indicate any risks to price stability. Many will probably agree that leaning against the wind is the right response in principle but will have doubts about whether a slight increase in monetary policy rates is an effective tool for curbing a credit boom. Some would argue that monetary policy, unlike individual macroprudential tools, can at least partially address the wide range of processes and linkages generating a credit boom. Central banks' monetary policy independence enables them to deploy monetary tools quickly, whereas the application of macroprudential tools may require them to negotiate with other authorities, overcome political resistance or change the law. Leaning against the wind as a safeguard against growth in the vulnerability of the system is supported by the existence of the "bank" channels of monetary policy transmission, especially the risk-taking channel. Woodford (2012) states that taking financial stability into account when setting monetary policy rates is merely a natural extension of flexible inflation targeting. Conflicts can arise between the price stability and financial stability objectives, but they also arise between the price stability and economic stability objectives, which are covered by flexible inflation targeting in its conventional sense.

Despite all this debate, there is a consensus that the use of macroprudential policy tools is the primary and preferred way of preventing increased financial sector vulnerability. Monetary policy tools should be used only rarely for this purpose, primarily during credit booms accompanied by soaring asset prices. In this situation, the central bank can convincingly communicate the need to set interest rates at a higher level than that fully consistent with hitting the inflation target at the monetary policy horizon. Such communication can enhance the effectiveness of macroprudential policy.

7 A similar situation occurred around 2011, when firms' access to credit worsened in some countries as a result of the systemic crisis in the euro area. To improve the situation, it was first necessary to restore confidence in the stability of banks by increasing their capital adequacy ratios.

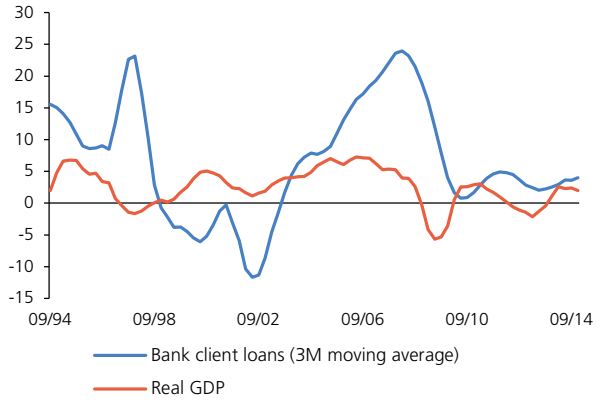
4. THE IMPACT OF MONETARY AND MACROPRUDENTIAL MEASURES IN THE CZECH ECONOMY

One of the key conclusions of post-crisis studies of the financial cycle is that sharp growth in the ratio of credit to GDP is strongly correlated with subsequent banking crises (Aikman and Liang, 2014; Borio, 2012; Schularick and Taylor, 2012). This conclusion cannot be applied mechanically in the assessment of systemic risk. In relation to the size of the domestic economy the Czech financial sector is small by international standards and its growth over the last decade has been linked largely with economic transformation and convergence. The limited significance of its capital markets also makes it less able to generate rapid growth in private sector debt. However, this does not mean the Czech economy is immune to credit booms sowing the seeds of future financial crises. In the Czech Republic, as elsewhere, bank client credit is procyclical, and the credit cycle is more volatile than the business cycle (see Chart 1). The possibility of a credit boom arising is also indicated by the observation that differences in relative changes in bank client loans in the domestic economy tend to widen with growth in relative changes in real GDP.

Disinflationary and deflationary pressures have caused central banks in many advanced economies to pursue monetary policies based on very low interest rates or on interventions to weaken their domestic currencies. In some cases, this monetary easing has been accompanied by quantitative easing. Against this backdrop, some of these economies are starting to show tendencies that might become a source of systemic risk. Some national authorities have already responded by setting non-zero countercyclical capital buffer rates or tightening their regulations on property exposures. According to CNB analyses, the Czech economy was near the bottom of the financial cycle during 2014 and lending was recovering only gradually.[8] At the same time, however, the CNB deems it necessary to deploy preventive tools for the eventuality of an overheating of the residential and commercial property markets which are able to moderate any excessive future credit expansion. For that reason, the CNB formulated a set of recommendations for credit institutions providing retail loans secured by residential property (see section 4.4).

CHART 1

ANNUAL REAL GDP GROWTH AND BANK CLIENT LOANS
(%)



Source: CNB and CZSO
Note: The 2014 Q4 GDP data represent a preliminary estimate and the data for 1994–1996 are the authors' estimate.

In light of the current situation, we simulate below the effects of changes in the monetary conditions, the capital adequacy ratio of banks and house prices. This simulation illustrates the need to coordinate monetary and macroprudential policies given the risks associated with credit growth and house price growth. For illustration, one typical tool is chosen for each policy: short-term interest rates for monetary policy and capital requirements for macroprudential policy.[9]

4.1 A VAR model with a large number of variables

We employ a Bayesian vector autoregression (BVAR) model to analyse the impacts of changes in monetary and financial conditions. VAR models are routinely used to analyse monetary transmission and as an ancillary tool in inflation forecasting. Usually, however, they work with only a few variables and cannot be used to assess the interaction of monetary and macroprudential policies. This problem can be overcome by using a large BVAR model, which allows us to conduct our analysis on a much larger number of variables by making an assumption about the prior distribution of the parameters. BVAR models have been shown to outperform simple VAR in forecast accuracy (Banbura et al., 2010). They are also suitable for analysing time series of limited length, as in our case.[10]

8 For details, see the assessment relating to the Provision on setting the countercyclical capital buffer rate on the CNB website (Financial stability > Macroprudential policy > The countercyclical capital buffer).

9 For both policies, the effects are analysed under standard conditions. We therefore abstract from situations that might arise during an acute banking crisis or at the zero lower bound on interest rates.

10 With the standard VAR model the number of variables is limited by the length of the time series, which is short in the Czech Republic. In such case, only a limited number of variables can be included in the model. This

The initial VAR(p) model is defined as follows:

$$Y_t = c + \sum_{j=1}^{p} A_j Y_{t-j} + u_t \qquad (1)$$

where $Y_t = (y_{1,t}, y_{2,t}, \ldots, y_{n,t})'$ is a vector of endogenous variables, u_t is a vector of residuals with distribution $N(0,\Sigma)$, $c = (c_1, \ldots, c_2)'$ is a vector of intercepts and A_j is a matrix of coefficients.

The prior follows a Normal inverted Wishart distribution (Litterman, 1986; Sims and Zha, 1998; Banbura et al., 2010, among others).[11] In estimating and setting the prior distribution, we follow Banbura et al. (2010). First, we estimate a small benchmark VAR model[12] composed of several key variables – the industrial production index, the consumer price index, nominal short-term interest rates and the nominal exchange rate. The choice of these variables hinges on the nature of the Czech economy (a small open economy where the central bank targets inflation using a reaction function close to the Taylor rule). In the next step, we set the prior for the large BVAR model so as to control for overfitting of the model.[13]

To identify the interaction between monetary and macroprudential policies together with the relevant transmission channels as accurately as possible, we need to include as much of the available information as possible in the analysis. For this reason, we use a set of 114 variables for the period of January 2002 to October 2014 with a monthly time frequency. Banbura et al. (2010) showed that by setting an appropriate prior in relation to the model size, BVARs can be estimated even for such a large number of variables. The same methodology was used to analyse monetary policy transmission and risk premium changes on Hungarian data, where the inclusion of a large number of variables better explained the transmission mechanism and led to an increase in the forecasting performance of the model compared to a VAR model with a limited number of variables (Carare and Popescu, 2011).

The set of variables can be divided into six blocks: (i) the real economy (the industrial production index, the construction production index, retail sales, the housing market, GDP expenditure); (ii) prices and wages (the consumer price index, the industrial producer price index, house prices, real wages); (iii) the labour market (the general unemployment rate, the registered number of employees, job vacancies), (iv) money and credit aggregates; (v) financial variables (interest rates, exchange rates, the market index, etc.); (vi) the external environment.[14]

4.2 Effects of changes in the monetary conditions, the capital adequacy ratio and house prices

Monetary policy authorities normally use short-term nominal interest rates or the exchange rate to achieve price stability. Macroprudential policy can be conducted using a whole range of tools, which can have both cyclical and structural effects (ESRB, 2014). On a general level, these tools can, for simplicity, be divided into two groups. The first acts via changes in capital requirements. The second affects the credit supply and demand conditions. For the purposes of this article, a monetary policy easing is represented by a reduction in the short-term nominal interest rate.[15] The effect of a macroprudential policy tightening is then proxied by an increase in the capital adequacy ratio (the ratio of regulatory capital to risk-weighted assets of banks).[16] Note that changes in bank capital adequacy ratios caused by changes in prudential requirements cannot be distinguished from changes due to other factors.[17] Given the small number of observations for which the capital adequacy ratio changed "exogenously" because of a decision made by the regulator, the simulation results should be interpreted with caution.

The reduction in short-term nominal interest rates (a negative shock) and the increase in the capital adequacy ratio (a positive shock) are identified by recursively applying the Cholesky decomposition to the covariance matrix. For this purpose, the panel of variables is divided into two

can potentially distort the results of the analysis and reduce the forecasting performance of the model.

11 The prior distribution is based on the Minnesota prior, which is extended to the inverted Wishart distribution for the covariance matrix of the residuals. The main advantage of this distribution is that it allows the posterior distribution to be derived analytically and eliminates the need to simulate it.

12 This small benchmark model is only used to set the "tightness" of the parameters and has no further implications for the final analysis.

13 If the model is overfitted to the training data it will learn relationships that are not present in the data.

14 All the variables, along with their transformations and prior distributions, are listed in an electronic appendix on the CNB website.

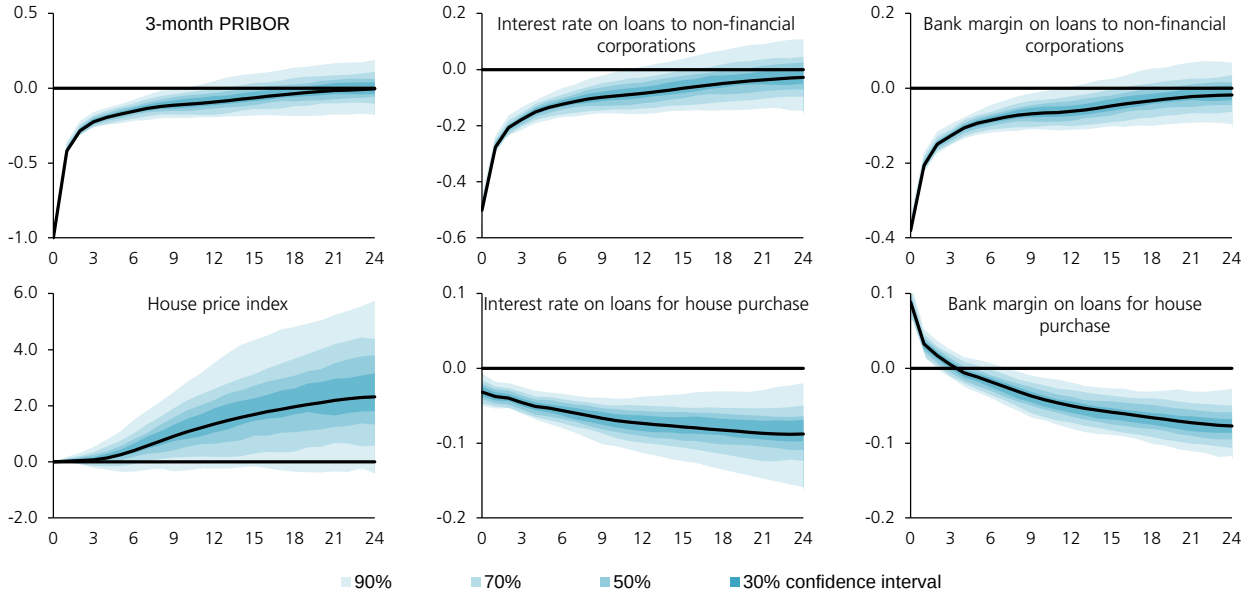
15 The CNB's main monetary policy tool is the two-week (2W) repo rate. As the repo rate does not change continuously, it is proxied by the three-month interbank PRIBOR, which is strongly correlated with the 2W repo rate (0.98 for our time series).

16 A similar approach to analysing the impact of changes in the capital requirements using VAR models was presented, for example, in Noss and Toffano (2014) and Berrospide and Edge (2010).

17 Only part of the changes in the capital adequacy ratios of individual banks reflects the regulator's specific requirements. Banks routinely increase their capital adequacy ratios above the regulatory minimum autonomously due to "collective" market pressure or as a forward-looking response to expected or announced regulatory changes.

CHART 2

EFFECT OF AN EASING OF THE MONETARY CONDITIONS
(%; x-axis: months)



Source: CNB and CZSO, authors' calculations
Note: The chart presents impulse responses to a negative monetary shock with the corresponding posterior Bayesian confidence intervals.

categories: slow- and fast-moving (Stock and Watson, 2005; Banbura et al., 2010). The assumption is that slow-moving variables display a lagged response to a shock while fast-moving ones react contemporaneously.

In the monetary policy shock identification, the blocks describing the external environment, the real economy, prices and wages, and money and credit aggregates fall into the slow-moving category (in the given order). The remaining variables are classed as fast-moving. In the macroprudential policy shock identification, the increase in the capital adequacy ratio is ranked behind the block of variables for interest rates and credit aggregates (the ordering of the other variables is the same as for the monetary policy shock). This reflects the assumption that capital adequacy ratios have a delayed effect on the real economy and lending, whereas variables characterising the real economy and credit aggregates affect capital adequacy ratios immediately. The delay is due to the fact that it takes time to implement changes to the capital adequacy ratio into loan agreements (Berrospide and Edge, 2010).[18]

The effects of a monetary easing, a capital adequacy ratio increase and a house price increase are presented graphically using impulse responses, which show the response of selected variables to the identified shock and the propagation of that shock over time.[19] Our methodology makes it possible to illustrate how a monetary shock transmits to the Czech economy not only via the commonly highlighted channels (the interest rate and exchange rate channels), but also through the asset price channel.[20]

A monetary easing in the form of a reduction in short-term interest rates transmits quickly to lending rates.[21] This pass-through is stronger in the non-financial corporations sector than in the household sector (see Chart 2).[22] This reflects how loans are priced in these sectors. Rates on loans to non-financial corporations are tied largely to the interbank rate,

18 In tests of the robustness of the estimates, the capital ratio ranked ahead of credit aggregates. Changing the ordering has no significant effect on the resulting impulse responses of the selected variables.

19 The size of the dataset makes it impossible to present all the impulse responses here. Only relevant variables were selected for the analysis. The full dataset is given in an electronic appendix on the CNB website.

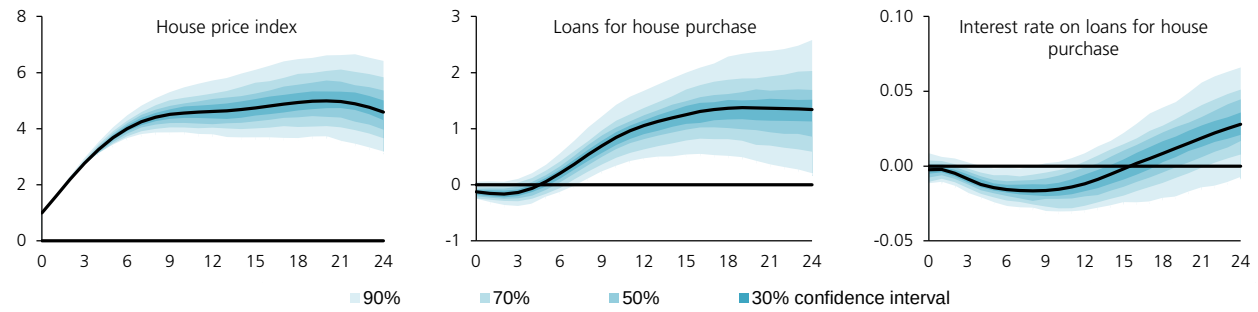
20 An easing of the monetary conditions in the economy generally leads to growth in real activity and prices and to depreciation of the exchange rate, with the impact peaking in 3–4 quarters. This is consistent with estimates in previous studies for the Czech economy (Borys and Horváth, 2009; see the electronic appendix).

21 The analysis Transmission of financial market interest rates to retail interest rates published in Inflation Report II/2009 (CNB, 2009) produced a similar result.

22 The interest rates in Charts 2–4 pertain to the stock of loans.

CHART 3

EFFECT OF AN INCREASE IN HOUSE PRICES
(%; x-axis: months)



Source: CNB and CZSO, authors' calculations
Note: The chart presents impulse responses to a positive shock to the house price index with the corresponding posterior Bayesian confidence intervals.

whereas in the household sector a much larger proportion of interest rates are fixed. In the household sector, rates on loans for house purchase, consisting mostly of mortgages, go down the most. Only around a quarter of these loans have a floating rates or rates fixed for up to one year. As interest rates fall, banks' margins on loans to non-financial corporations decrease, while their margins on loans for house purchase initially increase. This may indicate greater competition and stronger links to clients in the segment of lending to non-financial corporations.

Margins on loans for house purchase start to fall in the third period after the initial monetary easing. This is caused by a longer-lasting decline in interest rates on loans for house purchase. This effect is again associated with the fixed interest rates on a large proportion of loans for house purchase. As the interbank rate goes down, banks' costs decrease but their revenues from such loans stay constant. In time, these types of loans are revalued and the margin starts to fall.

An easing of the monetary conditions passes through to growth in house prices and therefore also in the value of collateral. A monetary policy easing thus improves borrowers' balance sheets. However, if this improvement is used to increase the loan amount, it also gives rise to increased financial risk. If house prices suddenly drop and the default rate simultaneously rises, loans will be less well secured than banks originally expected.

The effect of a change in house prices can be seen from the response of the economy to a shock to the house price index (see Chart 3). A one-off increase in house prices leads to an expansion in loans to households for house purchase and a decline in the rate on such loans. Lending rates may go down in response to the increase in house prices (due to a decrease in the risk premium caused by higher collateral value).

An increase in the capital adequacy ratio leads to a gradual decrease in the loan stock and in house prices. The interest rate in the non-financial corporations sector stays flat in the first three quarters and then starts to go down in response to a fall in the money market rate. In the household sector, the interest rate steadily rises due to a reduction in collateral value resulting from the fall in house prices (see Chart 4).

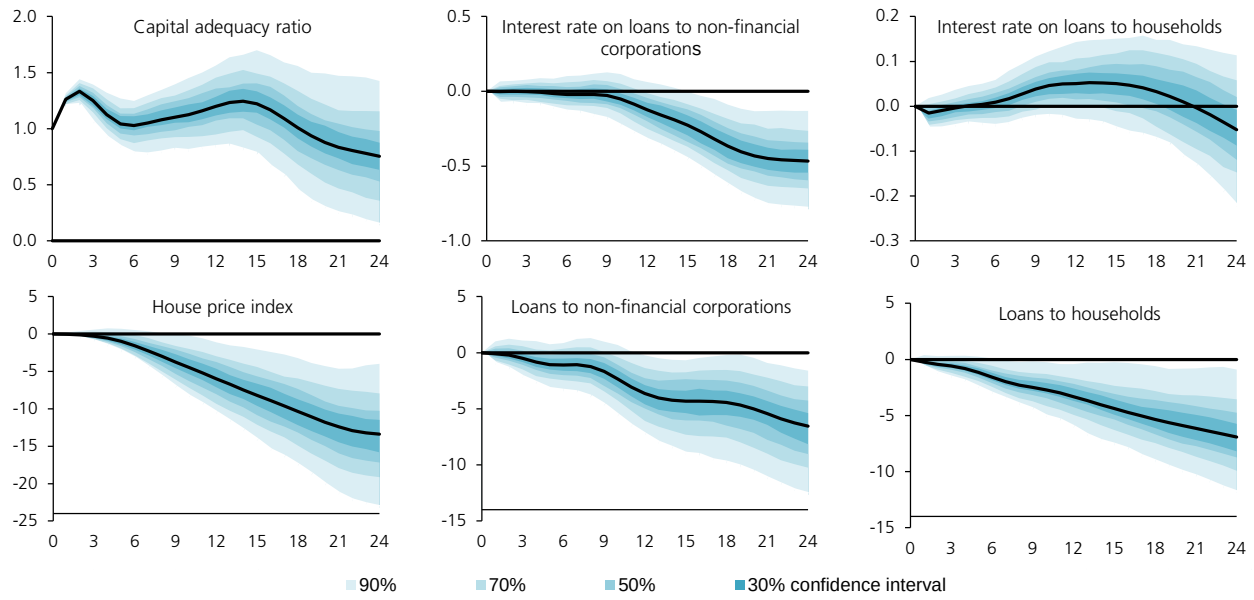
5. CONCLUSION

The growing debate about the effect of sustained easy monetary conditions on the formation of financial imbalances raises a question about the interaction of monetary policy and financial stability policies. Monetary policy has to seek a compromise between stabilising prices and stabilising output, while macroprudential policy is concerned with finding a compromise between adequate returns and acceptable risks. The interactions between these compromises make it necessary to set monetary and macroprudential policies simultaneously. The optimal mix of the two depends on the current position of the economy in the financial and business cycle, the structural characteristics of the financial system and the types of shocks faced by the economy at any given moment.

Monetary and macroprudential policy tools are not independent, as they affect both the monetary and credit conditions via their effect on credit growth. Our analysis, conducted using a Bayesian vector autoregression model, reveals that a conflict can arise between the two policies under certain conditions in the Czech economy. Easy monetary policy fosters growth in the prices of assets that

CHART 4

EFFECT OF AN INCREASE IN THE CAPITAL ADEQUACY RATIO
(%; x-axis: months)



Source: CNB and CZSO, authors' calculations
Note: The chart presents impulse responses to a positive shock to the capital adequacy ratio with the corresponding posterior Bayesian confidence intervals.

can be used as collateral when applying for a loan. By contrast, a macroprudential tightening leads to a reduction in asset prices and a slowdown in credit expansion. It can be very difficult to decide on the optimal policy mix in reality. Macroeconomic forecasts tell us about risks expected in the short run, whereas financial stability analyses reveal potential vulnerabilities in the financial system in the longer run. Naturally, therefore, monetary policy tools are rarely used to achieve the objective of financial stability. Sometimes, however, macroprudential policy tools may not deliver a strong enough effect or may not be immediately activatable. In such case it may be necessary to deploy monetary policy tools, if only as a second-best solution.

REFERENCES

ADRIAN, T., LIANG, N. (2014): *Monetary Policy, Financial Conditions, and Financial Stability*, Federal Reserve Bank of New York, Staff Report No. 690.

ADRIAN, T., SHIN, H. S. (2010): *The Changing Nature of Financial Intermediation and the Financial Crisis of 2007-09*, Federal Reserve Bank of New York, Staff Report No. 439.

AIKMAN, D., HALDANE, A. G., NELSON, B. D. (2014): *Curbing the Credit Cycle*, The Economic Journal, March 2014.

BAILLIU, J., MEH, C., ZHANG, Y. (2012): *Macroprudential Rules and Monetary Policy when Financial Frictions Matter*, Bank of Canada Working Paper 2012-6.

BANBURA, M., GIANNONE, D., REICHLIN, L. (2010): *Large Bayesian Vector Auto Regressions*, Journal of Applied Econometrics 25(1), pp. 71–92.

BERNANKE, B. (2002): *Asset-Price "Bubbles" and Monetary Policy*, New York Chapter of the National Association for Business Economics, New York, 15 October 2002.

BERNANKE, B., GERTLER, M. (1989): *Agency Costs, Net Worth, and Business Fluctuations*, American Economic Review 79(1), pp. 14–31.

BERROSPIDE, J. M., EDGE, R. M. (2010): *The Effects of Bank Capital on Lending: What Do We Know, and What Does It Mean?* Federal Reserve Board, mimeo.

BIS (2014): *84th Annual Report*, June 2014.

BORIO, C. (2012): *The Financial Cycle and Macroeconomics: What Have We Learnt?* BIS Working Paper 395.

BORIO, C. (2014): *Monetary Policy and Financial Stability: What Role in Prevention and Recovery?* BIS Working Paper 440.

BORIO, C., ZHU, H. (2008): *Capital Regulation, Risk-taking and Monetary Policy: A Missing Link in the Transmission Mechanism?* BIS Working Paper 268.

BORYS, M. M., HORVÁTH, R. (2008): *The Effects of Monetary Policy in the Czech Republic: An Empirical Study*, William Davidson Institute Working Paper No. 922.

CARARE, A., POPESCU, A. (2011): *Monetary Policy and Risk-Premium Shocks in Hungary: Results from a Large Bayesian VAR*, IMF Working Paper 11/259.

CNB (2009): *Inflation Report II/2009*, May 2009.

DIAMOND, D. W., RAJAN, R. G. (2012): *Illiquid Banks, Financial Stability, and Interest Rate Policy*, Journal of Political Economy 120(3), pp. 552 - 591.

ECB (2014): *Financial Stability Review*, November 2014.

ÉGERT, B., MACDONALD, R. (2009): *Monetary Transmission Mechanism in Central and Eastern Europe: Surveying the Surveyable*, Journal of Economic Surveys 23(2), pp. 277–327.

ESRB (2014): *The ESRB Handbook on Operationalising Macro-prudential Policy in the Banking Sect*or, March 2014.

FRAIT, J., KOMÁRKOVÁ, Z. (2012): *Macroprudential Policy and Its Instruments in a Small EU Economy*, CNB Research and Policy Note 3/2012.

FRAIT, J., KOMÁRKOVÁ, Z., KOMÁREK, L. (2011): *Monetary Policy in a Small Economy after Tsunami: A New Consensus on the Horizon?* Czech Journal of Economics and Finance 61(1), pp. 5–33.

FRANTA, M., HOLUB, T., KRÁL, P., KUBICOVÁ, I., ŠMÍDKOVÁ, K., VAŠÍČEK, B. (2014): *The Exchange Rate as an Instrument at Zero Interest Rates: The Case of the Czech Republic*, CNB Research and Policy Note 3/2014.

IMF (2013): *The Interaction of Monetary and Macroprudential Policies*, IMF Policy Paper.

IMF (2014): *Global Financial Stability Report*, October 2014.

LITTERMAN, R. B. (1986): *Forecasting with Bayesian Vector Autoregressions – Five Years of Experience*, Journal of Business and Economic Statistics 4(1), pp. 25–38.

MADDALONI, A., PEYDRÓ, J. (2013): *Monetary Policy, Macroprudential Policy, and Banking Stability: Evidence from the Euro Area*, International Journal of Central Banking 9(1), pp. 121–169.

Mandel, M., Tomšík, V. (2015): *Dynamics and Balance of Savings, Investments, and Credits in Business Cycle – The Case of the Czech Republic*, Politická ekonomie 63(1), pp. 32–56.

MCLEAY, M., RADIA, A., THOMAS, R. (2014): *Money Creation in the Modern Economy*, Bank of England Quarterly Bulletin 54(1), pp. 14–27.

NOSS, J., TOFFANO, P. (2014): *Estimating the Impact of Changes in Aggregate Bank Capital Requirements During an Upswing*, Bank of England Working Paper No. 494.

SCHULARICK, M., TAYLOR, A. (2012): *Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870–2008*, American Economic Review 102(2), pp. 1029–1061.

Shakir, T., Tong, M. (2014): *The Interaction of the FPC and the MPC*, Bank of England Quarterly Bulletin 54(4), pp. 396–408.

SIMS, C. A., ZHA, T. (1998): *Bayesian Methods for Dynamic Multivariate Models*, International Economic Review 39(4), pp. 949–968.

STOCK, J. H., WATSON, M. W. (2005): *An Empirical Comparison of Methods for Forecasting Using Many Predictors*, Princeton University, manuscript.

TOVAR, C. (2008): *DSGE Models and Central Banks*, BIS Working Paper 258.

WOODFORD, M. (2012): *Inflation Targeting and Financial Stability*, Sveriges Riksbank Economic Review 2012:1, pp. 7–32.