THE EFFECT OF ACCOMMODATIVE MONETARY POLICY ON THE RISK WEIGHTS APPLIED BY DOMESTIC BANKS

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This article examines the effect of accommodative monetary policy on risk perception and risk measurement by domestic banks that use internal models to estimate the risk parameters entering the calculation of their capital requirements. Low interest rates can influence risk parameter estimates either directly or indirectly through their impact on asset prices, asset price volatility, valuation, firms' cash flow and so on. They can also affect the perceived riskiness of existing borrowers and new loan applicants, thereby further reducing risk parameter estimates. The results of our empirical analysis point to the existence of a risk-taking channel for banks that use the IRB approach for at least a portion of their exposures, as we find a positive, statistically significant relationship between the implicit risk weights of those banks and a number of monetary policy variables.

1. INTRODUCTION

Over the last ten years or so, increasing attention has been paid to the long-run impact of easy monetary policy on banks' risk behaviour via the risk-taking channel. In the short run, a monetary policy easing generally enhances the stability of banks, as low interest rates improve the overall quality of their loan portfolios. In the long run, though, low interest rates may induce banks to increase both the size and the riskiness of their assets in order to attain their original target yields (the search-for-yield hypothesis;[1] Gambacorta, 2009; Diamond and Rajan, 2012). Risks can also increase on the liability side – low monetary policy rates can lead in the long run to growth in asset prices, which can induce banks to provide short-term funding secured by those assets and in turn give rise to increasing maturity transformation (Adrian and Liang, 2014). In addition, accommodative monetary policy can affect estimates of risk parameters such as the probability of default (PD) and the loss given default (LGD), which then enter the calculations of the capital requirements of banks that use internal models and the calculations of implicit risk weights[2] (Gambacorta, 2009).

This article sets out to test empirically the relationship between the monetary policy stance and the implicit risk weights characterising banks' assessment of the riskiness of their assets. A bank quantifies a larger capital requirement for assets that it evaluates as riskier. This is reflected in a higher implicit risk weight. If the implicit risk weight decreases, the bank can expand its credit portfolio without increasing its capital. Our empirical analysis is conducted using data for a period of predominantly accommodative monetary conditions, so its results cannot automatically be interpreted in terms of monetary policy tightening. Consequently, the article focuses primarily on discussing the effect of easy monetary policy.

The article is structured as follows. Section 2 is devoted to the approaches used to determine capital requirements for credit risk. Section 3 discusses the mechanism of monetary policy transmission through the risk-taking channel. Section 4 presents the methodology and data used. Section 5 gives the results of the empirical analysis. Section 6 discusses their implications for financial stability and central bank policy. Section 7 concludes.

2. APPROACHES TO DETERMINING CAPITAL REQUIREMENTS FOR CREDIT RISK

The current CRD IV/CRR regulatory framework[3] allows the use of two approaches to determining capital requirements for credit risk: a standardised approach (STA) and/or an internal rating-based approach (IRB). The STA approach takes account of the type, external rating and collateral

1 Search for yield is a phenomenon where, at a time of generally low asset yields, economic agents try to compensate for this fact by seeking riskier-than-usual investment opportunities, which carry a premium for the increased risk. Such behaviour can increase the future risks to the financial system.

2 For simplicity, we refer here to risk weights even though under the internal rating-based (IRB) approach the capital requirement is set for a given asset and the resulting risk weight is thus implicit (the ratio of risk-weighted exposures to the total exposures of banks).

3 CRD IV (the Capital Requirements Directive) is Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013 on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms; CRR (the Capital Requirements Regulation) is Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms; it was published in the Official Journal on 27 June 2013 and has been in force since 28 June 2013. For more details, see https://www.cnb.cz/en/faq/faqs_the_capital.html.

quality of the exposure. The IRB approach is based on an internal rating set by the bank and reflects the perceived riskiness of individual asset classes in the given economic environment. A bank uses the IRB approach to derive capital requirements from its own evaluation of the riskiness of its portfolio, i.e. on the basis of its own model-based estimates of the probability of default (PD) and the loss given default (LGD). These risk parameters, along with the exposure at default (EAD) and the maturity of the exposure (M), are used to calculate risk-weighted exposures and regulatory capital requirements according to formulas defined in CRD IV/CRR. The IRB approach is subdivided into the Foundation IRB (F-IRB) and Advanced IRB (A-IRB) approaches, which differ in terms of the extent of internal risk parameter estimates. Under the F-IRB approach, banks only estimate PD, while the other risk parameters are determined by the regulator. Under the A-IRB approach, banks estimate their own PD, LGD and EAD values.

The risk parameters can be estimated using various modelling techniques and usually encompass a broad set of macroeconomic and financial indicators (such as GDP growth rates, inflation, labour market data, interest rates, spreads and volatility indices, asset price growth and market prices of bonds and equity) and obligor-specific characteristics (such as corporate soundness ratios and the type and amount of collateral used). There are numerous studies in the literature dealing with risk parameter estimation methods and analysing the relationship between the explanatory variables and the resulting risk parameters. The relevant studies from our perspective examine the relationship between risk parameter estimates and interest rates (as a proxy for the monetary policy stance). They include, for example, Drehmann et al. (2008), who find a statistically significant positive relationship between the real interest rate and PD for corporate exposures, and Volk (2013) and Bonfim (2009), who find a statistically significant positive relationship between interest rates on loans to corporations and PD for corporate exposures. Jiménez and Saurina (2006) find a similar relationship between interest rates and non-performing loans, which are closely related to PD. Less attention is given in the literature to LGD estimates. Altman et al. (2002) estimate a statistically significant positive correlation between LGD and PD, while Jiménez and Saurina (2006) stress that during recessions (when PD usually increases) banks may require higher collateral from their customers, which would reduce LGD; in such case, LGD and PD would be negatively correlated.

3. THE EFFECT OF EASY MONETARY POLICY ON THE IMPLICIT RISK WEIGHTS APPLIED BY BANKS

As mentioned in the introduction, the risk-taking channel refers to a broad set of possible ways in which monetary policy can influence the risk behaviour of banks and other financial institutions. This article is devoted to just one of these ways, as depicted in Figure 1. The figure describes the process whereby low interest rates affect the risk parameter estimates that enter the calculation of banks' capital requirements under the IRB approach. Low interest rates can influence risk parameter estimates either directly (by entering as one of the variables) or indirectly through their impact on asset prices, asset price volatility, valuation, firms' cash flow and so on. They can also affect the perceived riskiness of existing borrowers and new loan applicants, thus further reducing risk parameter estimates. In the case of existing borrowers, lower interest rates are reflected in a decline in their debt service costs and hence in their probability of default.[4] As for new loan applicants, low interest rates can make them less risky (which may be reflected in a better credit rating), i.e. applicants who would not get a loan at higher interest rates may be seen as creditworthy. Lower risk parameter estimates translate into lower risk-weighted exposures or lower implicit risk weights, leading, ceteris paribus, to a higher capital ratio.

There is little empirical analysis of this relationship in the literature. One paper on a related theme is that by Gambacorta (2009), who finds a statistically significant link between a prolonged period of low interest rates and banks' risk-taking. Bank expected default frequencies (EDFs) are used as a proxy for bank riskiness, and the number of consecutive quarters with interest rates below both the natural rate[5] and the rate implied by a Taylor rule is used to proxy for an extended period of low interest rates. De Nicolò et al. (2010) support the existence of the risk-taking channel by estimating the effect of interest rates on banks' risk weights using data for the USA. They show that lower interest rates are generally associated with greater risk-taking by banks (through a search for yield and the effect on asset prices).

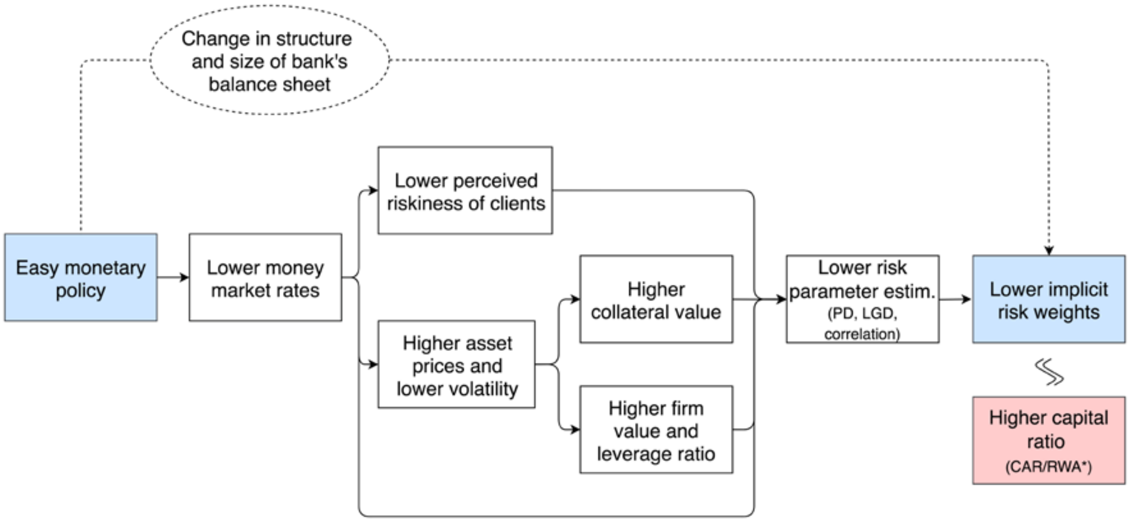
As indicated in Figure 1, implicit risk weight levels are affected not only by the chosen regulatory approach and the internal risk parameter estimates, but also by the bank's

4 The speed of transmission through this channel will depend on the residual fixation of interest rates on the existing loan portfolio; the higher the residual fixation, the slower the transmission.

5 Gambacorta (2009) defines the natural rate as the average real rate in 1985–2000 (for Japan, 1985–1995; for Switzerland, 2000–2005) plus the four-quarter growth in potential output less its long-term average (see Graph 1, p. 46).

FIGURE 1

SIMPLIFIED SCHEME OF THE EFFECT OF EASY MONETARY POLICY ON THE IMPLICIT RISK WEIGHTS OF IRB BANKS



Source: Authors
Pozn.: * CAR/RWA – ratio of regulatory capital to risk-weighted assets.

asset structure, which monetary policy can also influence (through the credit channel, for example). In order to filter out this effect, we additionally use control variables for bank asset structure in the empirical specification (see section 4 for more details). Consequently, the resulting estimate of the relationship between the monetary policy stance and banks' risk weights should not reflect change in the structure of banks' assets.

4. EMPIRICAL MODEL AND DATA

The effect of monetary policy on banks' implicit risk weights is analysed by means of an empirical model and bank-level supervisory panel data. Implicit risk weights are generally affected by three main factors – the regulatory approach (STA versus IRB), the bank's asset structure and the business cycle. To capture the effect of monetary policy, we need to use control variables for all these factors in the empirical specification, although we additionally use a number of other control variables:

$$RW_{i,t} = \alpha_1 RW_{i,t-1} + \alpha_2 MP_t + \alpha_3 X_{i,t-1} + \alpha_4 \%\Delta GDP_t + \alpha_5 VIX_t + \alpha_6 Reg_{i,t} + \upsilon_i + \varepsilon_{i,t}, \quad (1)$$

where $RW_{i,t}$ denotes the implicit risk weights (the ratio of risk-weighted exposures to total assets[6]) for bank *i* at time *t*, MP_t is a monetary policy proxy, $X_{i,t-1}$ is a vector of control variables, $\%\Delta GDP_t$ is annual real GDP growth and VIX_t is the Chicago Board Options Exchange Volatility Index.[7]

Real GDP growth is used to capture the business cycle in the domestic economy and the VIX index to capture volatility on global financial markets. $Reg_{i,t}$ is a dummy variable which takes the value of 1 if the bank's total regulatory capital ratio is less than 1.5 pp above the regulatory minimum of 8% and zero otherwise (Berrospide and Edge, 2010). This variable captures potential pressures arising from low bank capitalisation (or capitalisation close to the regulatory minimum); such pressures may come both from the regulator and from investors and creditors; υ_i captures bank-level fixed effects and $\varepsilon_{i,t}$ is a random error term.

The vector of control variables $X_{i,t-1}$ includes proxies for bank size (the natural logarithm of total assets), credit risk (the ratio of loan loss provisions to total assets) and

6 To calculate the implicit risk weights, we work solely with the risk-weighted exposures for credit risk, which accounted for around 90% of all risk-weighted exposures as of 2016 Q4. We also deal only with balance sheet items and unconsolidated data.
7 The VIX index is a measure of implicit volatility for S&P 500 index (SPX) put and call options traded on the Chicago Board Options Exchange.

capitalisation (the ratio of regulatory capital to total assets) and variables capturing bank asset structure (various categories of loans to the private sector, interbank loans, government bonds and claims on central banks, as a percentage of total assets in each case).[8]

The proxy for bank size captures the fact that large banks tend to face less risk than small ones (Berger et al., 2008; Flannery and Rangan, 2008; Brei and Gambacorta, 2014). The inclusion of this variable is also relevant from the perspective of the too-big-to-fail hypothesis: larger banks may tend to behave less prudently because they can implicitly rely on government support if they run into serious difficulty (Afonso et al., 2014).

The ratio of loan loss provisions to total assets serves as an indicator of the riskiness of banks' loan portfolios (Brei and Gambacorta, 2014). Banks build up loan loss provisions in response to increased credit risk (Frait and Komárková, 2013). Higher credit risk should also be reflected in the risk parameter estimates used to calculate the capital requirements of IRB banks, hence a positive correlation can be expected between the two variables (Cummings and Durrani, 2016).

The ratio of regulatory capital to total assets captures any tendency of banks with more capital to take on more risk (Flannery and Rangan, 2008). It can therefore be regarded as a proxy for banks' loss-absorbing capacity.

The asset structure variables capture the different levels of risk associated with different assets. For instance, loans tend to be regarded as riskier than bonds issued by countries with high credit ratings,[9] unsecured loans as riskier than secured loans, and so on.

The final dataset covers 20 domestic banks from 2003 Q1 to 2016 Q4 (56 quarters altogether).[10] This gives us a total of 963 observations. The dynamic panel model in equation (1) is estimated using a bootstrap method based on De Vos et al. (2015).[11]

4.1 Implicit risk weights and regulatory approaches

In the Czech Republic, the IRB approach is used by all large banks and some medium-sized banks and their building societies (with a combined market share of approximately 80% as of the end of 2016); Chart 1 compares the implicit risk weights of IRB and STA banks.[12] The first wave of migration to the IRB approach occurred in 2007 Q3. Chart 1a shows that the implicit risk weights of IRB banks fell sharply immediately after the switch to the IRB approach. This contrasts with the STA approach, where risk weights began to decrease a few quarters later. In the case of the STA approach, the decline was caused by a fall in the ratio of loans to total assets (see CNB, 2016, p. 144) and a rise in the ratio of less risky exposures to central governments and central banks (see Chart 3b). The fall in the implicit risk weights of IRB banks cannot be explained solely by the change in asset structure, so migration to the IRB approach also played a role.

Chart 2 compares implicit risk weights divided into four main asset classes: (i) exposures to central governments and central banks, (ii) exposures to institutions, (iii) corporate exposures and (iv) retail exposures.[13] The implicit risk weights for banks that use the STA and IRB approaches differ across the main asset classes, the difference increasing with increasing riskiness of the asset class. The difference is due to the nature of the IRB approach, under which a bank implicitly derives risk weights on the basis of an internal assessment of the riskiness of its portfolio, i.e. on the basis of its own model-based PD and LGD estimates. Except for exposures to central governments and central banks, the implicit risk weights of IRB banks are lower than those of STA banks, especially for retail exposures.

8 The bank-level control variables are included with a lag of one quarter, as, for example, in Brei and Gambacorta (2014).
9 For example, a credit rating of AA or higher (or the equivalent thereof for external credit assessment institutions using different scales) corresponds to a credit quality step of 1, which, under Article 114 of the CRR, is assigned a risk weight of 0%. For more details, see Article 136 of the CRR and Annex III of Commission Implementing Regulation (EU) 2016/1799 of 7 October 2016.
10 We use unconsolidated data. The Czech Export Bank (CEB) and the Czech-Moravian Guarantee and Development Bank (CMGDB) were excluded from the analysis because they are wholly owned by the Czech state (which thus guarantees their liabilities, including, in the case of the CEB, those arising from derivatives) and have different business models and volatile credit portfolios. ERB bank was also excluded due to insolvency.
11 This method is used for the following reasons. When estimating model (1), we need to take into account the inclusion of the lagged dependent variable among the independent variables on the right-hand side of the regression equation (we work with dynamic panel data); otherwise, the estimates would be biased. In the literature, this problem is typically solved by applying generalised method of moments (GMM) estimators. However, their use is only justified when the data panel contains just a small number of observations in the time dimension (De Vos et al., 2015). Our panel does not satisfy this condition. We therefore use a dynamic panel model estimated using the bootstrap method of De Vos et al. (2015), which is presented in the literature as an alternative to GMM estimators if the time dimension of the panel is relatively high. The estimation technique is discussed in more detail in Malovaná et al. (2017).
12 We define IRB banks as those using the IRB approach for at least some portion of their exposures as of the end of 2016. We define STA banks as those using solely the STA approach as of the end of 2016.
13 We classify other exposures for STA banks as "others". This class contains a wide range of exposures that are not distinguished under the IRB approach, such as exposures secured by property and exposures in default.

CHART 1a)

IMPLICIT RISK WEIGHTS OF IRB BANKS
(%)

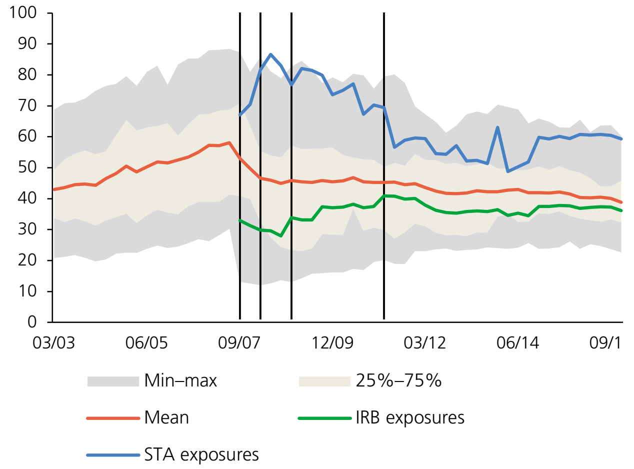
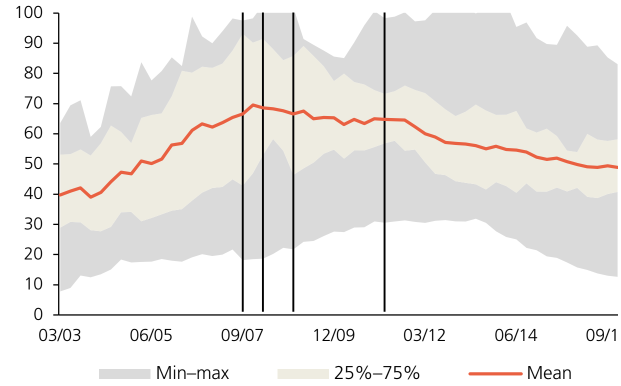


CHART 1b)

IMPLICIT RISK WEIGHTS OF STA BANKS
(%)



Source: CNB, authors' calculation
Note: Implicit risk weights are calculated as risk-weighted exposures divided by total assets. IRB banks – banks using the IRB approach for at least some portion of their exposures as of 2016 Q4; STA banks – banks using solely the STA approach. All IRB banks simultaneously use the IRB approach (IRB exposures) and the STA approach for a certain (usually relatively small) portion of their exposures (STA exposures). The vertical lines denote the four waves of migration of domestic banks to the IRB approach – 2007 Q3, 2008 Q1, 2008 Q4 and 2011 Q1.

CHART 2a)

IMPLICIT RISK WEIGHTS BY ASSET CLASSES – IRB BANKS
(%)

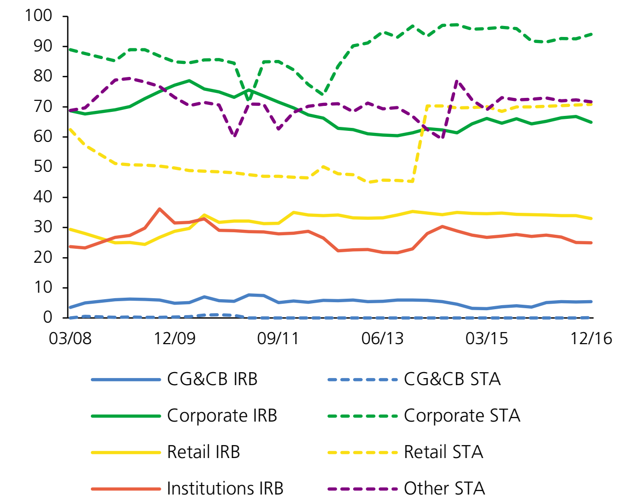
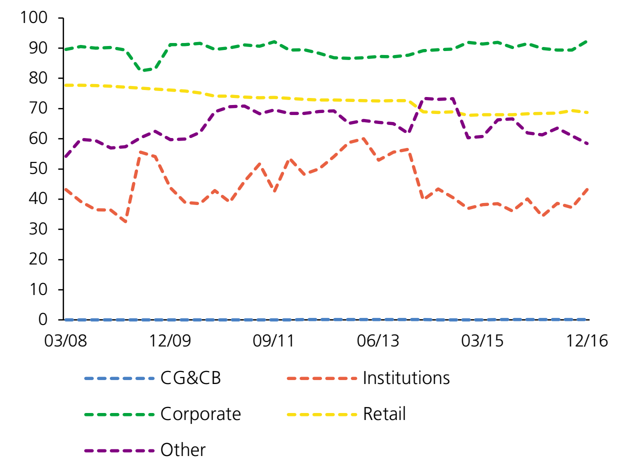


CHART 2b)

IMPLICIT RISK WEIGHTS BY ASSET CLASSES – STA BANKS
(%)



Source: CNB, authors' calculations
Note: Implicit risk weights are calculated as risk-weighted exposures divided by total assets. IRB banks – banks using the IRB approach for at least some portion of their exposures as of 2016 Q4; STA banks – banks using solely the STA approach. All IRB banks simultaneously use the IRB approach (solid lines) and the STA approach for a certain (usually relatively small) portion of their exposures (dashed lines). The share of STA exposures to institutions of IRB banks is zero or nearly zero for the majority of the period analysed, so the average risk weight for this exposure category is not reported in the chart. CG&CB – exposures to central governments and central banks.

CHART 3a)

EXPOSURES BY ASSET CLASSES – IRB BANKS
(%)

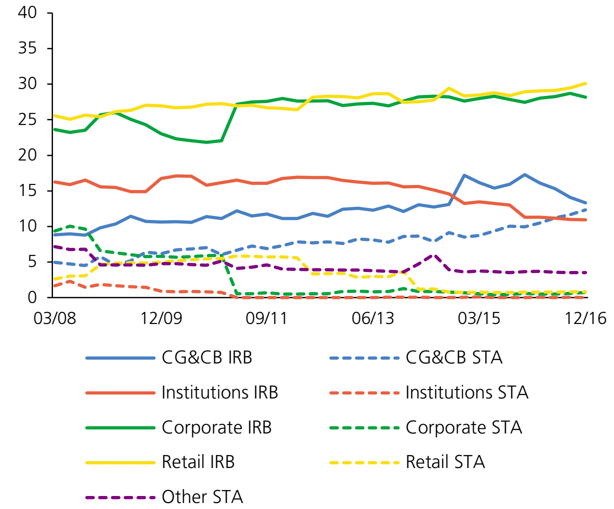
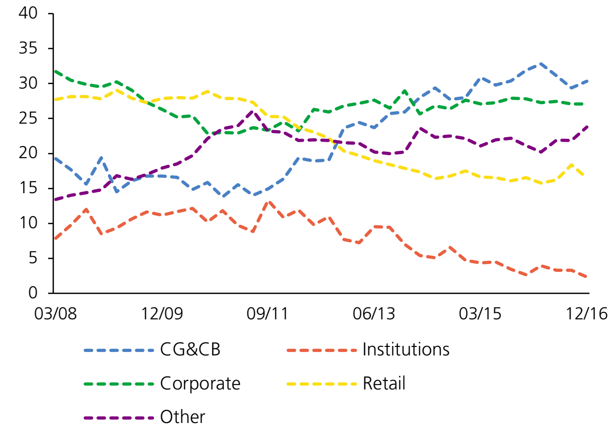


CHART 3b)

EXPOSURES BY ASSET CLASSES – STA BANKS
(%)



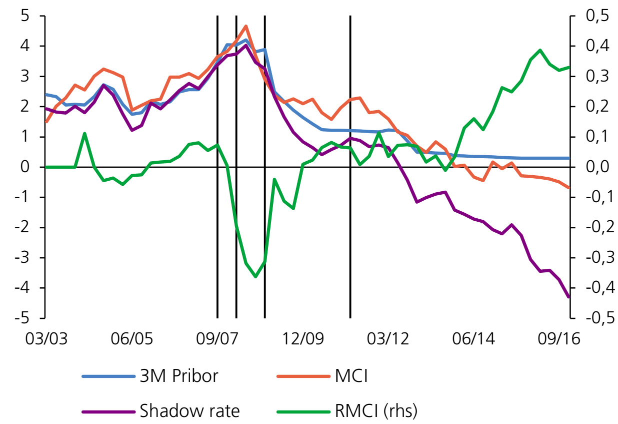
Source: CNB, authors' calculations
Note: IRB banks – banks using the IRB approach for at least some portion of their exposures as of 2016 Q4; STA banks – banks using solely the STA approach. All IRB banks simultaneously use the IRB approach (solid lines) and the STA approach for a certain (usually relatively small) portion of their exposures (dashed lines). CG&CB – exposures to central governments and central banks.

4.2 Monetary policy variables

The monetary policy stance is proxied in the model by four different variables: the 3M PRIBOR, the monetary policy index (MCI) proposed by Malovaná and Frait (2017),[14] the real monetary conditions index (RMCI) estimated by the CNB (2015)[15] and shadow rates as suggested by Krippner (2012).[16] Chart 4 shows the evolution of the monetary policy variables between 2003 and 2016. The monetary policy indices and shadow rates are used to account for the effect of both conventional and unconventional monetary policy and to reflect the problem of the zero lower bound on interest rates. In the specification with the 3M PRIBOR, we additionally control for the yield curve slope (the spread between the 3M PRIBOR and the 10-year government bond yield), which should also help overcome the problem of the zero lower bound and at least partially capture the effect of the prolonged period of monetary easing (Borio et al., 2015; Brei and Gambacorta, 2014).

CHART 4

MONETARY POLICY VARIABLES
(3M PRIBOR and shadow rate in %; MCI and RMCI indices)



Source: CNB, authors' calculations
Note: MCI – the monetary conditions index as estimated by Malovaná and Frait (2017), positive values refer to tight monetary conditions, index standardised by the 3M Pribor; RMCI – the real monetary conditions index as estimated by CNB (2015a), positive values refer to easy monetary conditions; the shadow rate as estimated by Krippner (2012). The vertical lines denote the four waves of migration of domestic banks to the IRB approach – 2007 Q3, 2008 Q1, 2008 Q4 and 2011 Q1.

14 The MCI is estimated using a dynamic factor model containing a wide range of monetary policy variables, including interest rates and yields at various maturities and the exchange rate.
15 The RMCI is constructed as a weighted average of the deviations of the domestic ex ante real interest rate and the real exchange rate from their equilibrium levels.
16 The shadow rate is constructed as a hypothetical shadow yield curve by adjusting the standard yield curve for the effect of the existence of cash holdings imposing the lower bound on interest rates.

5. EMPIRICAL RESULTS

The model in equation (1) is estimated for each of the monetary policy variables and regulatory approaches in turn (see Table 1). Column 1 shows the estimation results for the specification with the total implicit risk weights of all banks, column 2 those for the specification with the total implicit risk weights of IRB banks (i.e. banks using the IRB approach for at least a portion of their exposures), and column 3 those for the specification with the IRB implicit risk weights (i.e. the risk weights of exposures under the IRB approach) of banks with at least 75% of their risk-weighted exposures calculated under the A-IRB approach as of the end of 2016. For the sake of brevity, only the estimates of the coefficients for the relationship between the monetary policy variable and the implicit risk weights are reported in Table 1; complete estimates of all the coefficients can be found in Malovaná et al. (2017) on the CNB website.

TABLE 1

ESTIMATION RESULTS – BASELINE SPECIFICATION

	(1)	(2)	(3)
Banks:	All	IRB	A-IRB
Dependent variable:	RW	RW	RW IRB
3-month Pribor	-0.047	0.696**	0.885***
	(0.152)	(0.269)	(0.300)
Shadow rate	0.074	0.307**	0.382***
	(0.085)	(0.127)	(0.135)
MCI	0.084	0.583***	0.721***
	(0.126)	(0.189)	(0.190)
RMCI	-0.287	-3.469***	-2.451**
	(0.968)	(1.189)	(1.223)
Observations	963/899	310	204

Source: CNB, authors' calculations
Note: This table presents the bootstrap-based corrected LSDV regression (De Vos et al., 2015) estimates of equation (1). Bootstrapped standard errors are reported in parentheses. ***, ** and * denote the 1%, 5%, and 10% significance levels. RW – implicit risk weights calculated as risk-weighted exposures divided by total assets; RW IRB – IRB risk weights calculated as risk-weighted exposures under the IRB approach divided by non-risk-weighted exposures under the IRB approach. The lower number of observations in column 1 is due to the fact that the time series of the real monetary conditions index (RMCI) is available only from 2004 Q1.

TABLE 2

ESTIMATION RESULTS FOR IRB BANKS – SPECIFICATIONS WITH VARIOUS DATASET LENGTHS

	(1)	(2)	(3)	(4)	(5)
End of sample	2012 Q4	2013 Q4	2014 Q4	2015 Q4	2016 Q4
3-month Pribor	0.448	1.137***	1.177***	1.026***	0.696**
	(0.415)	(0.409)	(0.354)	(0.31)1	(0.269)
Shadow rate	-0.027	0.558**	0.634***	0.531***	0.307**
	(0.298)	(0.278)	(0.208)	(0.166)	(0.127)
MCI	0.589	1.064***	0.890***	0.799***	0.583***
	(0.372)	(0.308)	(0.237)	(0.217)	(0.189)
RMCI	1.002	-1.072	-3.991**	-4.674***	-3.469***
	(1.735)	(1.819)	(1.789)	(1.464)	(1.189)
Observations	166	202	238	274	310

Source: CNB, authors' calculations
Pozn.: Bootstrapped standard errors are reported in parentheses. ***, ** and * denote the 1%, 5%, and 10% significance levels.

The results are consistent across all four monetary policy variables and generally confirm the existence of the risk-taking channel for banks that use the IRB approach for at least a portion of their exposures: there turns out to be a strong, statistically significant relationship between monetary policy easing and lower implicit risk weights of IRB banks (column 2 in Table 1). Specifically, a 1 pp decrease in the 3M PRIBOR, the shadow rate and the MCI transmits, on average, to a 0.3–0.7 pp decrease in implicit risk weights. The relationship is even stronger for banks mainly using the A-IRB approach (column 3 in Table 1). In this case, a 1 pp decrease in the 3M PRIBOR, the shadow rate and the MCI leads, on average, to a 0.4–0.9 pp decrease in implicit risk weights.[17] As for the RMCI, it can be said that more accommodative monetary conditions (a greater deviation from the equilibrium levels) are associated with lower implicit risk weights of both IRB banks and banks mainly using the A-IRB approach. For the whole sample covering both STA and IRB banks, the relationship is statistically insignificant (column 1 in Table 1). This is consistent with the transmission mechanism discussed in section 3.[18]

In addition to the results presented in Table 1, we conducted estimates using datasets ending in different years by progressively excluding the years 2013 to 2016, characterised by very accommodative monetary conditions, from the original dataset (see Table 2). The dataset ending in 2012 Q4 (column 1) covers only two months of the zero lower bound period (starting in November 2012) and does not cover the exchange rate commitment period (November 2013–April 2017).[19] As the dataset gets progressively longer, an increasingly long period of accommodative monetary conditions becomes incorporated into the estimate. This allows us to track the gradually changing relationship between easing monetary conditions and banks' implicit risk weights. The existence of the risk-taking channel turns out to depend on the inclusion of the period 2013–2016. We interpret this finding as meaning that the prolonged period of accommodative monetary conditions has been key to the existence of the risk-taking channel in the Czech Republic.[20]

A wide range of control estimates corroborating the findings presented here can be found in Malovaná et al. (2017). The baseline specification of model (1) is estimated for the Visegrad Four countries (the Czech Republic, Hungary, Poland and Slovakia), whose banking sectors are similar in several regards. These results support the existence of the risk-taking channel. Estimates conducted for banks with different levels of capital reveal that the relationship between accommodative monetary policy and implicit risk weights is stronger for less-capitalised banks.[21] Berger et al. (2008), who examine the capital adequacy of US banks, come to a similar conclusion. The inclusion of an additional variable for growth in residential property prices does not influence this relationship.

6. IMPLICATIONS FOR FINANCIAL STABILITY AND CENTRAL BANK POLICY

The results of our analysis indicate that the effect of monetary policy on financial stability cannot be considered neutral.[22] The relationships identified between the monetary

17 The results remain quantitatively the same when we omit the first two quarters following the switch to the IRB approach from the analysis for individual banks.

18 The coefficient estimates of the remaining control variables mostly have the intuitive sign. For example, a higher ratio of loan loss provisions to total assets is associated with higher implicit risk weights of IRB banks, i.e. banks' average risk weights increase with increasing credit risk (decreasing loan quality). The coefficient on VIX is also positive and statistically significant in the specifications with IRB banks, indicating that banks take into account changes in global market volatility in their estimation of implicit risk parameters. The coefficient on the dummy for regulatory pressures is positive and statistically significant in the majority of the specifications. This suggests that banks with capital close to the regulatory minimum of 8% attain higher risk weights on average. With regard to asset structure, the results indicate a negative, statistically significant relationship between the risk weights of banks that use the A-IRB approach for the majority of their exposures and the share of retail loans other than mortgage loans. The average implicit risk weight for this category of loans is lower than the total average implicit risk rate of this category of banks, so the relationship is as expected. The coefficients on the remaining asset class variables for the most part have the intuitive sign (the implicit risk weight increases/decreases with an increasing/decreasing share of riskier assets) but are not statistically significant at the 10% significance level.

19 Monetary policy started to be eased in August 2008; the two-week repo rate was lowered by 3.7 pp between July 2008 and November 2012 (when the zero lower bound, i.e. technical zero of 0.05%, was reached).

20 Economic growth in the domestic economy started to recover gradually in the same period. A question may thus arise regarding the significance of the contribution of the easy monetary conditions by comparison with that of the renewed growth. The empirical model uses a control variable for annual real GDP growth to capture the business cycle in the domestic economy. For this reason, we regard the relationship identified after the inclusion of the years 2013–2016 as a consequence of the protracted easy monetary policy, not economic growth. Moreover, GDP started rising sharply in annual terms only in 2014 (by 6.3% in nominal terms and 3.4% in real terms, as opposed to just 0.5% and -0.5% respectively in 2013).

21 We define less-capitalised banks as those whose total regulatory capital ratio lies in the first quartile of the distribution of this ratio.

22 Numerous other studies have documented the effect of monetary policy on financial stability. On the one hand, monetary policy affects the conditions on financial markets, for example by influencing asset prices or banks' risk behaviour (Bernanke and Kuttner, 2005; Altunbas et al, 2010). On the other hand, in a situation where a financial crisis is developing, monetary policy can support financial stability (for instance by providing funds at longer maturities), even if it cannot guarantee it

TABLE 3

RELATIONSHIP BETWEEN THE MONETARY POLICY STANCE AND THE IMPLICIT RISK WEIGHTS OF IRB BANKS IN VARIOUS PHASES OF THE FINANCIAL CYCLE

	Relationship identified:	
	Easy monetary conditions	Tight monetary conditions
High or rising financial imbalances: High systemic risk, over-optimism, high private sector leverage, high overvaluation of asset prices, etc.	↓ RW	↑ RW
Low and stable or falling financial imbalances: Low systemic risk, sustainable private sector leverage, near-equilibrium asset prices, etc.	↓ RW	↑ RW

Source: Authors
Note: Red field – risk of undervaluation (upper left) or overvaluation (lower right) of the necessary level of capital; green field – low risk of undervaluation/overvaluation of the necessary level of capital.

policy stance and the implicit risk weights of banks that use internal models are summarised in Table 3; the potential risks to financial stability arising from these relationships will differ depending on the position of the economy in the financial cycle and on the current level and expected evolution of financial imbalances.

If financial imbalances are at a low level, for example, following the financial crisis, accommodative monetary policy need not cause increased risk-taking. In this situation, the tendency to take on more risk is low and accommodative monetary policy can conversely help maintain the supply of credit to the sound part of the real economy. Along with the decline in risk weights, the bank could release part of its capital and use it to cover the capital requirements brought about by the expansion of its loan portfolio.

If, however, the economy is in an expansionary phase of the financial cycle and credit growth is rising, the ability of banks and their customers to perceive risk may decrease and financial imbalances may start to form. In the long run, a monetary policy easing may therefore contribute to the generation of hidden risks – risks that could materialise in the future as a sharp deterioration in loan portfolio quality. A decline in implicit risk weights, whether as a result of accommodative monetary policy or a growth phase of the cycle,[23] may thus pose a risk of *undervaluation* of the necessary level of capital. In such case, it would be justified to take the evolution of risk weights into account when applying the relevant macroprudential policy tools, which are the main line of defence against the build-up of systemic risks.

The empirical relationship between monetary policy and the implicit risk weights of banks that use internal models was estimated using data for a period of predominantly accommodative monetary conditions. For this reason, we cannot automatically assume that it worked or will work at times of tightening monetary conditions. If we were to assume this, however, we could interpret it in the logic of Table 3. Monetary policy tightening might then not be desirable from the financial stability perspective in a situation where the economy is starting to recover slowly from a financial crisis and the level of systemic risk is low. In such conditions, growth in implicit risk weights could pose a risk of *overvaluation* of the necessary level of capital. This could depress the supply of credit by banks and in turn slow the overall economic recovery.

Numerous international studies and supranational regulatory authorities have also pointed to potential weaknesses in the current regulatory framework governing the IRB approach and the related possibility of inappropriate risk assessment. These studies state that the risk-weight estimates, which are used to determine capital requirements, are highly heterogeneous across countries and banks (EBA, 2013; BCBS, 2013; BCBS, 2016; Danielsson et al., 2016). This means that different banks may assess the same risk differently to some extent. Some studies also point out that the estimated risk weight assigned to each asset may not correspond to its true risk, i.e. the risk may be underestimated (Behn et al., 2016a;

(Gameiro et al., 2011). Villeroy de Galhau (2017) goes as far as to say that monetary policy is never neutral with respect to financial stability and that the two interact even in normal times.

23 In an expansionary phase of the financial and economic cycle, banks' asset quality rises and their credit risk falls. This is reflected in lower estimates of the risk parameters entering the calculation of banks' capital requirements under the IRB approach and hence in lower implicit risk weights.

Mariathasan and Merrouche, 2014).[24] It is therefore desirable to regularly assess whether the evolution and current level of risk weights pose a risk of undervaluation of the necessary level of capital and imply a need to take that risk into account when applying the relevant macroprudential policy tools**.**

7. CONCLUSION

Easy monetary conditions can influence banks' risk behaviour in a number of ways. Among other things, they can affect estimates of risk parameters such as the probability of default and the loss given default, which then enter the calculations of the capital requirements of banks that use internal models and the calculations of implicit risk weights. Low interest rates can influence risk parameter estimates either directly or indirectly through their impact on asset prices, asset price volatility, valuation, firms' cash flow and so on. They can also affect the perceived riskiness of existing borrowers and new loan applicants, thereby further reducing risk parameter estimates.

This article empirically estimates the relationship between accommodative monetary policy and the implicit risk weights of domestic banks. The results point to the existence of a risk-taking channel for banks that use the IRB approach for at least a portion of their exposures, i.e. to a positive, statistically significant relationship between the implicit risk weights of those banks and a number of monetary policy variables. At the same time, the inclusion of the period 2013–2016, a prolonged period of accommodative monetary conditions, turns out to be key to the existence of this relationship.

The potential risks to financial stability arising from these relationships will differ depending on the position of the economy in the financial cycle and on the current level and expected evolution of financial imbalances. At times of low financial imbalances, for example in the period following the financial crisis, the tendency to take on more risk is low and accommodative monetary policy thus need not cause increased risk-taking. By contrast, in an expansionary phase of the financial cycle, when financial imbalances are starting to form, a monetary policy easing may in the long run contribute to the generation of hidden risks and potentially pose a risk of undervaluation of the necessary level of capital. In such case, it would be justified to take the evolution of risk weights into account when applying the relevant macroprudential policy tools. The primary and preferred way of ensuring financial stability in such a situation would be to use macroprudential policy tools, while keeping monetary policy instruments targeted at price stability.[25]

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24 Another potential weakness of risk-sensitive capital regulation is its inherent procyclicality. This consists in the fact that risk parameter estimates are highest at the lowest point of the financial cycle (owing to a high NPL ratio and worsening quality of other assets); in the expansionary phase of the cycle, by contrast, asset quality rises and risk parameter estimates fall (for more details, see, for example, Borio et al., 2001; Rochet, 2008; Repullo et al., 2010; Behn et al., 2016b, Brož et al., 2017; BCBS, 2016).

25 For more details, see the blog article by Vladimír Tomšík and Jan Frait *Pro plnění dvou cílů potřebuje ČNB minimálně dva nástroje* (*The CNB needs at least two instruments to fulfil two targets*, available in Czech only) at http://www.cnb.cz/cs/o_cnb/blog_cnb/prispevky/tomsik_frait_20160307.html.

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