WORKING PAPER SERIES 15

2018

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CNB CZECH NATIONAL BANK

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The Leverage Ratio and Its Impact on Capital Regulation

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Abstract

The capital regulation reform package proposed for the EU banking sector envisages the introduction of a minimum leverage ratio as a (non-risk-weighted) prudential backstop. In this paper, we use Czech bank-level data to explore the implications of introducing a leverage ratio into the capital regulatory framework. Our results confirm that the capital and leverage ratios complement each other. On the other hand, if a minimum leverage ratio is binding on some institutions, the increase in macroprudential capital buffers does not necessarily lead to a real increase in the capital and resilience of those institutions. We therefore describe possible settings of the macroprudential leverage ratio that would maintain the effectiveness of macroprudential policy. Furthermore, we derive channels through which the capital and leverage ratios might be affected and test the functionality of those channels. We find that the leverage ratio is far less procyclical than the capital ratio.

Abstrakt

Navrhovaný soubor opatření na reformu kapitálové regulace bankovního sektoru EU předpokládá zavedení minimální hodnoty pákového poměru jako (rizikově nevážené) obezřetnostní pojistky. V tomto článku využíváme data pro ČR na úrovni jednotlivých bank, abychom prozkoumali implikace začlenění pákového poměru do rámce kapitálové regulace. Naše výsledky potvrzují, že kapitálový a pákový poměr se vzájemně doplňují. Na druhou stranu, je-li minimální pákový poměr pro některé instituce závazný, zvýšení makroobezřetnostních kapitálových rezerv nemusí nutně vést ke skutečnému nárůstu kapitálu a odolnosti těchto institucí. Popisujeme proto možnosti nastavení makroobezřetnostního pákového poměru, které by zachovaly účinnost makroobezřetnostní politiky. Dále odvozujeme kanály, jejichž prostřednictvím by mohl být kapitálový a pákový poměr ovlivňován, a testujeme funkčnost těchto kanálů. Zjišťujeme, že pákový poměr je mnohem méně procyklický než kapitálový poměr.

JEL Codes: G21, G28.

Keywords: Capital ratio, leverage ratio, macroprudential policy, regulation.

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This work was supported by Czech National Bank Research Project No. C3/16.
The authors would like to thank to the referees Helena Sůvová and Jiří Witzany, the research coordinator Simona Malovaná and to the participants at the Czech National Bank seminar held on 5 December 2018 for insightful comments. All remaining errors and omissions are those of the authors.
The views expressed in this paper are those of the authors and not necessarily those of the Czech National Bank or the Czech Ministry of Finance.

Nontechnical Summary

The general objective of capital regulation is to increase banks' resilience to unpredictable losses and to ensure that any losses they do incur are borne by their owners. The CRD IV regulatory framework extends capital regulation to include (risk-weighted) macroprudential capital buffers, which should further increase the banking sector's resilience to systemic risks. However, experience has shown that a capital level based on risk-weighted assets may not be a sufficient guarantee of stability if the banking sector is excessively leveraged and the real risks of exposures are underestimated for whatever reason. The Basel Committee on Banking Supervision (BCBS) has therefore proposed regulatory changes associated with risk weights, but their real full impact on capital levels will only be felt in the distant future (2027). Beside these initiatives, the BCBS previously came up with the concept of the leverage ratio as a prudential backstop in capital regulation. The leverage ratio, which this paper focuses on, abstracts from the various credit risk levels of different asset classes and links Tier 1 capital to total exposures, comprising total assets plus selected off-balance-sheet items. In late 2010, the BCBS recommended a methodology for calculating the leverage ratio and preliminarily set the minimum ratio (referred to here as the microprudential leverage ratio) at 3%. Neither the form nor the calibration of the leverage ratio as a binding regulatory tool has been set definitively yet. The legislative process is still ongoing and the topic is becoming more and more complex.

In the paper, we explore the implications of introducing the leverage ratio into the capital regulation framework of the banking sector. We argue that the introduction of a microprudential leverage ratio as a regulatory requirement in the future should increase banks' resilience to less risky exposures and their resilience in an environment where aggregate risk weights are well below the critical average risk weight (CARW). On the other hand, if the microprudential leverage ratio is higher than the total capital ratio requirement including any relevant capital buffers (the microprudential leverage ratio is binding), the application of macroprudential capital buffers does not necessarily lead to a real increase in the volume of capital.

Our estimates confirm a mostly intuitive relationship between risk weights and the capital and leverage ratios using Czech bank-level data. Other things held constant, increasing risk weights reduces the capital ratio directly through the denominator effect. Banks have incentives to react to growing risks by topping up their capital, which leads to an increase in the leverage ratio, but the response is dependent on the relative size of the bank capital surplus, which can differ across bank groups. In general, banks with high capital surpluses could let their capital ratios decrease (and draw on their capital surpluses). In this case, the leverage ratio would not be influenced. Furthermore, we determine four basic channels through which a bank's capital position may be affected. The aggregate risk weights generally decline during a financial boom due to asset quality improvements (asset quality channel), the volume of exposures (asset volume channel) and the ratio of client loans to total assets (asset structure channel) tend to grow. These changes increase profitability (asset profitability channel). At the same time, however, a possible fall in risk weights (asset quality channel) increases the capital ratio and the bank can thus hold a lower level of capital to meet the regulatory capital requirement. In such a situation, the complementary nature of the leverage ratio including the macroprudential buffer could be an important tool for maintaining the resilience of the banking system.

1. Introduction

The general objective of capital regulation is to increase banks' resilience to unpredictable losses and to ensure that any losses they do incur are borne by their owners. This should ultimately curb risky behaviour by banks and reduce the likelihood of financial instability in the banking sector. The CRD IV regulatory framework extends capital regulation to include (risk-weighted) macroprudential capital buffers, which should further increase the banking sector's resilience to systemic risks. However, experience has shown that a capital level based on risk-weighted assets may not be a sufficient guarantee of stability if the banking sector is excessively leveraged and the real risks of exposures are underestimated for whatever reason. The Basel Committee on Banking Supervision (BCBS) has therefore proposed regulatory changes associated with risk weights, but their real full impact on capital levels will only be felt in the distant future (2027). Beside these initiatives, the BCBS previously came up with the concept of the leverage ratio as a prudential backstop in capital regulation. The leverage ratio, which this paper focuses on, abstracts from the various credit risk levels of different asset classes and links Tier 1 capital to total exposures, comprising total assets plus selected off-balance-sheet items.

In late 2010, the BCBS recommended a methodology for calculating the leverage ratio and preliminarily set the minimum ratio (referred to here as the microprudential leverage ratio) at 3%, which limits the leverage of total exposures to 33.3 times Tier 1 capital. The reform package submitted by the European Commission in November 2016 discusses the introduction of a binding leverage requirement into the current capital regulation (CRR). The CRR does not contain any minimum required leverage ratio yet, but this should form part of the CRR2 reform package if the latter is adopted in the future. The preliminary calibration of the minimum leverage ratio is based on the recommendations of the Basel Committee and on the European Banking Authority's report on the impact assessment and calibration of the leverage ratio (EBA, 2016a), which agrees with the minimum of 3% recommended by the Basel Committee.

This preliminary leverage ratio may not fulfil its role of prudential backstop in certain situations. We therefore focus on the use of macroprudential leverage buffers as envisaged and elaborated by the European Systemic Risk Board (ESRB), which has recommended their use in macroprudential policy. They should serve to maintain the effectiveness of activated macroprudential capital buffers aimed at mitigating excessive credit growth and leverage (ESRB, 2013). National authorities may introduce them in the event of a substantial build-up of systemic risk, as the Bank of England did recently (BoE, 2015). Possible settings and modes of use of the macroprudential leverage ratio are described in ESRB (2015), but these are not binding in any way. Moreover, the BCBS (2017) reform package proposes the introduction of a macroprudential leverage ratio for global systemically important banks (G-SIBs) and the introduction of a national discretion to temporarily exclude banks' reserves at the central bank from the denominator of the leverage ratio under exceptional macroeconomic circumstances.

The legislative process is still ongoing and the topic is becoming more and more complex. We therefore explore the implications of introducing the leverage ratio into the capital regulation framework of the banking sector. We begin by describing the nature of, and the relationship between, the leverage and capital ratios (also referred to as the two tools below). We then describe possible settings of the macroprudential leverage ratio and their impact on the effectiveness of certain macroprudential policies. We go on to analyse the relationships between the two tools and selected financial indicators using Czech bank-level data in 2002−2017. Specifically, we use a series of panel vector autoregression model estimates to (i) verify the potential drivers of risk-weighted assets and (ii) estimate the effects of possible channels of the bank capital position.

2. The Theoretical Relationship between the Capital and Leverage Ratios[1]

Neither the form nor the calibration of the leverage ratio as a binding regulatory tool has been set definitively yet. We provide a few examples to illustrate the importance of the leverage ratio as a supplementary tool in capital regulation of the banking sector. These examples are based on the preliminary form of the tool as described in ESRB (2015). **Table 1** summarizes the terms used in this paper relating to the two tools.[2]

Table 1: Terms Relating to Capital Regulation Tools

Capital ratio	Ratio of capital to total risk exposures that bank actually holds (in %)
Minimum capital ratio	Ratio of regulatory minimum capital to total risk exposures (in %)
Macroprudential capital buffers	Add-ons to minimum capital ratio depending on evolution of systemic risk (in %)
Total capital ratio requirement	Sum of minimum capital ratio and macroprudential capital buffers (in %)
Leverage ratio	Ratio of Tier 1 capital to total exposures that bank actually holds (in %)
Microprudential leverage ratio	Minimum prescribed leverage ratio (in %)
Macroprudential leverage ratio	Add-on to leverage ratio above its microprudential level depending on evolution of systemic risk (in %)
Total leverage ratio requirement	Sum of microprudential and macroprudential leverage ratios (in %)
Capital requirement	Absolute amount of capital implied by total capital or leverage ratio (in CZK)
Capitalization	Absolute amount of capital that bank actually holds (in CZK)

The **capital ratio** is a capital regulation tool that reflects the riskiness of assets. It is based on the capital requirement,[3] which is a function of the regulatory minimum capital ratio, the amount of assets and the risk weights of the relevant asset classes:

$$RWR = K^{RWR} / RWA \text{, where } RWA = RW \cdot TA \quad (1)$$

which gives this formula for the capital requirement:

$$K^{RWR} = \left(RW \cdot TA\right) \cdot RWR \quad (2)$$

[1] This section draws heavily on Pfeifer et al. (2017a), an article published in the Czech Journal of Economics and Finance.

[2] These terms are for reference only and should not be taken as binding, as some of them have yet to be incorporated into legislation because the regulatory process is still ongoing.

[3] In this article, we do not concern ourselves with the capital requirements for market risk and operational risk, which are based on other types of risks than credit risk. This is a simplification, as we work solely with the capital requirement for credit risk, which accounted for approximately 85% of the total capital requirement. We also use total risk exposures rather than risk-weighted exposures.

where RWR is the total capital ratio requirement (%), K^{RWR} is the capital requirement implied by the total capital ratio requirement, RWA are risk-weighted assets, RW is the average risk weight across all asset classes and TA are total assets.

The main advantage of the capital ratio is that it takes into account the riskiness of assets. The general idea is that a bank which invests in high-risk assets should hold more capital than one that invests in low-risk assets. CRD IV allows risk weights – and hence the riskiness of an asset – to be determined using either a standardized approach (STA) or an internal rating-based approach (IRB). Banks applying the STA approach determine risk weights according to values laid down by law,[4] whereas those using the IRB approach use internal models. The main risk characteristics which determine the risk weights in banks' IRB models are the probability of default (PD) and the loss given default (LGD).[5]

The IRB approach is generally used to measure credit risk by large banks. While its advantages include greater sensitivity of the capital requirement to the risk structure of banks' assets, it tends to produce a lower risk weight for a given asset class than the STA approach.[6] Moreover, given the relative complexity of the IRB approach, some authors express concerns about the risk of insufficiently strict models, or "model risk" (Leslé and Avramova, 2012). Brož et al. (2017) additionally show that the risk weights of exposures under the IRB approach are procyclical with respect to the financial cycle. Aikman et al. (2014a) assert that financial systems are better characterized by existing uncertainty than by the assessment of frequently unpredictable risk. For this reason, they believe that complex approaches to setting capital requirements should be complemented with simple yet comprehensive ones. BIS (2016b) and EBA (2016b) analyse the differences across banks in the RWA calculation and their consequences and propose legislative changes to the IRB approach. The basic backstop will be a lower limit on risk weights under the IRB approach (an "output floor"), which should correspond to 72.5% of risk-weighted assets under the STA approach (phased in between 2022 and 2027).[7] However, the risk weights under the STA approach will take credit risk more into account. For example, the risk weights for housing and commercial property loans will not be fixed, but will be dependent on the loan-to-value ratio. CNB calculations (2018, p. 113) made using data as of 31 December 2017 show that the revised rules would lead to a decrease in the average risk weight in this category.

The **leverage ratio** is a function of Tier 1 capital and total exposures, comprising total assets plus selected off-balance-sheet items:[8]

$$LR = K^{LR} / TE \qquad (3)$$

[4] Under the STA approach, the asset class, its external rating and any collateral are taken into account when determining the risk weight. As of the end of 2015, the STA approach was being used to determine risk weights for 29% of total exposures (CNB, 2016, pp. 46), so the IRB approach to determining credit risk was dominant.

[5] Other variables enter the equation for the calculation of risk weights. For details, see Articles 153–154 of the CRR.

[6] This is true for Czech banks (CNB, 2015, pp. 42–45).

[7] Moreover, in the future (from 2020), there will be a requirement for adequate representation of data from a period of economic contraction in the data sets used for calibrating IRB parameters (see EBA, 2017).

[8] Besides total assets, total exposures partially include the values of derivatives and add-ons for counterparty credit risk of repurchase transactions, securities or commodities lending or borrowing transactions, long settlement transactions and margin lending transactions. Other off-balance-sheet items are adjusted by the relevant coefficient. For details, see BIS (2016a) or ESRB (2015, pp. 12–27).

which gives the following capital requirement calculation:

$$K^{LR} = TE \cdot LR \tag{4}$$

where LR is total leverage ratio requirement (%), K^{LR} is the capital requirement implied by the total leverage ratio requirement and TE are total exposures[9] for the leverage ratio calculation.

The leverage ratio is therefore a (currently non-binding) capital regulatory tool that does not reflect the riskiness of assets. Experience from the global financial crisis has shown that banks can record large losses even on assets that are generally regarded as low risk and have been assigned the highest rating (securitized assets and government bonds). As a result, these "safe" assets have low risk weights and the capital requirement for them is therefore low. A bank can thus lower its overall capital requirements by changing its balance-sheet structure towards certain types of "safe" assets. The leverage ratio sets the capital requirement regardless of the riskiness of assets and thus defines the minimum absolute capital requirement. The risk of insufficient capital due to "model risk", procyclicality or changes in balance-sheet structure towards "safe" assets can therefore be mitigated by setting the tool at the right level. Introducing the microprudential leverage ratio implies setting the maximum leverage level. Juselius and Drehmann (2015) state that leverage, together with the debt service burden, are the main drivers of the financial cycle. The main objective of introducing the leverage ratio is therefore to increase banks' resilience to less likely losses due to the credit risk of assets with relatively low risk weights. This can reduce the probability and size of future financial crises. A potentially positive impact of the leverage ratio on financial stability is mentioned, for example, by Bair (2015), Grill et al. (2015) and Pfeifer et al. (2017a).

Table 2 summarizes the pros and cons of the capital and leverage ratios[10] and illustrates their complementary relationship, with the pros of one offsetting the cons of the other and vice versa. The leverage ratio to some extent mitigates the weaknesses of the capital ratio, such as modelling method complexity, model risk and procyclicality, all of which can lead to a lower capital requirement. Conversely, the capital ratio reduces the risk of funds being moved into riskier, higher-yield assets – a real risk if only the leverage ratio is in force.

Table 2: Pros and Cons of Capital Regulation Tools

Leverage ratio	Pros	(1) Increases resilience to less likely but highly correlated losses (2) Simple tool (3) Countercyclical
	Cons	(1) Increases risk of transfer of assets into riskier, higher-yield assets (2) Can be major regulatory change for banks specializing in low-risk assets
Capital ratio	Pros	(1) Reflects level of risk of assets and thus reduces incentive to allocate resources into riskier, higher-yield assets (2) Allows for more effective management of credit risk (IRB models)
	Cons	(1) Reliant on risk assessment of all types of assets – model risk (IRB models) (2) Low capitalization for allegedly less risky assets (3) Complex and insufficiently comparable

Source: Pfeifer et al. (2017a).

[9] To better explain the role of the leverage ratio in capital regulation, we abstract from off-balance-sheet exposures and use a simplified leverage ratio defined as the ratio of Tier 1 capital to total assets. In other words, we assume that total assets equal total exposures.

[10] For details on the costs and benefits of introducing the leverage ratio, see Fender and Lewrick (2015).

In fact, setting a risk-weight floor under the IRB approach would have a similar effect as introducing a microprudential leverage ratio.[11] This option may be more appropriate where model risk or systemic risk is associated with a specific asset class or sector. However, if those risks cannot be ruled out for other asset classes and other sectors, it seems easier and more effective to use the leverage ratio and set risk-weight floors for multiple asset classes (for details, see ESRB, 2015, pp. 23–25).

2.1 The Constraining Effect of the Capital and Leverage Ratios

The complementary relationship between the two tools suggests that they have different effects on a bank's capital requirement (see **Table 3**). To illustrate those different effects, we chose the same settings of the two tools as in ESRB (2015), i.e. a total capital ratio requirement expressed in terms of Tier 1 capital[12] of 8.5% (a minimum requirement of 6% plus a 2.5% capital conservation buffer[13]) and a microprudential leverage ratio of 3%. We then chose individual asset classes and corresponding regulatory risk weights based on the STA approach. The different effects of the leverage and capital ratios are clear from the last two columns of the table. A focus by banks on riskier assets is associated with a higher capital requirement based on the total capital ratio requirement, whereas a focus on less risky assets is associated with a higher requirement based on the microprudential leverage ratio.

Table 3: Minimum Capital Requirement Given a Microprudential Leverage Ratio of 3% and a Risk-weighted Capital Requirement of 8.5%

Asset class (100)	*STA regulatory risk weights of banks (in %)*	**Capital**	
		Microprudential leverage ratio	*Risk-weighted requirement*
Central governments	0	3.0	0.0
Financial institutions	20	3.0	1.7
Retail – mortgage loans	**35**	**3.0**	**3.0**
Retail – consumer loans	75	3.0	6.4
Corporate sector	100	3.0	8.5

Note: As an example, we chose an exposure of CZK 100,000 and assumed a microprudential leverage ratio of 3% and a total capital ratio requirement of 8.5%. Using the formula for computing capital requirements, we calculated the capital requirements based on the leverage and capital ratios (last two columns, in CZK thousands).

Table 3 shows that, given relevant settings of the two tools, the microprudential leverage ratio (3%) leads to the same capital requirement (CZK 3,000) as the total capital ratio requirement (8.5%) at an average risk weight of 35%. With the said settings of the two tools, a risk weight of 35% therefore represents the critical average risk weight (CARW), which we obtain by dividing the total leverage ratio requirement by the total capital ratio requirement (3/8.5).[14] The CARW is

[11] There is an ongoing discussion on this issue (BIS, 2016b).

[12] The leverage ratio is also expressed in terms of Tier 1 capital for now.

[13] Although the capital conservation buffer is commonly classed as a macroprudential tool, it is in essence a newly defined element of the traditional microprudential capital requirements. In order to simplify, we do not consider Pillar 2 idiosyncratic capital requirements, which can also interact with the leverage ratio.

[14] If we did not abstract from off-balance-sheet items for the leverage ratio, the equation would be: $CARW = (LR/RWR) \cdot (TE/TA)$.

therefore the average risk weight at which the bank is equally constrained by the two tools, or at which the bank must maintain the same capital requirement to comply with both tools.

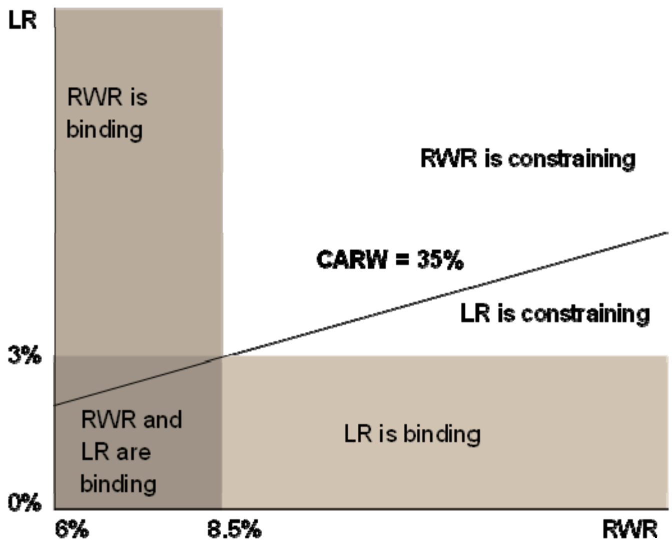
$$CARW = LR / RWR \tag{5}$$

It also holds that:

$$\begin{aligned} K^{LR} &= K^{RWR} \text{ if } CARW = RW \\ K^{LR} &> K^{RWR} \text{ if } CARW > RW \\ K^{LR} &< K^{RWR} \text{ if } CARW < RW \end{aligned} \tag{6}$$

So, if both tools are applied, banks will be constrained by at least one of them at any given moment in time, depending on which capital requirement is higher (the leverage ratio or the capital ratio). The constraining effect of the specific tool depends, in addition to its setting, on banks' business model or risk weights. In our illustrative example, if a bank has an average risk weight above 35%, it will be constrained by the capital ratio. Conversely, if the risk weight is below 35%, the leverage ratio will be constraining (see **Figure 1**). The CARW level therefore determines the constraining effect of the two tools.

Figure 1: Constraining Effect of the Leverage and Capital Ratios Given a Constant CARW



Note: LR denotes the total leverage ratio requirement and RWR the total capital ratio requirement. If the LR is identified as constraining, banks must hold more capital under the leverage ratio requirement. If the RWR is constraining, banks must hold more capital based on the regulatory capital ratio. The area denoted as binding is the area associated with a breach of the regulatory requirement in our illustrative example.

Source: Fender and Lewrick (2015); compiled by the authors

Note that if changes in the settings of the two tools are equal in percentage terms, the CARW level will not change (see **Figure 1**). However, if they change differently, the CARW will also change. For example, an increase in the regulatory capital ratio (i.e. as a result of the introduction of, or an increase in, macroprudential capital buffers) will reduce the CARW and hence also the constraining effect of the leverage ratio. Therefore, it has been proposed that the leverage ratio requirement should take into account the level of capital buffers and thus become a macroprudential policy tool.

2.2 The Macroprudential Leverage Ratio as a Complement to Macroprudential Capital Buffers

Macroprudential capital buffers usually fulfil two macroprudential policy objectives: (i) to prevent misaligned incentives for financial institutions (the structural dimension of systemic risk and (ii) to prevent excessive credit growth and leverage (the cyclical dimension of systemic risk). In this section, we will look at possible ways of linking the two objectives to the macroprudential leverage ratio. We will therefore assume that the microprudential leverage ratio is in force as a capital regulation tool.

To mitigate the structural dimension of systemic risk, CRD IV allows the application of a broadly defined systemic risk buffer (SRB). This buffer is currently applied in some jurisdictions to systemically important institutions and has the same objective as those for global and other systemically important institutions (G-SIIs and O-SIIs respectively).[15] These buffers are meant to increase the resilience of systemically important institutions, whose failure could impair the stability of the entire financial system. ESRB (2015) describes the option of linking the above buffers to a "**structural macroprudential leverage ratio**", the application of which would simultaneously increase the total leverage ratio requirement.

In periods of excessive credit growth and leverage, which are associated with an elevated risk of future losses, CRD IV provides for the application of a countercyclical capital buffer (CCyB).[16] The objective of the CCyB is to reduce the risk of excessive credit growth and the effect of the cycle on capital requirements. In booms, the risk weights of IRB banks[17] can move procyclically (Aikman et al., 2014b) due to procyclicality in the components used to calculate them, as PD and LGD (see section 2 of this paper) are derived from measures[18] that tend to be lower in booms and higher in recessions. Given the recurring expansion and contraction phases of the economic and financial cycle, the economy can be expected to slow after a period of strong growth.[19] The CCyB is therefore applied during a boom so it can later be released during a contraction. This should lead to greater resilience of banks and lower amplitude of the credit cycle. ESRB (2015) describes the option of linking the CCyB to a "**countercyclical macroprudential leverage ratio**".

2.2.1 The Impact of the (Non-)Introduction of the Macroprudential Leverage Ratio

In section 2, we followed the lead of the ESRB (2015) by using a CARW of 35%. However, the CARW can vary depending on the settings of the total leverage and total capital ratios (see **Table 4**). The CARW is lowered among other things by the introduction of macroprudential capital buffers without the simultaneous introduction of a macroprudential leverage ratio. This

[15] The SRB is governed by Article 133 of the CRD and the G-SII and O-SII buffers by Article 131 of the CRD.

[16] The CCyB is governed by Article 136 of the CRD.

[17] At the moment, procyclical movement in the components of risk weights can pose a risk to IRB banks. If risk triggers are introduced in the STA approach (BIS, 2015), a similar risk could apply to STA banks.

[18] PD is derived from the ratio of NPLs to total loans in the investment portfolio and LGD from the rate of recovery of a given NPL.

[19] In a contraction phase of the financial cycle, by contrast, PD, LGD and hence also risk weights tend to be overestimated even though they are often falling due to investments being moved into less risky assets. This could constrain lending activity and hinder economic recovery.

lowers the risk weight indicating the minimum absolute capital requirement and reduces the constraining effect of the microprudential leverage ratio.

If, for example, the SRB is introduced for systemically important institutions and the structural macroprudential leverage ratio is not simultaneously activated, the CARW for those institutions will decrease, because the total capital ratio requirement will rise while the total leverage ratio requirement will remain unchanged. The CARW will thus be lower and the leverage ratio less constraining for systemically important institutions than for the rest of the sector. Conversely, if the structural macroprudential leverage ratio is introduced simultaneously, the total leverage ratio requirement will be higher and the maximum leverage level lower for systemically important institutions than for the rest of the banking sector.

Table 4: Effects of Macroprudential Capital Buffers on Bank Resilience (Assumption: Total Exposures = CZK 1,000; RW = 25%; Microprudential Leverage Ratio = 3%)

Items included in total capital ratio requirement	**Total capital ratio requirement**		**Microprudential leverage ratio**		**CARW**
	%	**CZK**	**%**	**CZK**	**%**
Minimum capital ratio (MCR)	6.0	15.0	3.0	**30.0**	50
MCR+CCoB	8.5	21.3	3.0	**30.0**	35
MCR+CCoB+CCyB	11.0	27,5	3.0	**30.0**	27
MCR+ CCoB+CCyB+SRB	14	**35.0**	3.0	30.0	21

Note: MCR = minimum capital ratio (Tier 1), Tier 1 = highest-quality regulatory capital; CCoB = capital conservation buffer; CCyB = countercyclical capital buffer; SRB = systemic risk buffer.

If the countercyclical macroprudential leverage ratio is not activated at the same time as the CCyB, the constraining effect of the microprudential leverage ratio will decrease during an expansion phase of the financial cycle. The risk weight implying the minimum absolute capital requirement will fall as the CARW decreases. Conversely, if the countercyclical macroprudential leverage ratio is simultaneously applied, the maximum leverage level will fall in an expansion phase of the financial cycle.

A rise in the macroprudential capital buffers without a corresponding increase in the macroprudential leverage ratio therefore always leads to a fall in the CARW and a decrease in the constraining effect of the leverage ratio. If, despite the fall in the CARW, the average risk weight remains lower than the CARW for some banks, an increase in the macroprudential capital buffers may not have a constraining effect on those banks (eventually only part of the macroprudential capital buffers would be usable) – see **Table 4**. The capital requirement based on the microprudential leverage ratio would remain higher than the capital requirement based on the total capital ratio requirement (see section 2.2). These banks would thus continue to be constrained by the microprudential leverage ratio, and their capital requirement may not sufficiently take into account the increase in systemic risk. The introduction of the macroprudential leverage ratio could therefore have a positive effect on the attainment of macroprudential policy objectives, especially in a situation where systemic risk is rising and the risk weights of banks with significant market shares are below the CARW (the microprudential leverage ratio is higher than the minimum capital ratio). This is because the macroprudential leverage ratio has a similar objective as the macroprudential capital buffers, the only difference being that it constrains banks with risk weights below the CARW, on which macroprudential capital buffers do not have a constraining effect.

According to ESRB (2015), for the purposes of setting the macroprudential leverage ratio, it is possible to make some changes in line with the evolution of systemic risk or to apply a fixed rule that automatically keeps the CARW constant over time (which implies a constant constraining effect of the two capital regulation tools). In other words, a fixed rule can be used to ensure that the risk weight indicating the minimum capital requirement does not change.

We will not deal any further with minor adjustments to the macroprudential leverage ratio, as they can differ from case to case. We will concentrate on clarifying how the fixed rule could be applied.

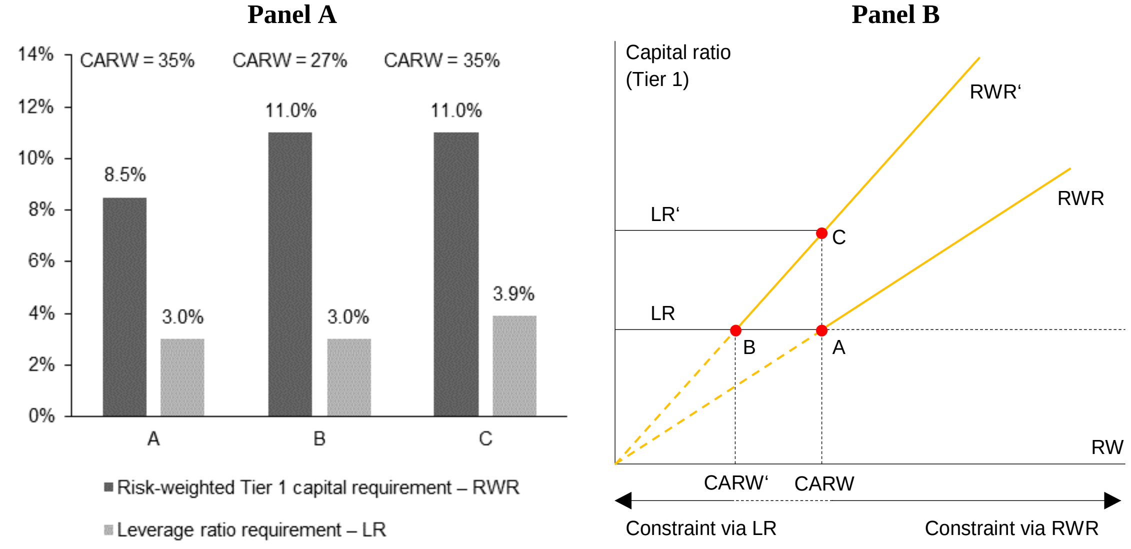
2.2.2 Setting the Macroprudential Leverage Ratio Using a Fixed Rule with an Initial CARW of 35%

We start with the example of setting the countercyclical macroprudential leverage ratio[20] using a fixed rule keeping the CARW constant at 35%. Then we look at the effect of a different initial CARW on the macroprudential leverage ratio when the fixed rule is applied.

Figures 2A and **2B** depict three different scenarios, all of them assuming a microprudential leverage ratio of 3% and a total capital ratio requirement of 8.5%. In scenario A, macroprudential buffers are not added to the total capital ratio requirement and the CARW is therefore 35% (3/8.5). In scenarios B and C, the maximum CCyB of 2.5% is introduced. However, these scenarios differ in the introduction of the countercyclical macroprudential leverage ratio. In scenario B, the macroprudential leverage ratio is not introduced and the total leverage ratio requirement remains at 3%. The CARW therefore falls to 27% (moving from point A to point B in **Figure 2B**). With this shift, the constraining effect of the capital ratio increases at the expense of that of the leverage ratio. In scenario C, the 2.5% CCyB is incorporated into the total leverage ratio requirement so that the CARW stays constant at 35% (the fixed rule mentioned above). The total leverage ratio requirement therefore rises to 3.9%, while the countercyclical macroprudential leverage ratio is 0.9% (point C in **Figure 2B**). As the CARW is kept constant, the constraining effect of the two tools remains the same as before the introduction of the CCyB. By definition, however, the minimum capital requirement increases and conversely the maximum possible leverage for banks decreases as the total leverage ratio requirement rises.

[20] The situation is more complicated for the structural macroprudential leverage ratio, as it only applies to certain institutions.

Figure 2: Effect of Introducing a Macroprudential Leverage Ratio on the CARW and the Constraining Effect of the Two Tools



2.2.3 The Effect of the CARW Level on the Macroprudential Leverage Ratio with the Fixed Rule Applied

When the fixed rule is applied, the initial CARW level has an effect on the macroprudential leverage ratio in addition to the setting of the constraining effect of the two tools, as it holds that:

$$\Delta LR = CARW \cdot \Delta RWR \qquad (7)$$

where ΔLR is the change in the total leverage ratio requirement and ΔRWR is the change in the total capital ratio requirement. In our example, the initial CARW can be 35% or 50% (see **Table 5**), which, for example, given the introduction of the maximum CCyB and keeping the CARW constant, leads to a macroprudential leverage ratio in the range of 0.9%–1.3%.

Table 5: Effects of the Minimum Capital Requirement Level on the CARW and the Macroprudential Leverage Ratio

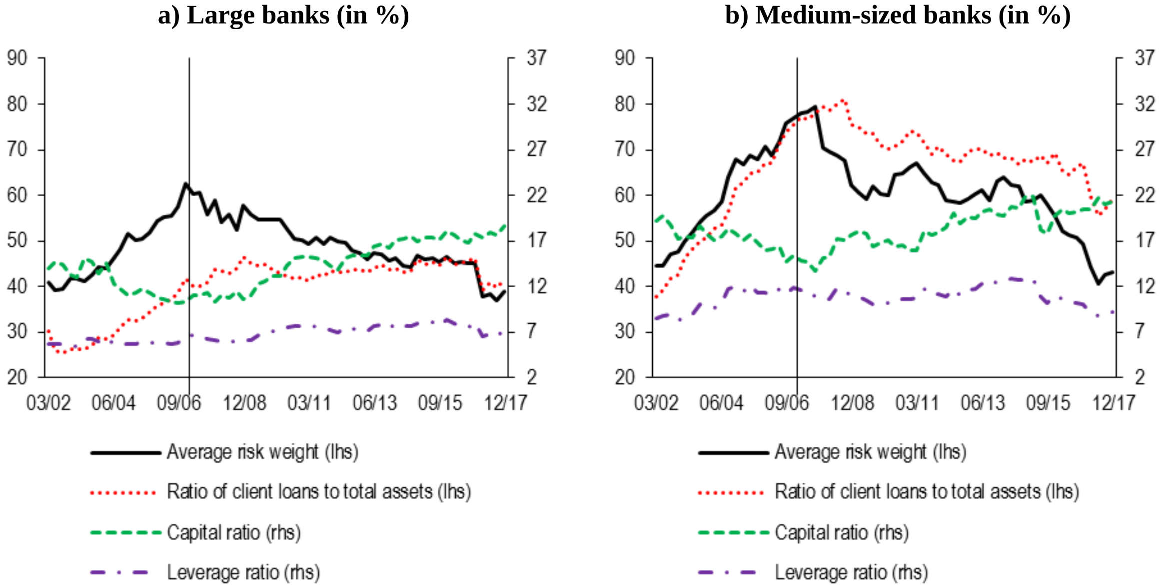
Items included in total capital ratio requirement	Total capital ratio requirement	Microprudential leverage ratio	CARW	Macroprudential leverage ratio		
				CCyB = 2.5%	SRB = 3%	CCoB = 2.5%
MCR	6.0	3.0	50	1.3	1.5	1.3
MCR+CCoB	8.5	3.0	35	0.9	1.1	-

Note: MCR = minimum capital ratio (Tier 1), Tier 1 = highest-quality regulatory capital, CCoB = capital conservation buffer, CCyB = countercyclical capital buffer, SRB = systemic risk buffer. The macroprudential leverage ratio, given in the final three columns of the table, is computed as the CARW multiplied by the relevant macroprudential capital buffer.

3. A First Glance at the Interaction of the Capital and Leverage Ratios

In this section, we first illustrate the relationship between the two tools and selected financial indicators for medium-sized and large banks in the Czech Republic in the period 2002–2017.[21] Given the significant role of risk weights, we then check for different impacts of changes in risk weights on the leverage and capital ratios.

Figure 3: Indicators Relating to Capital Regulation – Large and Medium-Sized Banks



Note: The vertical line denotes the start of the gradual migration to the IRB approach to measuring credit risk, which concerned all large banks and some medium-sized banks and building societies (in the majority of their portfolios). All small banks, however, still use the STA approach.

Source: CNB

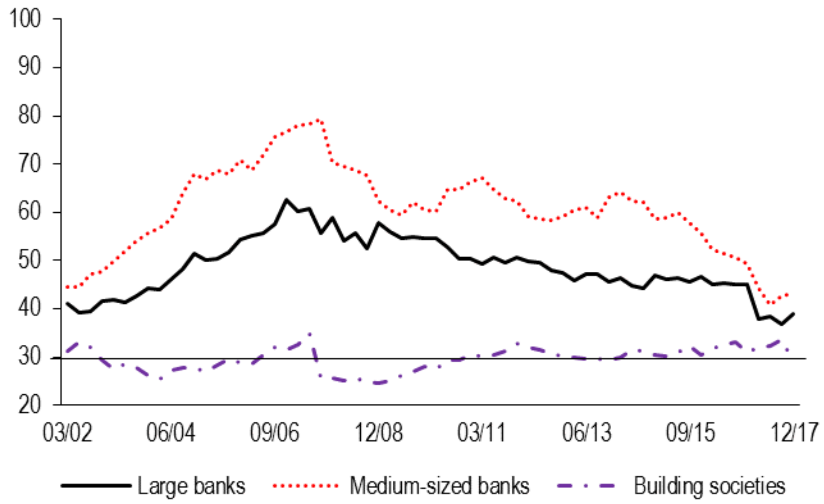
Figures 3a) and **3b)** illustrate the evolution of the leverage and capital ratios, risk weights and ratio of loans to total assets on the example of large and medium-sized banks. The risk weights are affected by the asset structure, which changes over time as a result of change not only in the ratio of loans to total assets, but also in the credit portfolio structure. However, the financial indicators used in the figures do not capture the change in credit portfolio structure. In the case of the IRB approach, the risk weights are also affected by the cyclicality of the components used to calculate them (especially the probability of default). In general, risk weights started to fall simultaneously with the switch to the IRB approach.

In section 2.2, we stated that the CARW level determines the intensity of effect of the individual capital regulation tools in the banking sector. By comparing the CARW and the average risk weights, we can determine which of the two tools has a constraining effect on a specific bank. For the purposes of explaining the relationship between the leverage and capital ratios, we have so far worked with a CARW of 35%, as in ESRB (2015). At this CARW level, the leverage ratio would represent a constraint for building societies in the Czech Republic, since the capital requirement

[21] For the purpose of the bank-level analysis, we divide banks according to their balance-sheet totals into large (over CZK 250 billion) and medium-sized (CZK 50 to 250 billion) banks and building societies. Note that we discard small banks from the analysis, as many of the financial indicators we consider are significantly influenced by the initial phase of small banks' business life cycle.

based on the leverage ratio would be higher than that based on the capital ratio over the entire period under review (see **Figure 4**). However, a substantial decline in risk weights is visible for all the other types of banks in recent years as well.

Figure 4: Risk Weights for Bank Types in the Czech Republic (in %)

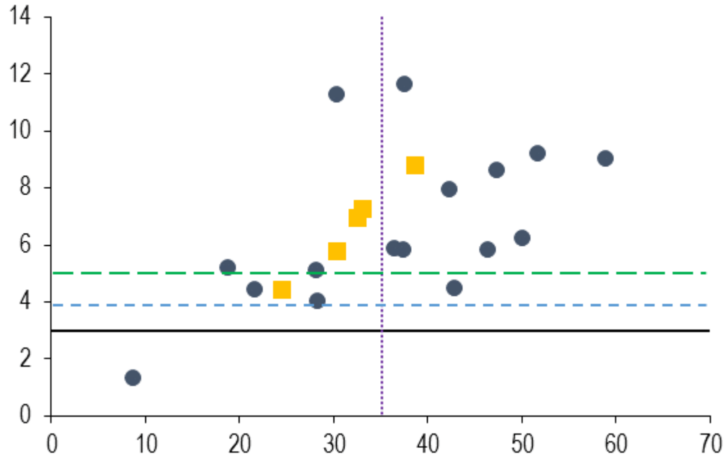


Note: The average risk weight is calculated as the ratio of risk-weighted assets to total assets. The thick horizontal line denotes a CARW of 35%.

Source: CNB

Figure 5 depicts the risk weights and leverage ratios for banks. One bank would currently be non-compliant with a microprudential leverage ratio of 3%. If we were to take into account the setting of the macroprudential leverage ratio in the scenario highlighted in **Table 5** (as also used by ESRB, 2015), i.e. a maximum countercyclical component of 0.9% and a structural component of 1.1%, another bank would be non-compliant with the maximum total leverage ratio requirement. For those two institutions and another two building societies, the leverage ratio would be constraining, as their risk weight is below 35%.

Figure 5: Leverage Ratios and Risk Weights across Banks as of End-2017 (X-Axis: Risk Weights in %; Y-Axis: Leverage Ratio in %)



Note: In this case, the leverage ratio calculation includes the effect of the off-balance sheet. Squared dots depict systemically important banks and round dots small and medium-sized banks and building societies. The vertical line illustrates a CARW of 35%. The solid black horizontal line illustrates a microprudential leverage ratio of 3%, the blue dotted line additionally a cyclical macroprudential leverage ratio of 0.9% and the green dashed line additionally a structural macroprudential leverage ratio for systemically important institutions of 1.1%.

Source: CNB

3.1 Leverage Ratios Adjusted for Exposures to the CNB

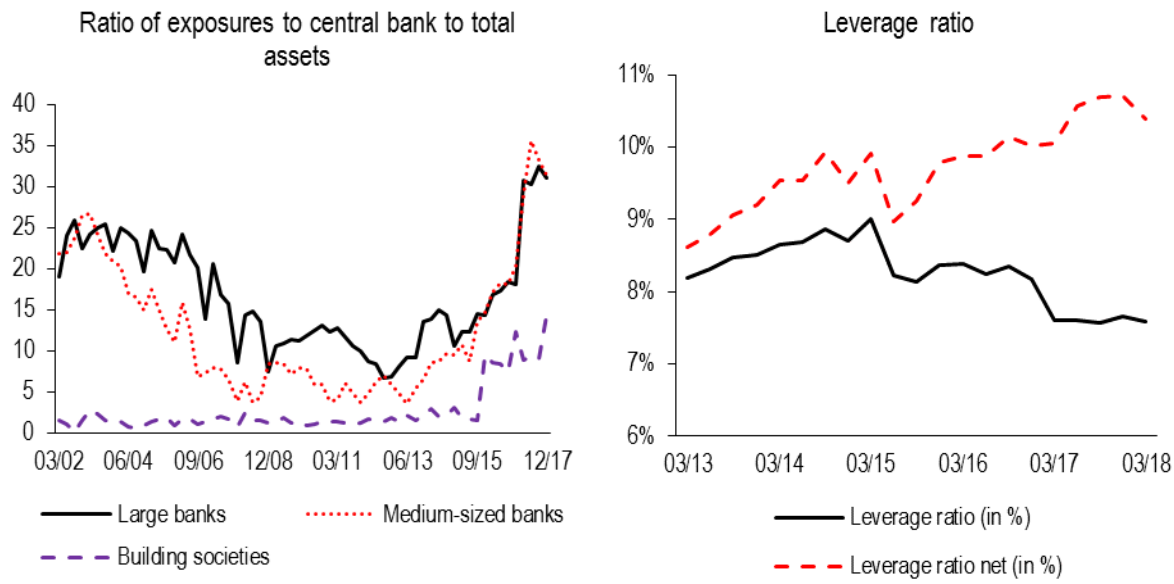
At the end of 2017, the BCBS (2017) presented a package of reform proposals. The reform package, among other things, proposes a national discretion allowing banks' reserves at the central bank to be temporarily excluded from the denominator of the leverage ratio under exceptional macroeconomic circumstances. Furthermore, the jurisdiction applying this discretion must also increase the minimum leverage ratio to maintain the same level of resilience provided by the leverage ratio. The United Kingdom has already adjusted the calculation of total exposures used in the denominator of the leverage ratio. UK PRA Policy Statement 21/17 states in this respect: "[…] *exclude central bank claims matched by deposits in the same currency and of identical or longer maturity from the definition of the total leverage exposure measure in the UK leverage ratio framework*".[22] The UK has also increased the minimum leverage ratio from 3% to 3.25%.

Such discretion is relevant to the Czech Republic as well, due to the significant share of exposures to the central bank in the balance sheet of the domestic banking sector. After the onset of the global financial crisis in 2008, central banks worldwide cut policy rates sharply and some of them continued to ease policy by various unconventional measures. The CNB used foreign exchange rate interventions as an additional monetary policy instrument (see Brůha and Tonner, 2017, for detailed information). The exchange rate commitment policy was reflected in a significant increase in banks' exposures to the CNB, which currently account for almost one-third of banks'

[22] Central bank claims means the following exposures of a firm to a central bank, provided these are denominated in the national currency of such central bank: banknotes and coins constituting legal currency in the jurisdiction of the central bank; reserves held by a firm at the central bank; and any assets representing debt claims on the central bank with a maturity of no longer than 3 months.

total assets. The leverage ratio may have been affected by the banking sector's high exposures to the central bank (see **Figure 6**).

Figure 6: Banks' Exposures to the Central Bank and Their Impact on the Leverage Ratio



Note: The asymmetric exchange rate commitment entered into force on 7 November 2013. Leverage ratio net denotes leverage ratio with banks' total assets net of exposures to the central bank.

Source: CNB

In line with the conclusions of the discussion in the BCBS, the CNB temporarily regards a leverage ratio excluding exposures to the central bank from the denominator of the formula as a more relevant leverage indicator for analytical purposes (CNB, 2018).

4. Microeconomic Evidence from Czech Bank-Level Data

In the empirical part of the paper, we use quarterly data on domestic banks drawn from the Czech National Bank's internal database.[23] Specifically, we collect data for various financial indicators for each bank in the sample and analyse how changes in the bank's balance-sheet items affect its capital position. Since most domestic banks have relatively simple and comparable business models, we believe our analytical outcomes are not that sensitive to the relative sample heterogeneity. Still, to address this potential issue, we divide banks according to their balance-sheet totals into large (over CZK 250 billion) and medium-sized (CZK 50 to 250 billion) banks. We also separately consider building societies, because their business model differs from that of universal banks. We discard small banks (7.3% market share) from our analysis, as many of the financial indicators we consider are significantly influenced by the initial phase of small banks' business life cycle, which we cannot control for. Furthermore, some small banks are government-owned and as such have rather specific business models. The summary statistics, along with the transformations of the data in levels, are provided in **Appendix A**.

[23] The data entering the empirical analysis are non-public and can be provided only to CNB staff with proper authorization.

Note that since the data on leverage ratios are not available in a long enough time series for us to compute the denominator, we use a simplified leverage ratio calculated as the ratio of Tier 1 capital to total assets (instead of total exposures), i.e. excluding off-balance-sheet items.[24] This simplification, however, does not pose a problem to, or bias, our estimates, as Czech banks are currently characterized by a relatively conservative business model focusing on lending to non-financial corporations and mortgages. The Czech banking sector's off-balance sheet is therefore relatively small (7.5% of total exposures as of 2017 Q4), justifying the above simplification.

4.1 Model Selection

The analysis is carried out using panel vector autoregression (PVAR) models. The primary motivation for choosing the family of VAR models was to come up with an approach that would be simple to execute and easy to interpret. Second, VAR models are sufficiently general, making them useful as a theory-free way of letting the data speak to order-of-causality questions. Third, we can find many types of autoregressive patterns in financial time series, so the financial market does not form a random entity. The VAR model incorporates these patterns and, for each variable entering the model, computes an equation explaining the variable's evolution based on its own lagged values. PVAR models have the structure of VAR models, in the sense that all the variables are assumed to be endogenous and interdependent, but a cross-sectional dimension is added to the representation (Canova and Ciccarelli, 2013). Our baseline PVAR takes the following form:

$$y_{it} = A_0 + A_1 y_{i,t-1} + \ldots + A_p y_{i,t-p} + f_i + u_t \text{, for } i = 1,\ldots,N \text{ and } t = 1,\ldots,T \qquad (8)$$

where $u_t \sim iid(0,\Sigma)$. We estimate the model using fixed time-invariant effects f_i. Following Georgoutsos and Moratis (2017), we only consider the lags of the same unit endogenous variables, thus not allowing for dynamic interdependencies.[25] The model is then estimated using the Arellano and Bover (1995) GMM estimator. Since we sort the individual banks into individual groups prior to estimation, we do not allow for cross-sectional heterogeneities either.

In our baseline model, the vector of endogenous variables comprises (i) the leverage ratio, (ii) the capital ratio, (iii) the capital surplus, (iv) the risk-weighted assets to total assets ratio, (v) the client loans to total assets ratio and (vi) the non-performing loans to total loans ratio. The chosen variables are meant to reflect the structure of banks' balance sheets while keeping the model traceable in the number of parameters to be estimated. Due to the significant increase in banks' exposures to the CNB during the exchange rate commitment policy, we cleansed the leverage ratio and risk-weighted assets of exposures to the central bank. We applied a Cholesky decomposition of the variance-covariance matrix in order to obtain the dynamic response of the chosen dependent variables to the defined shocks. Impulse response functions (IRFs) were obtained within a band representing a 95% confidence interval estimated by Monte Carlo simulations (1,000 iterations). Since the ordering of the variables may affect the IRFs, we rely in the main text on the generalized IRFs as proposed by Pesaran and Shin (1988). Still, Luetkepohl (1991) argues that the ordering of the variables makes little difference when the correlation of the

[24] The harmonized leverage ratio (according to the delegated act on the leverage ratio) has been reported only since 2016 and the time series is not fully homogeneous.

[25] As shown by Petersen (2009), if a standard mean-differencing procedure is employed to eliminate fixed effects, allowing for individual fixed effects in the presence of dependent lags in the VAR causes the coefficients to be biased.

residuals is small, which is our case. We plot the median responses to show the central tendency of the estimated response functions. The responses were normalized to represent 100 basis points' (bps) worth of shocks.[26]

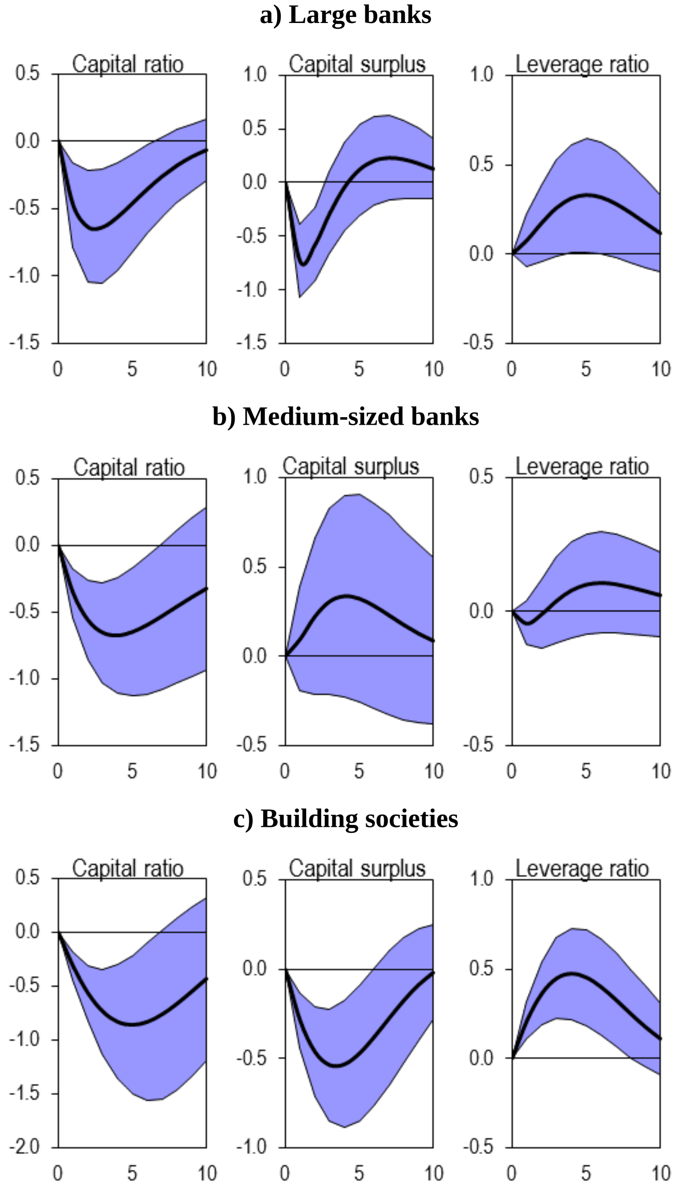
4.2 How Are Changes in Risk Weights Transmitted to the Capital and Leverage Ratios?

In our first empirical exercise, we discuss the mechanics of how changes in risk weights can be transmitted to the capital and leverage ratio. To this end, we simulate a market situation in which the share of risk-weighted assets in total assets increases unexpectedly. The results are summarized in **Figure 7** using IRFs and fully confirm our original assumptions. Following the shock, the capital ratio decreases due to the denominator effect. Generally, banks react to the growing risks by topping up their capital level, which conversely leads to an increase in the leverage ratio, highlighting the complementary relationship between the capital and leverage ratios. At the same time, however, the relative decrease in the capital ratio depends on the difference between the regulatory capital ratio and the actual capital ratio (the capital surplus). In another words, the inclusion of the capital surplus in the model is crucial. If it was omitted, the results could be significantly biased, since banks with high capital surpluses could very well let their capital ratios decrease (and draw on their capital surpluses). This is especially important for banking sectors where banks maintain their regulatory capital ratios well in excess of the regulatory minimum, as is the case of the Czech Republic (see Malovaná, 2017, for further analysis).

We now turn our attention to the individual bank groups' responses, as they vary in some cases. The effect of a change in the ratio of risk-weighted assets to total assets has the expected sign in the case of large and medium-sized banks. The capital ratio decreases together with the capital surplus, conforming nicely to the fact that banks in the Czech Republic maintain their capital ratio well in excess of the regulatory requirement. They can thus absorb an increase in risks without necessarily raising their capital, which explains the statistically insignificant response of the leverage ratio. The effect of the shock is also strong for building societies. This can be explained by their relatively low risk weights, which imply a lower capital requirement, i.e. a lower numerator in the capital ratio. An increase in its denominator, or risk-weighted assets, then causes a larger decline in the capital ratio. Conversely, an increase in the total capital ratio requirement, for example in the form of the introduction of a macroprudential capital buffer, will not necessarily increase the capital requirement significantly in absolute terms in a situation of low risk weights.

[26] We use the STATA code of Love and Zicchino (2006) for the panel VAR estimation.

Figure 7: Responses to a Positive Shock to the Risk-weighted Assets to Total Assets Ratio



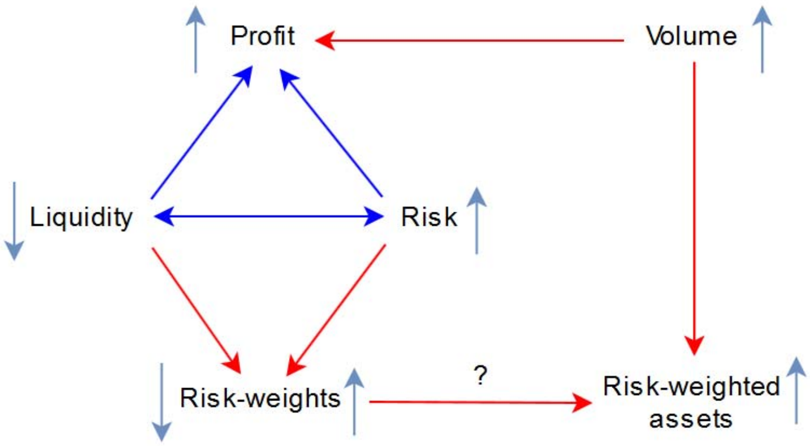
Note: The charts present generalized impulse responses computed by applying a variable-specific Cholesky factor. The x-axis shows the number of quarters after the shock and the y-axis the strength of the response to the 100 bps shock in percentages. The continuous line indicates the median response with 95% probability bands. All series are in log annualized growth rates.

4.3 Channels Affecting Bank Capital Positions

Since the ratio of risk-weighted assets to total assets has clear implications for the capital and leverage ratios, we continue the analysis by taking a close look at the potential drivers of risk-weighted assets. In fact, the description of the factors influencing the evolution of risk-weighted assets is simultaneously a description of the bank's capital position. We use a "magic triangle" to sketch the basic characteristics of banking assets and assume an indirect relationship between risks and liquidity. A higher share of liquid assets implies a lower share of riskier assets and consequently a lower level of risk weights (under the assumption that the riskiness of the asset classes remains unchanged). At the same time, higher profitability is associated with higher riskiness of assets and thus lower liquidity levels. Under these circumstances, a bank's goal would be to maximize revenue in relation to risks and liquidity.

Further, we can safely assume that the amount of revenues is also influenced by the volume of bank exposures. Therefore, we broaden the magic triangle into a quadrangle (**Figure 8**). The increasing volume of assets results in an increase in revenues and simultaneously in an increasing risk of future losses. To maximize profit, banks are constantly trying to allocate liquidity into riskier, less liquid assets and increase their volume. By doing so, they ultimately alter their capital and liquidity positions (while keeping in mind the regulatory requirements and liquidity profile of the banking system).[27]

Figure 8: Factors Influencing RWA and Basic Characteristics of Banking Assets



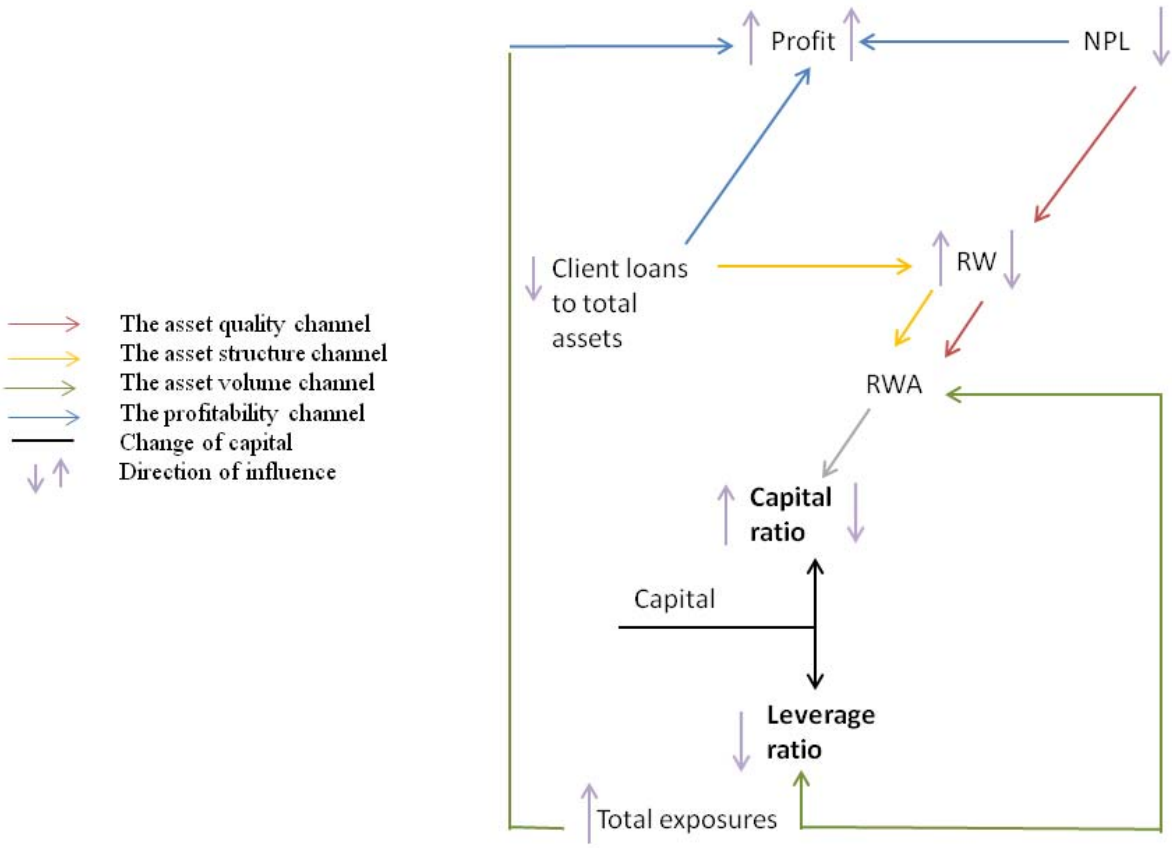
We determine four basic channels through which a bank's capital position may be affected:

- *Asset structure channel* – "liquidity" (further approximated by the share of client loans in total assets).
- *Asset volume channel* – the change in "asset volume" resulting from the bank's reaction to the changing external conditions and the evolution of the cycle.
- *Asset quality channel* – "risk" (further approximated by the ratio of non-performing loans to total assets).
- *Profitability channel* – "profit" (further approximated by the ratio of interest profit to total assets). This channel comprises the effects of changes in the structure, volume and quality of assets on the bank's profit. It does not directly affect the volume of risk-weighted exposures.

Using the set of proxy variables defined above, we can attempt to draw out the relationships between the balance-sheet channels. The impact of particular channels can evidently differ according to the distinct phases of the financial cycle. To reduce visual clutter, **Figure 9** depicts the linkages of the individual variables related to the bank's capital position during a financial boom only.

[27] For more details about the interaction of the capital and liquidity positions, see Pfeifer et al. (2017b).

Figure 9: Channels Affecting a Bank's Capital Position during a Financial Boom



Note: RW = risk weights, RWA = risk-weighted assets, NPL = ratio of non-performing loans to total loans.

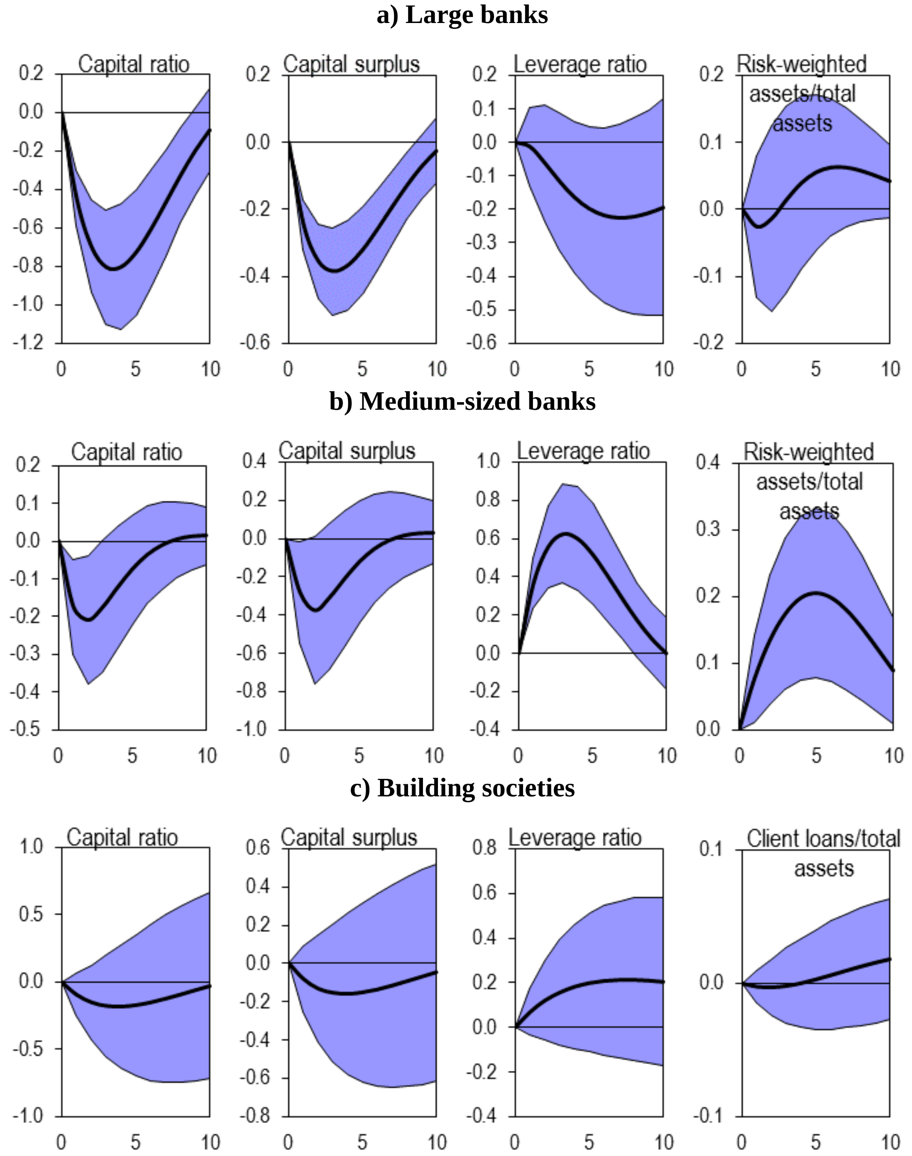
4.3.1 Asset Structure Channel

To verify the functionality of the **asset structure channel**, we simulate a situation under which banks decide to increase the ratio of client loans to total assets (**Figure 10**). In other words, banks alter their balance-sheet structure and expand the share of loans at the expense of quick liquid assets. This situation generally conforms to a financial boom period, when demand and supply factors cause a partial change in the asset structure from quick liquid assets towards more profitable loans. The ratio of client loans to total assets grows because of loosening credit standards and increased demand from clients. If a bank did not alter its business strategy during the financial boom and did not react to the increased demand for loans, it would lose part of its potential profit.

Our results show that the riskier asset structure reduces the capital ratio as expected, but mostly in the group of large banks. This may well be because all large banks use the IRB approach to credit risk management, or simply because they have a lower ratio of client loans to total assets and therefore lower risk weights. They can thus simultaneously increase the issuance of credit and maintain favourable liquidity and capital positions. Increasing the ratio of client loans not only increases the risk of banks' portfolios, but also expands the volume of risk-weighted assets (which pushes down the capital ratio). The functionality of this channel is also apparent from the responses of the group of medium-sized banks. The responses of building societies are the least significant. This can be explained by their specific business model, with its narrow focus on home-building loans, which are associated with low risk weights.

Most importantly, given that we model a closed, albeit dynamic, system, the volume of total assets remains unchanged during the simulated shock. The leverage ratio is thus not affected by the asset structure channel, because the ratios are set without taking into account the actual structure of the assets. The leverage ratio can only react with a lag, after banks respond to the growing risks and increase the share of capital. This is clearly visible in the response of the leverage ratio in the group of medium-sized banks.

Figure 10: Responses to a Positive Shock to the Client Loans to Total Assets Ratio



Note: Same as in Figure 7.

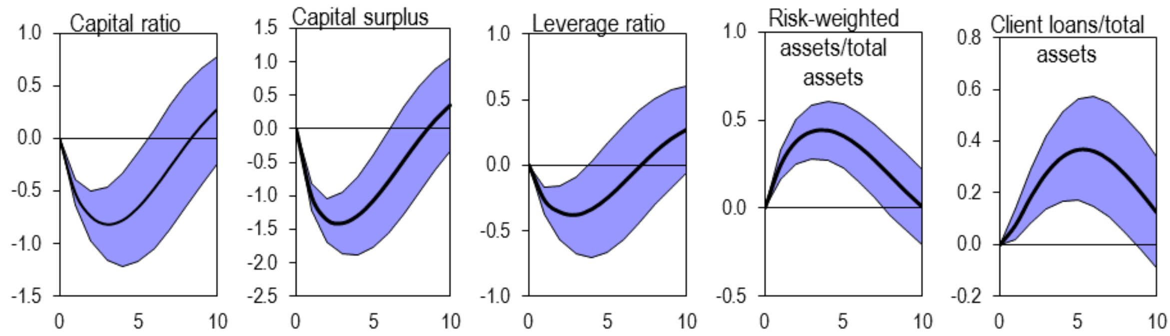
4.3.2 Asset Volume Channel

Second, we consider a situation in which banks expand their balance sheets (**Figure 11**). This situation should capture banks behaviour during a financial boom, when their portfolios generally expand. For this exercise, we replaced the ratio of non-performing loans to total loans in our baseline model with total assets. This allows us to explore the **asset volume channel** without any noise caused by either the materialization of credit risks during the global financial crisis or the cleansing of banks' balance sheets as of end-2002. At the same time, we keep a model with a reasonable number of parameters to estimate.

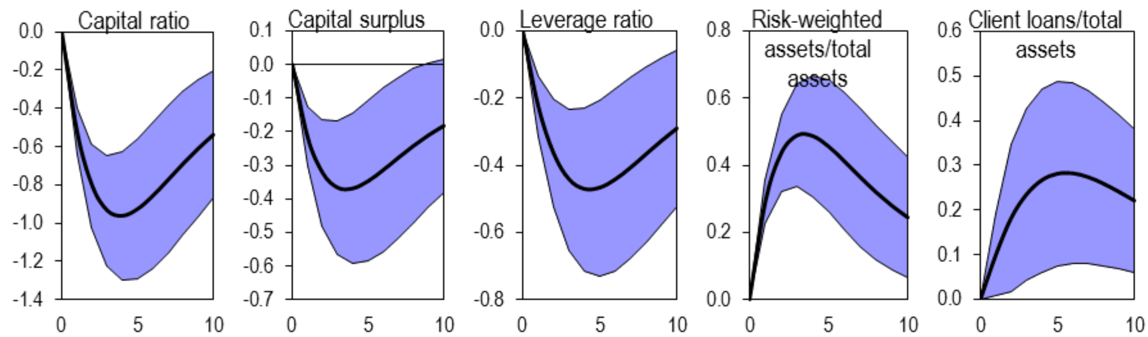
Given its computational logic, the leverage ratio can only be influenced by change in total bank exposures (i.e. through the asset volume channel) or by change in Tier 1 capital. Following an increase in total assets, we find a gradual decrease of the leverage ratio in all three groups of banks, as expected. At the same time, expanding the volume of assets is associated with an absolute increase in client loans and risk-weighted assets, which then pushes down the capital ratio as well. The asset volume channel thus affects both regulatory tools in a similar fashion. Moreover, it is found to be functional in all three groups of banks, making it less dependent on banks' different asset structures and/or business models than the asset structure channel.

Figure 11: Responses to a Positive Shock to Total Assets

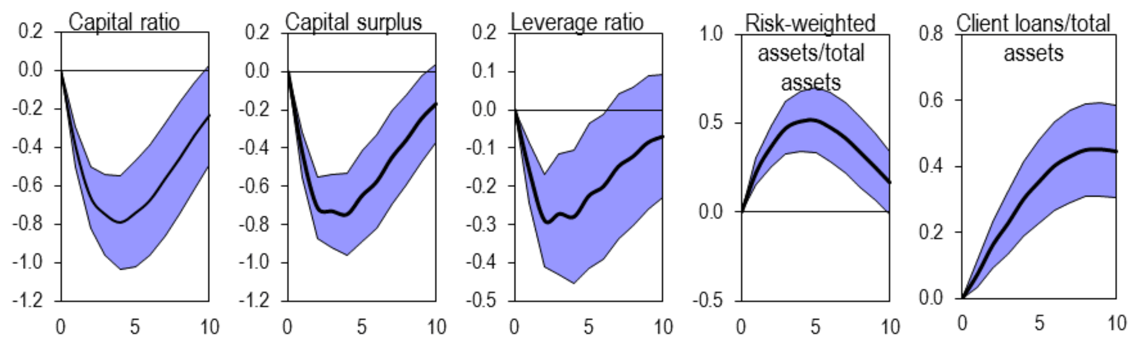
a) Large banks



b) Medium-sized banks



c) Building societies



Note: Same as in Figure 7.

4.3.3 Asset Quality Channel

Third, we analyse the **asset quality channel** by letting banks react to an unexpected increase in the non-performing loans to total loans ratio (**Figure 12**). The model is designed so as to capture banks' behaviour during a period of financial stress. Financial stress generally leads to growth in non-performing loans (NPLs) due to an increase in the probability of default. The asset quality factor thus leads to growth in risk weights and, under otherwise similar conditions, a decline in the capital ratio.[28] Given the same absolute level of bank capital, the capital surplus may decrease as well. Regulation through the capital ratio may thus be more prudent at a time of financial stress due to the impact of the procyclicality of risk weights.

Our results do not confirm the functionality of the asset quality channel in the case of Czech banks. This is because of the low level of NPLs and the introduction of the IRB approach (in 2007) in the Czech banking sector. We believe that this result can also be attributed to the relative dominance of the adverse asset structure channel during the global financial crisis. High market uncertainty generally fosters prudent behaviour by banks, manifested mostly in tightening credit standards and constraints on the supply of bank loans to the private sector. In this situation, banks naturally allocate more of their funds into less risky and more liquid assets, which should push risk weights down and increase the proportion of liquid assets in banks' portfolios. This more prudent behaviour is well documented by the responses of the relevant variables across all three bank groups. Following a surge in the ratio of NPLs to total loans, capital ratios increase as a result of an increase in banks' prudence. Banks also cut the supply of loans to the economy. One difference between large and medium-sized banks regarding the responses of risk-weighted assets is worth commenting on. In the group of large banks, the ratio of risk-weighted assets to total assets decreases, pointing to a greater role of the asset structure channel. In the group of medium-sized banks, by contrast, the same ratio increases, owing to a greater role of the asset quality channel due to a higher level of NPLs during the crisis and faster transmission of NPLs to risk weights for STA banks. Overall, the asset structure and asset quality channels are always both in place, and it is their relative intensity which determines whether the total risk weights decline or increase during an episode of financial stress. The reaction of the leverage ratio usually exhibits a growing tendency at times of financial stress, especially if the economy is deleveraging (financial leverage is decreasing).

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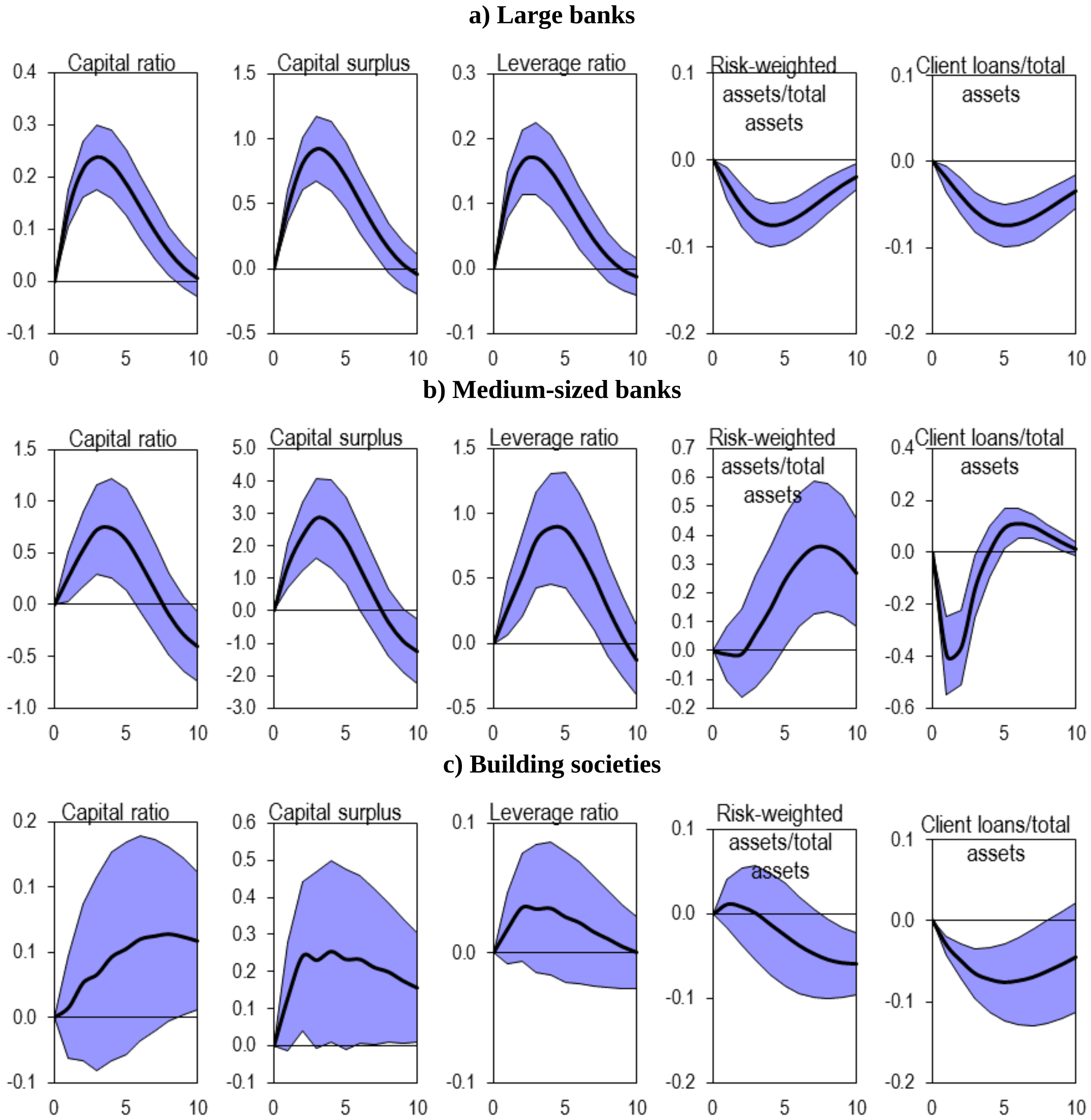
[28] The final impact on the capital ratio is determined by the specific decline in NPLs (or risk weights) and the asset growth rate.

Figure 12: Responses to a Positive Shock to the NPL to Total Loans Ratio

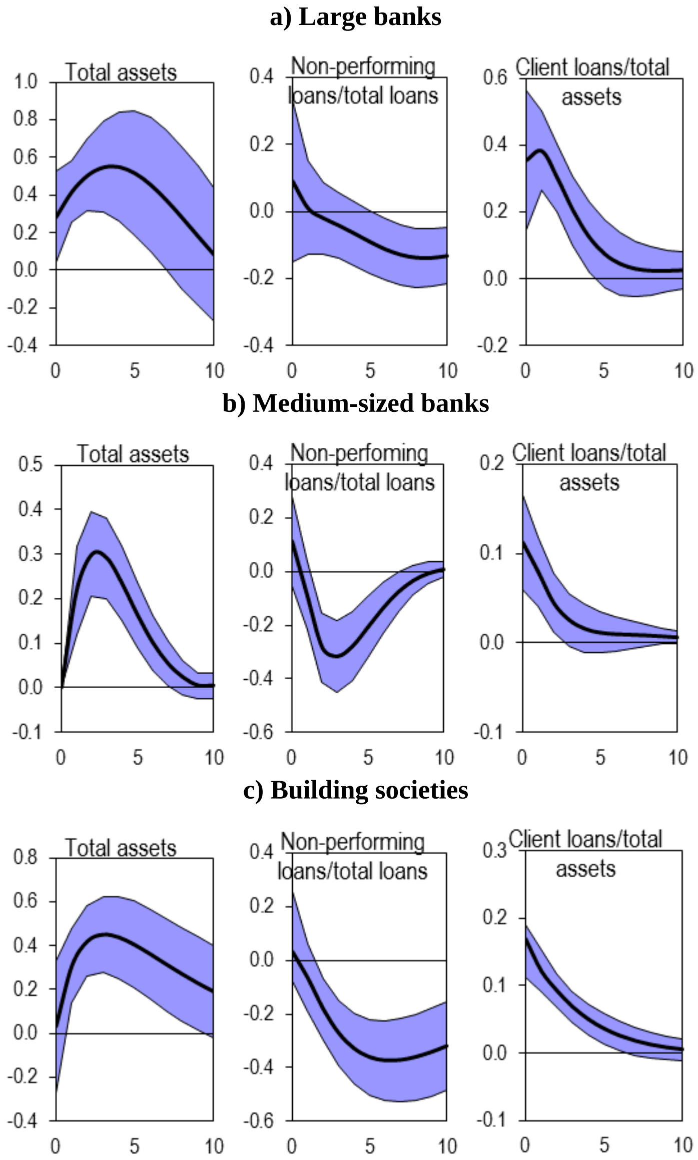


Note: Same as in Figure 7.

4.3.4 Asset Profitability Channel

Last, we analyse the **asset profitability channel** (**Figure 13**). This channel does not affect banks' capital position directly, but is ultimately linked to the three channels described above. For this purpose, we consider shocks to total assets (asset volume channel), the ratio of non-performing loans to total loans (asset quality channel) and the ratio of client loans to total assets (asset structure channel) and plot the responses of the ratio of interest revenue to total assets. As is evident from the responses, bank profitability increases during a financial boom due to the combined effects of the asset quality, asset structure and asset volume channels. Specifically, during an expansion phase of the financial cycle, risk weights and impairment losses tend to decrease, given the improved portfolio quality (asset quality channel). At the same time, the volume of assets increases (asset volume channel), as does the share of client loans in total loans (asset structure channel). All these changes lead to growth in profits (asset profitability channel), which banks can use to further strengthen their capital positions.[29]

Figure 13: Responses of the Ratio of Interest Revenue to Total Assets to Positive Shocks to Total Assets, NPLs and the Ratio of Client Loans to Total Assets



Note: Same as in Figure 7.

[29] For instance, Pfeifer and Hodula (2018) show that banks tend to exhibit cyclically overestimated profits during a financial boom and derive a series of metrics that can help policymakers capture such a development and adjust the countercyclical capital buffer accordingly.

5. Conclusion

In this paper, we discussed the relationship between the leverage and capital ratios as capital regulation tools. The introduction of a microprudential leverage ratio as a regulatory requirement in the future should increase banks' resilience to less risky exposures and their resilience in an environment where aggregate risk weights are well below the critical average risk weight (CARW). On the other hand, if the microprudential leverage ratio is higher than the total capital ratio requirement including any relevant capital buffers (the microprudential leverage ratio is binding), the application of macroprudential capital buffers does not necessarily lead to a real increase in the volume of capital. One way to overcome this potential limitation on the effectiveness of capital buffers in mitigating risks is to set a macroprudential leverage ratio, which could increase the resilience of the banking sector even in the aforementioned situation. To set the macroprudential leverage ratio, it may be appropriate to apply a fixed rule that keeps the CARW constant for all banks over time and hence also keeps the constraining effect of the two tools stable and predictable. When the fixed rule is applied, the initial CARW level has a significant effect on the level of the macroprudential leverage ratio. This approach seems to be in line with the idea of using the microprudential leverage ratio as a backstop for a certain system-wide minimum level of the risk weights of assets.

Our panel VAR estimates confirmed a mostly intuitive relationship between risk weights and the capital and leverage ratios using Czech bank-level data. Other things held constant, increasing risk weights reduces the capital ratio directly through the denominator effect. Banks have incentives to react to growing risks by topping up their capital, which leads to an increase in the leverage ratio. However, we found that the strength of the capital ratio response is dependent on the relative size of the bank capital surplus, which can differ across bank groups and countries. In general, banks with high capital surpluses could let their capital ratios decrease (and draw on their capital surpluses). In this case, the leverage ratio would not be influenced.

Furthermore, we determined four basic channels through which a bank's capital position may be affected: the asset quality, asset volume, asset structure and asset profitability channels. We found that while aggregate risk weights generally decline during a financial boom due to asset quality improvements (asset quality channel), the volume of exposures (asset volume channel) and the ratio of client loans to total assets (asset structure channel) tend to grow. These changes increase profitability (asset profitability channel). At the same time, however, a possible fall in risk weights (asset quality channel) increases the capital ratio and the bank can thus hold a lower level of capital to meet the regulatory capital requirement. In such a situation, the complementary nature of the leverage ratio including the macroprudential buffer could be an important tool for maintaining the resilience of the banking system. Growth in exposures during a financial boom reduces the leverage ratio, so the leverage ratio is far less procyclical than the capital ratio, or even countercyclical.

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Appendix A: Summary Statistics

Table A1: The following table describes the data used in our empirical exercises through the paper. All series are seasonally adjusted where applicable and run from 2002 Q1 to 2017 Q4 (this applies to the data in levels). All variables are transformed to be approximately stationary. In particular, Tcode shows the stationarity transformation for each variable (z_t): Tcode = 1 – no transformation (levels) and Tcode = 5 – annual change in logarithmic values $x_t = 100(\log z_t - \log z_{t-4})$.

Variables	Mnemonics	Sub-groups	N	Mean	Min	Max	Std. Dev.	Im-Pesaran-Shin	Fisher-ADF	Fisher-PP	Tcode	Source
Capital ratio	cap_ratio	large banks	240	0.69	-10.75	8.96	4.09	-2.90***	23.01***	30.25***	5	CNB
		medium-sized banks	300	0.35	-6.49	9.62	3.68	-4.35***	37.81***	50.43***		
		building societies	300	0.52	-8.91	13.52	4.43	-3.53***	30.23***	33.79***		
Capital surplus	cap_surplus	large banks	240	-2.72	-75.10	35.29	17.28	-3.37***	25.89***	47.91***	5	CNB
		medium-sized banks	300	-1.42	-22.06	20.52	7.81	-4.88***	43.65***	54.02***		
		building societies	240	-0.15	-27.96	46.84	14.80	-3.81***	29.62***	35.10***		
Leverage ratio	lev_ratio_net	large banks	240	0.84	-7.27	8.31	3.53	-3.93***	30.85***	38.28***	5	CNB
		medium-sized banks	300	0.49	-7.61	5.80	3.43	-4.97***	44.81***	60.31***		
		building societies	300	0.83	-11.51	8.38	4.24	-3.15***	27.36***	34.22***		
Risk-weighted assets/total assets	rwa_ta	large banks	240	-0.18	-8.72	6.53	3.46	-1.78**	15.43*	27.57***	5	CNB
		medium-sized banks	300	-0.21	-10.06	8.63	4.76	-3.66***	31.60***	42.56***		
		building societies	300	0.03	-13.34	5.68	4.07	-3.73***	32.13***	29.36***		
Client loans/total assets	credit_ta	large banks	240	1.17	-5.91	6.84	3.03	-1.85**	15.21*	38.66***	5	CNB
		medium-sized banks	300	1.04	-6.69	8.87	3.98	-5.51***	53.13***	53.84***		
		building societies	300	2.77	-2.46	9.90	3.61	-2.15*	22.28*	13.2698		
Total assets	assets	large banks	240	2.78	-1.17	10.52	2.59	-2.89***	22.01***	27.97***	5	CNB
		medium-sized banks	300	6.00	0.95	12.32	3.05	-2.73***	27.60***	28.71***		
		building societies	300	2.41	-3.34	13.37	4.21	-3.53***	31.69***	24.48***		
Non-performing loans/total client loans	npl_ta	large banks	240	-4.35	-30.39	20.99	10.92	-3.31***	28.61***	15.16*	5	CNB
		medium-sized banks	300	-2.11	-20.98	23.37	9.89	-2.57***	22.79***	34.47***		
		building societies	300	1.76	-9.66	13.19	5.75	-2.83***	24.52***	21.51**		
Interest revenue/total assets	ir_ta	large banks	240	-1.31	-10.36	9.40	3.45	-3.72***	29.38***	56.07***	5	CNB
		medium-sized banks	300	-1.14	-11.83	40.83	6.95	-6.07***	58.37***	84.60***		
		building societies	300	-0.77	-34.45	13.89	8.29	-6.93***	68.44***	92.25***		

Note: We use standard Stata packages for unit root tests. Null hypothesis of tests: series has unit root; ***, ** and * denote significance at the 1%, 5% and 10% level respectively.

Appendix B: PVAR Model Specifications and Underlying Statistics

Table B1: The following table describes the inclusion of endogenous variables in the PVAR models.

Endogenous variables	Model inclusion				
	Baseline	Asset structure channel	Asset volume channel	Asset quality channel	Asset profitability channel
cap_ratio	X	X	X	X	X
cap_surplus	X	X	X	X	X
lev_ratio_net	X	X	X	X	X
rwa_ta	X	X	X	X	X
credit_ta	X	X	X	X	X
assets			X		X
npl_ta	X	X		X	X
ir_ta					X

Tables B2 to B4 present the lag-order selection statistics. To reduce visual clutter, we report here only the baseline model statistics for the individual bank groups (the rest are available upon request). We rely on the model selection criteria by Andrews and Lu (2001) and the overall coefficient of determination to choose the optimal number of lags. Based on these criteria, the first-order VAR is the preferred model.[30]

Table B2: Lag-Order Selection Statistics (Baseline Model – Large Banks)

Lag number	Coeff. of determination	Hansen test	MMSC-Bayesian IC	MMSC-Akaike IC	MMSC-Hannan Quin IC
1	0.9643	44.6185	0.0053	-437.5389	-221.866
2	0.8601	106.319	0.0195	-279.0148	-135.2329
3	0.8361	84.4618	0.1534	-148.0484	-76.1574
4	0.6512	64.5435	0.2354	-105.513	-28.1253

Table B3: Lag-Order Selection Statistics (Baseline Model – Medium-Sized Banks)

Lag number	Coeff. of determination	Hansen test	MMSC-Bayesian IC	MMSC-Akaike IC	MMSC-Hannan Quin IC
1	0.7805	36.1157	0.0042	-354.1591	-179.5860
2	0.6961	86.0582	0.0157	-225.8442	-109.4622
3	0.6767	68.3663	0.1241	-119.8355	-61.6444
4	0.5271	52.2437	0.1905	-85.4058	-22.7655

Table B4: Lag-Order Selection Statistics (Baseline Model – Building Societies)

Lag number	Coeff. of determination	Hansen test	MMSC-Bayesian IC	MMSC-Akaike IC	MMSC-Hannan Quin IC
1	0.8316	107.9282	0.0069	-575.1545	-291.6477
2	0.7417	85.7402	0.0256	-366.7711	-177.7666
3	0.7210	45.2938	0.2016	-194.6128	-100.1105
4	0.5615	65.5204	0.3094	-138.6991	-36.9713

[30] Prior to estimating the impulse response functions, we also check the stability condition of the estimated PVAR. The eigenvalues confirm that all of our estimated models are stable.

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ISSN 1803-7070