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The transmission channels of  
monetary, macro- and  
microprudential policies and  
their interrelations

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# Contents

<b>Abstract</b>	<b>2</b>
<b>Executive summary</b>	<b>3</b>
<b>1 Introduction</b>	<b>4</b>
<b>2 Key features of monetary, micro-prudential and macroprudential policies</b>	<b>6</b>
2.1 Monetary policy instruments and objectives	6
<b>Box 1</b> Background on financial market infrastructures	8
2.2 Prudential policy instruments and objectives	9
2.3 Policy transmission	12
<b>3 Interactions between the three policies</b>	<b>20</b>
3.1 Interaction of micro- and macroprudential policies	20
3.2 Impact of prudential policies on monetary policy transmission	21
3.3 Impact of monetary policy on the transmission of micro- and macroprudential policies	28
<b>4 Model-based quantitative illustrations of capital-based MPIS</b>	<b>34</b>
4.1 Transmission of monetary and capital-based macroprudential policies	35
4.2 Interactions of monetary policy and capital-based macroprudential policies	41
4.3 Long-term benefits of prudential policies	46
4.4 External bank capital shock	49
<b>5 Conclusions</b>	<b>53</b>
<b>References</b>	<b>54</b>
<b>Annex</b>	<b>58</b>
<b>Acknowledgements</b>	<b>61</b>

# Abstract

This paper investigates the interrelations between monetary, macro- and microprudential policies. It first provides an overview of the three policies, starting with their main instruments and objectives. Monetary policy aims at maintaining price stability and promoting balanced economic growth, macroprudential policies aim at safeguarding the stability of the overall financial system, while microprudential policies contribute to the safety and soundness of individual entities. Subsequently, the paper provides a simplified description of their respective transmission mechanisms and analyses the interactions between them. A conceptual framework is first presented on the basis of which the analysis of the interactions across the different policies can be demonstrated in a stylised manner. These stylised descriptions are then further complemented by model-based simulations illustrating the significant complementarities and interactions between them. Finally, the paper concludes that from a conceptual point of view there are numerous areas of interaction between the policies. These create scope for synergies, which can be reaped by sharing information and expertise across the various policy areas.

**Keywords:** Central bank policies, non-standard measures, banking, financial regulation, DSGE models

**JEL codes:** E58 and G28

# Executive summary

The progress achieved in implementing the European Banking Union, in particular the setting up of the Single Supervisory Mechanism and the gradual development of macroprudential policies have increased the interest in understanding the different objectives they pursue, the instruments used to achieve them and how they potentially interact with each other.

The analysis of the channels of transmission can provide valuable insights regarding these interactions and is the subject of this study. In particular, this paper raises the question of how the efficiency and effectiveness of the policies in achieving their objectives may be affected in influencing the macroeconomy.

First, the paper provides an overview of the three policies, starting with the instruments and objectives of monetary policy, before moving on to microprudential and macroprudential policies. Further to the standard monetary policy tools, it discusses also non-standard measures, with emphasis on the recent tools that the ECB has adopted in particular the expanded asset purchase programme (APP), the introduction of the negative deposit facility rates and the targeted longer-term refinancing operations (TLTROs).

Second, it provides a simplified description of the respective transmission mechanisms of all policies. The discussion is also accompanied with a conceptual framework which characterises in a stylised manner the transmission channels. In addition, it highlights the role of financial market infrastructures on how these policies are transmitted to the economy, which all too often remain implicit in descriptions of the transmission mechanism.

Third, as all three policies influence economic, monetary and financial conditions, this paper discusses how they may effect each other's effectiveness in reaching their respective objectives. In this respect, the stylised conceptual framework is enriched to account for the interactions and interrelations between them. References are also made to potential interactions created by recent policy decisions and changes in the regulatory framework.

Lastly, the analysis is complemented by model-based simulation exercises illustrating the significant complementarities and interactions between the three policies.

This paper concludes that from a conceptual point of view there are numerous areas of interactions which suggest that there is a significant scope for synergies. Therefore, a constant sharing of information among the three policy areas is very beneficial in order to avoid conflicting effects and achieve better policy outcomes.

# 1 Introduction

The progress achieved in implementing the European Banking Union, in particular the setting up of the Single Supervisory Mechanism and the gradual development of macroprudential policies have increased the interest in understanding how micro- and macroprudential policies interact with each other and with monetary policy. This paper aims at analysing such interactions through the perspective of the transmission channels of the different policies.

Monetary policy, macroprudential and microprudential policies pursue different objectives and use different instruments to achieve them. However, changes in the various instruments may be transmitted through similar channels, i.e. affect the same financial instruments or economic sectors, implying that the three policies are likely to interact in a dampening or amplifying manner. This paper raises the question of how the potential interaction may affect the efficiency and effectiveness of the policies in achieving their objectives and in influencing the macroeconomy.

The paper first provides an overview of the three policies, starting with the instruments and objectives of monetary policy before moving on to prudential policies. Monetary policy aims at maintaining price stability and promoting balanced economic growth. Macroprudential policies aim at safeguarding the stability of the overall financial system, while microprudential policies aim at contributing to the safety and soundness of individual entities. Within the discussion, prudential policies are categorised into three broad areas, namely capital-based, asset-based and liquidity-based micro- or macroprudential policy instruments (MPIs). Subsequently, this paper provides a simplified description of the transmission mechanisms of the three policies. In doing so, it highlights the role of financial market infrastructures, which all too often remain implicit in descriptions of the transmission mechanism. The paper also discusses the transmission of the recent non-standard monetary policy tools that the ECB has adopted, in particular the expanded asset purchase programme (APP), the introduction of the negative deposit facility rates and the targeted longer-term refinancing operations (TLTROs). These measures have provided abundant liquidity in a low interest rate environment, mitigating distortions in funding markets and reducing the pro-cyclical contraction in lending to the non-financial private sector.

Secondly, a conceptual framework is introduced to characterise in a stylised manner the interactions between monetary, micro- and macroprudential policies. References are made to potential interactions created by recent policy decisions and changes in the regulatory framework. The stylised descriptions are then further complemented by model-based simulation exercises illustrating the significant complementarities and interactions between the three policies. The simulation exercises focus on the interactions between monetary and capital-based macroprudential policies. They include simulations of the impact of monetary policy on bank capital ratios, the impact on the macroeconomy of different phasing-in arrangements of capital-based prudential policies, the impact of capital-based prudential policies on monetary policy

transmission, the effect of the zero lower bound on interest rates on the transmission of capital-based prudential policies, the role of precautionary bank capital buffers and the role of bank risk in relation to the long-term benefits of prudential policies. Finally, the paper discusses the importance of unconstrained monetary policy and precautionary bank capital buffers in the event of a sudden loss of bank capital.

A number of caveats apply to this paper. First, the paper presents a joint overview of the transmission mechanism of the three policies – macroprudential, microprudential and monetary policy – from a euro area perspective. This institutional role emphasises banks' balance sheets as the transmitters of policies. This can also be justified by the relative greater importance of banks in the intermediation of both firms' and households' financing in the euro area compared, for example, to the US. However, the euro area is certainly witnessing an increasing role of non-banking activities in transmitting monetary policy, a notion which this paper does not seek to downplay. Some description and general terms of discussion for non-banking activities can be found in ECB (2016); however, the role of non-banking institutions is generally outside the scope of this occasional paper. Second, the paper might devote less attention to aspects that pertain to the competence of other European institutions that also have some macro- or microprudential competences such as the EBA, EOIPA, ESMA and ESRB. This choice has been made solely to maintain the focus of the presentation in the text.

This paper concludes that from a conceptual point of view there are numerous areas of interaction between the policies that create scope for synergies which can be reaped by sharing information and expertise across the various policy areas. However, the paper does not examine any dimensions regarding how the decision-making process should be organised. The model-based simulation exercises emphasise the importance of long phasing-in arrangements regarding increases in higher capital requirements in smoothing out the impact on the business cycle and inflation, the higher effectiveness of synchronised policy actions, the importance of unconstrained monetary policy in alleviating the negative impact of stricter capital requirements, the macroeconomic benefits of stronger bank capital buffers and the long-term benefits of higher bank capital requirements vis-à-vis higher levels of bank risk.

The remainder of this paper is organised as follows: Section 2 describes the policies and the corresponding transmission mechanisms. Section 3 discusses the interactions between all policies. Section 4 is devoted to the model-based simulations. Finally, Section 5 presents a conclusion.

## 2 Key features of monetary, micro-prudential and macroprudential policies

To set the stage for a discussion on the areas of policy interaction, this section first recalls the instruments and objectives of monetary and prudential policies. In addition, the typical transmission mechanisms of those policies and the role of financial market infrastructures are explained.

### 2.1 Monetary policy instruments and objectives

The monetary policy objective of most major central banks has been defined in terms of price stability, which some central banks combine with an objective of balanced economic growth and full employment. Taking the ECB as an example, its primary objective is maintaining price stability, which its Governing Council has specified more precisely as a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below, but close to, 2% over the medium term.

As a first step in pursuing their objective, central banks of jurisdictions with well-developed financial markets typically implement monetary policy by steering short-term interest rates. As the sole issuer of base money, i.e. banknotes and bank reserves, the central bank is in a good position to influence short-term interest rates. These short-term interest rates form the first step in the standard transmission channel with the last step being the effect of policy on inflation and economic activity. In practice, the central bank first determines which level of money market interest rates is required to achieve the objective. Next, the central bank will steer short-term money market rates to the desired level by signalling its monetary policy stance through its decisions on key interest rates and by managing the liquidity situation in the market.

Central banks stipulate an operational framework to implement their monetary policy, consisting of a number of instruments which for major central banks typically include key rates, open market operations, standing facilities and potentially also reserve requirements (in the case of the ECB, see EU, 2015). This framework defines the conditions for the interactions of solvent credit institutions with the central bank, with the aim of steering money market rates. The key rates signal the stance by setting the terms on which the central bank is willing to enter into transactions with credit institutions. The standing facilities determine the prices at which credit institutions can deposit funds at or draw funds from the central bank. Various open market operations can be distinguished, but typically they consist of either reverse transactions (i.e. repo or collateralised loans) or security purchases by the central bank. One purpose of required reserves is to create demand for central bank funds, which facilitates the steering of rates as the central bank controls the supply (Table 1).

**Table 1**  
Policy instruments and objectives

Policy	Instruments	Vulnerabilities and objectives	
<b>Monetary Policy</b>	Standard Monetary policy key rates Open Market Operations Standing Facilities Minimum Reserves	Price stability Balanced economic growth and full employment	
	Non-standard <sup>1</sup> APP/OMT/SMP VLTRO/TLTRO Eligible Collateral and Counterparts		
<b>Macroprudential</b>	LTVs/LTIs/LTDs Countercyclical capital buffer Capital conservation buffer Leverage ratio (not yet implemented in EU regulation)	Mitigate and prevent excessive credit growth and leverage (leverage and pricing of risk)	
	Liquidity coverage ratio Net stable funding ratio	Mitigate and prevent excessive maturity mismatch and market illiquidity (maturity transformation and liquidity)	
	Sectoral risk weights (in the residential and commercial property sectors) Intra-financial sector exposures	Limit direct and indirect exposure concentration (interconnection)	Financial stability (safeguarding against systemic risk)
	Capital surcharge on systemically important institutions	Limit the systemic impact of misaligned incentives with a view to reducing moral hazard (pricing of risk)	
	Systemic risk buffer CRD IV Art. 133, 134 Requirements on public disclosure	Strengthen resilience of banking system; also possibly addressing concentration and excessive exposures (interconnection)	
<b>Microprudential</b>	Minimum capital requirements Capital conservation buffer Leverage ratio	Solvency risk of individual credit institutions by requesting institutions to hold adequate amounts of capital ('capital buffers')	
	Large exposure limits Sectoral risk weights (in the residential and commercial property sectors) Intra-financial sector exposures	Limiting the exposure of a single institution to a client or a group of clients	Safety and soundness of credit institutions
	Liquidity coverage ratio Net stable funding ratio	Liquidity risks induced e.g. by maturity mismatch	

Source: ECB.

Apart from this standard toolkit, central banks have developed various non-standard measures to influence market interest rates and the availability of central bank money in periods when the nominal interest rates move closer to the effective lower bound. Central banks have resorted to such measures to complement or safeguard the impact of their policy through key rates, particularly following the global financial crisis that began in 2008. Examples include the expanded asset purchase programme (APP), the introduction of a negative deposit facility rate, measures

<sup>1</sup> The examples of non-standard instruments given are those used by the ECB between 2008 and 2016. However, many other central banks have used similar tools that are known under different acronyms and that target the market segments considered highly relevant for the transmission of monetary policy in their jurisdiction.



targeted at credit creation e.g. the targeted longer-term refinancing operations (TLTROs), forward guidance and changes to the collateral and counterparty framework (Table 1). These measures aim to provide abundant liquidity in a low interest rate environment and to mitigate distortions in funding markets (ECB, 2015) and to restore the pass-through mechanism from policy rates to bank lending rates (ECB, 2017).

## Box 1

### Background on financial market infrastructures

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According to the Committee on Payments Market Infrastructure (CPMI) of the Bank for International Settlements (BIS), a financial market infrastructure (FMI) can be defined as ‘a multilateral system among participating institutions, including the operator of the system, used for the purposes of clearing, settling, or recording payments, securities, derivatives, or other financial transactions’. FMIs are thus networks that interlink various participants directly or indirectly to process and settle transactions for the purpose of exchanging financial assets. While the safety and efficiency of FMIs are necessary for the functioning of the financial system, they ultimately contribute to generating trust in the currency.

FMIs, which are often referred to as the ‘plumbing’ of the financial system, are vital for the smooth functioning of the financial system and, in some cases, for the transmission of a central bank’s monetary policy. At the same time, they are directly or indirectly interrelated with prudential policies. Safely and efficiently functioning FMIs allow their participants to exchange financial assets in a safe and sound manner and thus support them in realising efficiency gains and effective risk management. In turn, FMIs that are malfunctioning or that are not properly designed can disturb the sound exchange of financial assets and increase the risks for their participants. As such, it is not surprising that FMIs settling in euro are regulated and overseen either by the Eurosystem directly or in collaboration with other central banks or national competent authorities. Any prudential policy action taken in this context can impact on other financial system actors and vice versa.

Some of the main FMIs settling in euro that play a role for both the interbank market and policy transmission in the euro area are: TARGET2, for settling individual payments in central bank money in real-time; CSD, which allow the processing of securities issues and transactions by book entry and offer custodial services; TARGET2 Securities (T2S), for settling securities individually in central bank money; Continuous Linked Settlement (CLS) for the settlement of foreign exchange transactions; and central counterparties (CCP), which become buyer to every seller and seller to every buyer thus guaranteeing the performance of mutual contract obligations (ECB, 2009).

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Finally, central banks need to rely on a smooth functioning financial market infrastructure supporting the transmission of its policies. In this regard, the ECB has the task of promoting safe and efficient market infrastructures, which are used to clear, settle or record financial transactions between market participants and thus constitute the technical channel for the transmission process of monetary policy. In this respect, the ECB acts as operator of its own infrastructures, especially of the large-value payment system TARGET2 and the securities settlement platform T2S, as overseer of financial market infrastructure by setting prudential standards,

assessing the relevant compliance by overseen entities and inducing change where needed, and as a catalyst in promoting market initiatives (see also Box 1).

## 2.2 Prudential policy instruments and objectives

Macroprudential and microprudential policies both aim to ensure the resilience and the sound working of the financial system. In turn, a sound financial system is expected to limit the probability of a misallocation of funds, sharp corrections in financial markets and associated sharp downturns in economic activity. Nevertheless, their focuses differ as explained below.

The main objective of macroprudential policy is to contribute to the stability of the financial system, thereby safeguarding the financial system against the build-up of systemic risk. Therefore, its focus is on all entities and their interactions as a whole. The policymaker will monitor at least four broad categories of vulnerabilities in the system:

1. (mis-) pricing of risk,
2. (over) leverage,
3. maturity (mismatch) and liquidity transformation,
4. (excess) interconnectedness and complexity.

See also Adrian et al (2014) for a discussion and Annex 7.2 for details.

Macroprudential policy typically monitors ‘temperature’-style measures of the risks in the financial system to identify the economy’s position in the so-called ‘financial cycle’, which is briefly explained below. A typical example of a financial cycle relates, but is not limited, to real estate. Cyclical fluctuations in credit volumes and residential property prices are closely interlinked, such that they can be used to describe a financial cycle. The close link across the two variables arises from the so-called leverage cycle, i.e. the mutually re-enforcing interplay between credit expansion, housing demand and the higher value of mortgage collateral (e.g. Kiyotaki and Moore, 1997; Geanakoplos, 2009). An increase in residential property prices immediately raises the value of collateral available for mortgages and therefore expands the potential supply of mortgages by banks. This, in turn, fuels housing demand and puts further upward pressure on residential property prices.

In this respect, macroprudential policy aims at containing systemic risks by implementing actions that have a twofold result with respect to the oscillations of the financial cycle. Financial cycles are kept within acceptable bounds in terms of levels and rates of change (‘smoothen the financial cycle’). By the same token, macroprudential policy aims at building resilience in the financial system so as to allow it to absorb downturns in the financial cycle without major disruptions (‘increase resilience’).

The ECB is able to conduct macroprudential policy with most of the banking supervisory instruments that are laid down in the EU Capital Requirements Regulation (CRR) and the Directive (CRD IV). The most important instruments are the systemic risk buffers and countercyclical capital buffers because they protect banks against adverse aggregate shocks. The ECB shares the described macroprudential powers with National Designated Authorities which operate in each euro area country: in particular, the ECB can top up measures issued within the remit of the CRR/CRDIV framework. The ECB also provides analytical support to the European System Risk Board (ESRB), an independent macroprudential authority, which is responsible for the macroprudential oversight of the EU financial system and the prevention and mitigation of systemic risk<sup>2</sup>.

The ECB also conducts macroprudential policy with regard to financial market infrastructures as laid out in the Principles for Financial Market Infrastructures of the Committee on Payments and Market Infrastructures and the International Organisation of Securities Commissions (CPMI/IOSCO) or the ECB Regulation on Oversight Requirements for Systemically Important Payment Systems (SIPS Regulation).

The objective of microprudential policy is to contribute to the safety and soundness of individual entities and thereby contribute to the stability of the system as a whole. What counts are the characteristics of the assets and liabilities, in particular in relation to the capital and provisions that the entity holds, and whether the associated time and risk structures of the entity's direct interactions with the 'rest of the system' will 'fit in' or 'match' one another 'well enough, for long enough', given certain assumptions on the initial state and evolution of the 'rest of the system' (i.e. scenario assessments).

The risk factors considered by microprudential authorities include risks to capital (credit risk, market risk, interest rate risk and operational risk), risks to liquidity and the funding position of the entity, as well as risks stemming from interdependencies (see Annex 7.1 for a definition of those risks). In addition, microprudential authorities look at risks associated with business models and profitability, as well as risks related to the internal governance and risk management practices of the entity.

Typically, the legal environment in which banks operate sets minimum requirements which have to be met by credit institutions at all times (e.g. in the EU the CRR and CRD IV are in place). Using supervisory judgement, the microprudential supervisor may apply additional requirements to single credit institutions (e.g. add-ons to specific thresholds or demand additional buffers). This means that the microprudential supervisor will consider whether the risks borne by the supervised entity are acceptable, within certain limits. To do so, it defines a number of magnitudes and sets some thresholds for what 'well enough, for long enough' means. The legal power bestowed on microprudential supervisors to enforce respect

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<sup>2</sup> The ESRB has a broader remit compared to the ECB, covering banks, insurers, asset managers, shadow banks, financial market infrastructures and other financial institutions and markets. In pursuing its macroprudential mandate, the ESRB monitors and assesses systemic risks and, where appropriate, issues warnings and recommendations.

for these thresholds turns them into instruments of microprudential policy. Notice that the macroprudential supervisor may rely on the same type of instruments but imposed on all credit institutions in the jurisdiction or combined with criteria that determine which credit institutions have to comply.

In the case of the ECB's Single Supervisory Mechanism (SSM), the target entities are credit institutions, which are made to internalise the costs caused by their activities in order to prevent them taking excessive risks. To ensure that the CRR and CRD IV requirements are met, the SSM conducts regular assessments as enshrined in the Supervisory Review and Evaluation Process (SREP). To ensure that the risks borne by banks are within acceptable ranges and that the stability of the financial system is not endangered, the ECB has the power to apply a wide range of both microprudential and macroprudential instruments. The targets of oversight are mainly financial market infrastructures and the oversight activity follows a three-step process: the ECB collects relevant information, assesses the information against its oversight objectives and makes changes where necessary.

This paper distinguishes three broad categories of prudential instruments, focussing on policies relating to credit institutions:

1. **capital-based** measures target banks' capital and provisioning requirements to increase the overall resilience of individual banks and the banking sector by mitigating the build-up of risk exposures. Moreover, by providing firms with sufficient buffers, instruments such as the countercyclical capital buffer should counter the risk of rapidly unwinding positions during contractionary phases. By increasing the resilience of systemically important institutions (e.g. via capital surcharges), capital-based measures can also mitigate some of the consequences of excessive interconnectedness. They include the capital ratios, the countercyclical capital buffer (CCyB), other capital buffers such as the capital conservation buffer or the leverage ratio (LR).<sup>3</sup>
2. **asset-based** measures impose quantitative restrictions on positions. For example, caps on Loan-to-Value (LTV) and Loan-to-Income (LTI) ratios or haircuts to securities used as collateral aim at ensuring adequate lending standards and addressing the excessive provision of credit. Large exposure restrictions address underdiversification, i.e. excessive dependence on and vulnerability to a particular client or group of connected clients, and interconnectedness<sup>4</sup>.

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<sup>3</sup> CCyBs allow macroprudential authorities to ask credit institutions to maintain an additional cushion of capital (up to 2.5 p.p.) depending on the status of the financial cycle; the cushion is built up in periods of a high financial cycle and lowered when the cycle is low. Changes to Risk Weights can be requested in the form of minimum floors with respect to what banks' internal models would suggest. Both measures were introduced in Europe by the EU's CRR/CRD IV Directives. The leverage ratio is an additional constraint on the balance sheet of credit institutions, measured as capital over total assets rather than over risk-weighted assets. Such a measure has not been yet introduced to the EU toolkit but will be soon.

<sup>4</sup> The use of asset-based measures is not within the remit of the ECB. Asset-based measures remain under national law. Each country in the EU has specific provisions for such instruments. In some cases their activation and use falls under the remit of central banks, while in other cases it is the national government that has the authority to use them.

3. **liquidity-based** instruments aim at containing banks' vulnerabilities stemming from over-exposure to short-term financing, maturity mismatches and lack of liquid assets. Examples are the Net Stable Funding Ratio (NSFR) and the Liquidity Coverage Ratio (LCR).<sup>5</sup> Such instruments are part of the Basel III framework as implemented in the EU by the CRR and CRD IV, which was primarily designed to mitigate liquidity and funding risk at individual bank level, but also to address sources of systemic risk.

In addition to the above measures, prudential authorities may also implement qualitative measures (such as measures to increase banks' resilience to risks of cybercrime or measures to improve banks' IT systems or governance structures). Prudential authorities may also resort to signalling, steering expectations or using moral suasion, including examining banks' risk governance and risk appetite. This implies that even if there are no formal, binding requirements, banks may be expected to behave in a certain way that preserves resilience and financial stability.

## 2.3 Policy transmission

The broad set of monetary and prudential policy instruments influences the economy and the financial system through a myriad of transmission mechanisms, which are characterised by variable and uncertain time lags. The changes in economic and financial conditions in turn determine the target variables of the policies in terms of price developments, financial stability and resilience.

Underlying the transmission process is the financial market infrastructure that connects the central bank with credit institutions for the settlement of central bank liquidity and securities, namely TARGET2 and T2S, which are integral to safe and efficient transactions. Moreover, financial market infrastructures interlink market participants and thus allow them to exchange financial assets in a harmonised, safe and efficient manner. In fact, financial market infrastructures exist for settling each transaction class, for example payments systems settling retail and large-value payments, securities settlement systems and central securities depositories (CSD) for handling securities transactions, central counterparties for, inter alia, handling derivatives, and foreign exchange systems for settling foreign exchange transactions. Where no financial market infrastructure is used, banks may internalise traffic as a correspondent banking service or transactions may be transacted over the counter (OTC).

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<sup>5</sup> The LCR forces a bank to hold enough high-quality liquid assets (HQLA) to be able to survive (i.e. not become cash-flow insolvent) for 30 days of hypothetical system-wide liquidity stress (during which its depositors would want to withdraw deposits, etc.). It is the ratio of liquid assets to estimated cash outflows under those stressed conditions; the minimum threshold is set to 100% and will be binding after a gradual phase-in period. The key of the LCR is in the detailed definitions of what counts as liquid assets. The NSFR on the other hand considers a one-year horizon. It is defined as the amount of available stable funding (ASF) relative to the amount of required stable funding (RSF) and it should also be at least 100% (see BCBS 2014). The details of its implementation by the EBA are still being discussed as of the beginning of 2017.

### 2.3.1 Monetary policy transmission

Transmission channels are well established as a concept in monetary policy. The black arrows in Chart 1 present a stylised scheme of the transmission of standard monetary policy decisions via adjustments to official interest rates through influencing expectations and conditions in financial markets and the banking system that impact on economic activity and price developments (see e.g. ECB (2011) for a discussion). The euro area banking sector is relatively large and plays an important role in the economy, as well as for both monetary and prudential policies. In the chart, the right rectangle shows that the banking sector is affected by changes in bank capital, bank funding cost, credit standards and bank deposit and lending rates. In this context, contemporary literature on monetary policy increasingly emphasises the fact that monetary policy transmission channels are closely linked to financial stability considerations.

Non-standard monetary policy measures can be seen as aiming to safeguard specific channels of the transmission scheme or to ease the monetary policy stance beyond the standard transmission of the policy rate. As illustrated by the red arrows in Chart 1, central bank interventions in specific market segments can directly impact on expectations and the term structure of interest rates, and support asset prices and/or the overall lending activity of the banking sector. Moreover, those measures are likely to determine the (bond) market conditions for non-bank credit. In addition, central bank purchases may support market liquidity and functioning, and thereby avoid the adverse consequences of a potential market breakdown in systemically important segments (e.g. ECB, 2015). The following main transmission channels of monetary policy can be distinguished, which are also summarised in Table 2:

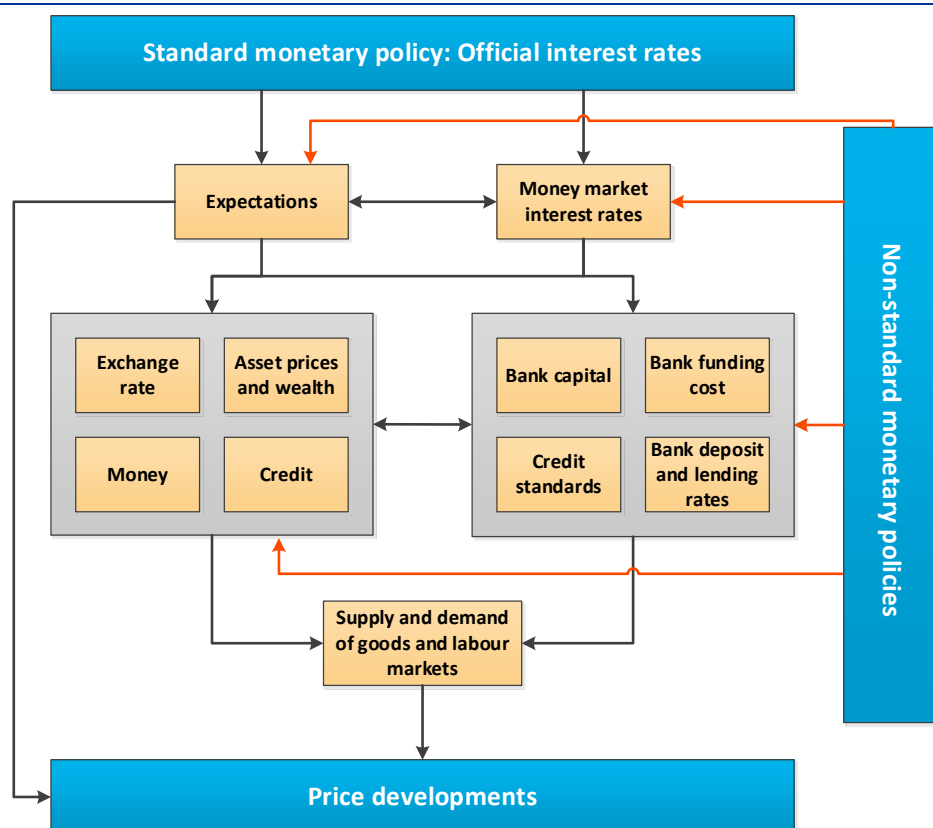
1. **Interest rate channel:** A policy-induced change in the policy interest rate(s) directly affects money-market interest rates and, indirectly, lending and deposit rates, which banks set for their customers. An increase in the short-term nominal interest rate can be expected to persist and should therefore – according to the expectations hypothesis of the term structure<sup>6</sup> – lead to an increase in longer-term nominal interest rates. When nominal prices are slow to adjust, these movements in nominal interest rates also translate into movements in real interest rates. Firms, finding that their real cost of borrowing over all horizons has increased, cut back on their investment expenditures or hiring decisions. Likewise, households facing higher real borrowing costs scale back on their purchases of homes, automobiles and other durable goods. This affects supply and demand conditions in the goods and labour markets resulting in a downward impact on inflation.

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<sup>6</sup> The hypothesis stipulates that the return on a long-term instrument should equal the geometric mean of returns on a series of short-term instruments.

**Chart 1**

Transmission mechanism of monetary policy



Source: ECB.

2. **Money channel:** A policy-induced increase in the monetary base can lead to deposit and loan creation that influences spending and inflation. In theory, if higher bank reserves lead to more lending and thus to the circulation of reserves, then via the money multiplier this also leads to an increase in the money supply, which in turn puts downward pressure on market interest rates. The associated credit provision, investment and spending have implications for inflation and output. It should be noted that asset purchase programmes are likely to have an impact on broad money. This can result from the direct effect of the purchases (when the securities are bought from the money holding sector) or from indirect effects relating to the use of the liquidity from the purchases related to portfolio rebalancing (ECB, 2015, section 4).
3. **Exchange rate channel:** In open economies, when the domestic nominal interest rate rises above its foreign counterpart, the domestic currency will tend to appreciate towards foreign exchange rates, due to its increased attractiveness as an investment currency. When prices are slow to adjust, this makes domestically produced goods more expensive than foreign produced goods. Net exports fall, as do domestic output and employment, while inflation decreases.



4. **Asset price and wealth channels:** A monetary policy induced increase in the nominal interest rates may, from an investor's point of view, raise the attractiveness of new debt instruments compared to equities and existing debt. Following such monetary tightening, the equilibrium across securities markets may be re-established partly through a fall in asset prices. This in turn induces smaller investment expenditures by the affected firms. In addition, changes in asset prices can have an impact on aggregate demand via changes in the value of collateral, affecting the amount that borrowers can borrow. Alternatively (or in addition), an increase in asset prices may reduce the risk premia that lenders demand from borrowers. Furthermore, consumption and investment are affected by movements in asset prices via wealth effects and the corresponding effects on the value of collateral. For example, as asset prices rise, household financial wealth increases, share-owning households and house owners become wealthier and may choose to increase their consumption.
5. **Balance sheet and profitability channel:** Higher interest rates lead to a decrease in the net worth of borrowers (because their debt burden is higher, as mentioned above), and to a decrease in the value of the assets of lenders (as explained above), so the demand for and supply of loans can both decrease. This can lead to further changes in asset prices through the so-called financial accelerator mechanism (Bernanke, Gertler and Gilchrist, 1996). A decline in the net worth of firms reduces the value of collateral that firms can use to borrow, resulting in tighter credit conditions. This leads to lower investment and economic activity, which further depresses firms' profitability and net worth. This will subsequently lead to a further tightening of financial conditions by lenders, thereby amplifying the contractionary impact of the initial interest rate increase. As a secondary effect, monetary policy tightening can therefore raise credit and financial stability risks.
6. **Bank funding and lending channel:** Monetary policy may affect the supply of loanable funds available to banks and thereby the amount of loans banks can create. Banks play a special role in the economy not only by issuing liabilities – bank deposits – which contribute to the broad monetary aggregates, but also by holding/creating assets – bank loans – for which few close substitutes exist. A tighter supply of bank loans or tighter credit conditions would again weigh on spending and investment. Central bank liquidity support in the event of a bank funding crisis can therefore be crucial in order to sustain loan origination to the private sector. This channel is also closely linked to (i) the money channel in terms of the availability of money and deposits as a funding source and (ii) the balance sheet channel for valuation effects on loan activity.

When conventional monetary policy changes, the set of risks to which a bank is exposed changes via the bank funding and lending channels. Changes to the short-term interest rate used by banks to refinance themselves – known as the Main Refinancing Operation (MRO) rate – are transmitted to both funding costs and lending rates. On the one hand, a rise in MRO is typically associated with an increase in funding costs as retail deposits become more expensive for the banks. The same applies to their wholesale funding as bond holders also



require higher interest rates to finance the banks. On the other hand, whether and how much lending rates might rise as a consequence of an increase in the MRO ultimately depends on the individual banks, the conditions in credit markets and whether the underlying loans have a fixed or a variable rate (ECB, 2017). In normal times, banks tend to choose to pass on an increase in funding costs to borrowers by raising the rates charged on new lending, otherwise profitability will be affected.

In periods where nominal interest rates are close to their effective lower bound, central banks use non-standard measures and provide funding cost relief for banks in order to ease borrowing conditions in the private, non-financial sector. More specifically, TLTROs provide banks with liquidity at the interest rate on the Eurosystem's deposit facility, on the condition that they show a sufficiently strong performance in loan origination. This triggers more competition in the bank loan market, which in turn compresses unit lending margins and the level of borrowing costs for the real economy. Furthermore, purchases of government, corporate and covered bonds and asset-backed securities under the APP also aim to foster loan creation and address the risks of an overly prolonged period of low inflation. Banks have been able to use the liquidity provided by the Eurosystem to substitute more expensive wholesale debt in a context of adverse market conditions, thereby allowing them to expand lending and reduce lending rates to households and firms.

Although in normal times monetary policy action is expected to pass through to lending rates to the private sector smoothly and therefore the direct impact of a monetary policy move on banks' profitability can be seen as limited, in crisis periods monetary policy can experience difficulties in two respects. Firstly, lowering the funding costs of banks with standard measures can be difficult if banks are perceived as risky, such that bank creditors could refuse to roll over bank liabilities and increase the premia banks have to pay to issue securities. On the other hand, rates applied to non-financial corporations might not be lowered because banks try to bolster profits in order to beef up their capital.

7. **Bank capital channel:** An increase in interest rates may lead to a fall in the value of bank capital, thus increasing the likelihood of hitting the binding capital constraint, therefore leading to a reduction in loan supply. The impact of monetary policy via this channel can be asymmetric, since the bank capital constraint is more likely to bind in times of contractions. It is also more important in times when the health of both the banking and corporate sectors jointly deteriorates. Finally, it is likely to increase in periods of occasional, but large, direct shocks to banks' balance sheets. Such shocks may occur as a result of regulatory changes or structural reforms of the banking sector. In general equilibrium, monetary policy can also influence stock market valuations of banks and thereby affect their solvency conditions.

Furthermore, non-standard measures can also strengthen the bank capital channel since they promote portfolio rebalancing through ECB intervention in the sovereign bond segment under the APP. The compression of returns in the sovereign bond market prompts investments in assets with higher risk-adjusted

returns. Banks play a key role in this transmission channel given that sovereign bond purchases under the APP lower term premia and, at the same time, induce a rebalancing of bank balance sheets, including the expansion of lending. In addition, the negative interest rate policy has also played a key role and reinforced the rebalancing of bank balance sheets, since banks are incentivised to offload the newly created cash reserves, leading to an expansion of asset holdings and lending.

8. **Risk-taking channel:** The perception, tolerance and pricing of risk by economic agents vary over time and can be influenced by policy. Accommodative monetary policy can induce risk-taking by private agents. In particular, low interest rates may support a search for yield, especially if there are also institutional or regulatory constraints supporting the case of pursuing nominal return targets. This would require investing in more risky assets or longer maturity to secure a yield pick-up. Central bank purchases of relatively safe assets as part of a quantitative easing programme can serve as an example as they aim to induce portfolio rebalancing towards riskier assets by investors, which would support a further easing in broader financing conditions in the economy. In addition, low interest rates affect valuations, incomes and cash flows (via the asset price and wealth channel) which can impact on banks' estimates and perception of risk.<sup>7</sup>
9. **Expectations channel:** Expectations of future official interest rate changes affect medium and long-term interest rates. In particular, longer-term interest rates depend in part on market expectations concerning the future course of short-term rates.

The central bank can, with its measures and communication, influence and guide economic agents' expectations of future inflation and thus influence price developments by signalling the future course of monetary policy. Expectations of future interest rates matter because they affect important economic decisions such as investment and durable consumption and thus, indirectly, employment, production and price-setting.<sup>8</sup>

The ability of the central bank to steer expectations and signal the future course of non-standard measures, i.e. forward guidance, has a crucial bearing on the effectiveness of these policies. The ECB's forward guidance has led to a downward revision of market expectations for future short-term interest rates and consequently to a compression in bank lending rates, thus providing further accommodation.

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<sup>7</sup> For a discussion, see e.g. Gambacorta (2009). See also Altunbas et al (2010), Angeloni and Faia (2013), Maddaloni and Peydro (2013), Adrian and Shin (2010), Diamond and Rajan (2006, 2012), Gertler and Karadi (2011).

<sup>8</sup> On the role of expectations for monetary policy, see Woodford (2003) and for evidence concerning the role of the future path of policy, see Gürkaynak et al. (2005).

**Table 2**  
Transmission channels

Transmission Channels	Description
<b>Interest rate</b>	Policy measures have an impact on money market rates, bank funding costs and saving and borrowing costs
<b>Money</b>	Changes in money supply affect liquidity conditions in the economy which may affect spending
<b>Exchange rate</b>	Affects price of imports and competitiveness
<b>Asset price and wealth</b>	Asset prices react to policy changes with implications for wealth due to valuation effects
<b>Balance sheet and profitability</b>	Changes in policy affect private sector balance sheets, net worth and collateral value
<b>Bank funding and lending</b>	Changes in policy affect bank lending supply and demand
<b>Bank capital</b>	Changes in policy have implications for bank capital and profitability
<b>Risk-taking</b>	Search for yield and lending behaviour. Accommodative policy for too long a period can create incentives for more risk-taking
<b>Expectations</b>	Influence private sector long-term expectations including by signalling the future policy course

Source: ECB.

### 2.3.2 Prudential policy transmission

Although transmission channels are less established for prudential policies, they also affect the balance sheet of financial institutions and thereby the set of risks and financial vulnerabilities under surveillance and, ultimately, financial stability.

Banks that are likely to be bound by the stricter capital-based requirements may react to them in several ways, if needed. For example, they may:

1. generate the higher amount of capital needed internally (e.g. by raising lending spreads and thereby increasing margins; by increasing earnings through higher operational efficiency, etc.);
2. raise capital by issuing equity or through retained earnings;
3. deleverage, e.g. cut lending to the private sector, or
4. de-risk, e.g. shift lending to safer borrowers while keeping overall lending volumes constant.

As lending spreads, dividends, equity and assets are used as input for calculating bank risk (i.e. credit risk, leverage, and solvency and profitability), measured risks and vulnerabilities also change.

Financial institutions might react to stricter asset-based requirements by reducing their risky holdings and thereby being less exposed to risk factors related to changes in the price of assets, for example to a downturn in house prices. The policies that restrict loan activity influence the credit standards of banks in an attempt to limit credit risk and protect solvency and profitability. The pricing in the targeted asset classes will adjust and thereby signal a reduction in risk. The same also holds for the valuation of financial institutions that are considered more resilient.

Banks may react to stricter liquidity-based requirements by seeking alternative sources of funding and larger holdings of liquid assets, making them more resilient to funding shocks. At the macro level, pricing in those funding markets and security markets will reflect the new demand. The measure itself mitigates liquidity and funding risk at individual bank level and thereby addresses some of the sources of systemic risk.

## 3 Interactions between the three policies

As all three policies influence monetary and financial conditions, the question arises of how they may influence each other's effectiveness in reaching their respective objectives. This section discusses the interactions between the three policies from a prudential policy and a monetary policy perspective: firstly, how do prudential policy actions impact upon the monetary policy transmission channels and, secondly, how do monetary policy actions impact upon the transmission of prudential policies?

The potential interference between the policies is non-negligible (ESRB, 2014). Whether policy measures re-inforce or act against each other depends on the extent to which those policy 'shocks' affect the other transmission channels respectively.

Clearly there is a need to take into account the interactions between the various policies; indeed, there is a growing body of literature on various options for coordinating policies or sharing information in order to mitigate potential areas of conflict. However, this paper focuses primarily on the economic analysis of policy interactions and therefore does not further explore the design of a possible coordination framework between the different policies.

### 3.1 Interaction of micro- and macroprudential policies

The fact that both micro- and macroprudential policies seek to dampen risk suggests that their goals are often aligned and the use of the same instruments does not need to lead to tensions. In practice, however, the goals may not always be perfectly aligned; see also Osinski et al. (2013).

While macroprudential buffers are designed to reduce pro-cyclicality more or less automatically, micro requirements are expected to be maintained at all times. This may lead to situations where some conflicts arise between the macro and the micro perspective. For instance, during the peak of the credit cycle the possibility of a clash between micro- and macroprudential points of view is at its greatest due to the so-called 'paradox of financial instability'. Such a situation can arise when aggressive risk-taking and compressed risk premia reinforce each other in a feedback loop during an asset price boom, so that the individual bank appears strongest from the microprudential indicator point of view precisely when the financial system as a whole is most vulnerable to a re-alignment. On the other hand, from a macro perspective, during a downturn banks should be allowed to run down the macro buffers as maintaining buffers for a longer time (which may seem good from a microprudential point of view) could exacerbate a crisis if they lead to an excessive collective contraction of lending to the economy and the associated negative feedback loop with adverse financial stability consequences. In turn, this will also have negative implications for individual banks. The main question is by how much and how quickly they should do so as reducing the buffers increases banks' vulnerability to shocks and therefore makes them more fragile from a microprudential

perspective. It is therefore essential to combine microprudential analysis with a macroprudential view in order to assess the appropriate adjustment of buffers according to the cycle. Similarly, for the treatment of collateral during the downturn, as with capital buffers, the microprudential supervisor would be more likely to prefer an increase in margin requirements as opposed to the macroprudential supervisor.

As regards liquidity requirements, under stressed conditions a microprudential insistence on maintaining higher liquidity buffers might lead to fire sales of less liquid assets in illiquid markets, which would make things worse from the macroprudential point of view as it could lead to a loss of confidence that could affect other markets.

For these reasons, having in place sufficient levels of coordination and communication between the two policy areas should help in dealing with these areas of friction. The need for cooperation also stems from two more factors:

1. many of the policies and regulations introduced since the financial crisis are inherently new. The design and application of prudential measures and the setting up of appropriate institutional arrangements is an on-going process and one cannot yet fully foresee what the individual and combined effects of these policies will be;
2. the timing of policies depends strongly on the point of the financial cycle that has been reached, but assessing the current state (via, for example, early warning and crisis indicators) poses considerable open challenges.

## 3.2 Impact of prudential policies on monetary policy transmission

Prudential policies may dampen or reinforce the transmission of monetary policy to the real economy in various ways. In general, a change or adjustment of prudential instruments by prudential authorities is likely to change – *ceteris paribus* – the conditions prevailing in specific stages of the monetary policy transmission process. Table 3 sketches the areas of interaction and the prudential instruments this may concern. The monetary policy maker will need to take those effects into account when setting its own policy instruments. In this respect, it can be argued that monetary policy has become more complex in the presence of prudential policies and in the context of the rapidly evolving regulatory landscape.

In the longer term, to the extent that prudential policies make financial firms healthier and reduce the probability of financial crises, they also reduce the magnitude and volatility of financial shocks to monetary policy transmission and the real economy.<sup>9</sup> This should facilitate the task of monetary policy to the extent that the central bank needs to switch to crisis mode less often. The oversight policies to promote the efficiency and safety of financial market infrastructures contribute likewise to risk

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<sup>9</sup> See e.g. BIS (2010) assessing the longer-term benefits and costs of regulatory intervention and concluding that despite a broad range of assumptions there was typically considerable room to tighten capital and liquidity requirements while still achieving positive net benefits for output.

mitigation, transparency and a sound financial system. In addition, they decrease transaction costs and promote open access, which in turn supports a sound foundation for the transmission of monetary policy.

**Table 3**  
Interactions of policies (●) with the monetary transmission channels

Transmission Channels	Monetary Policy	Macroprudential	Microprudential
Interest rate	●	●	●
Money	●		
Exchange rate	●		
Asset prices and wealth	●	●	●
Bank lending	●	Liquidity coverage ratio	Liquidity coverage ratio
		Net stable funding ratio	Net stable funding ratio
		Large exposure limits	Large exposure limits
		Sectorial risk weights (in the residential and commercial property sectors)	
		Intra-financial sector exposures	
Bank capital	●	Minimum capital requirements	Minimum capital requirements
		Countercyclical capital buffer	Capital conservation buffer
		Capital conservation buffer	
		Leverage ratio	
Firms' balance sheet and profitability	●	General equilibrium effects of LTVs/LTIs/LTDs are likely, i.e. a slowdown or contraction in asset prices affects balance sheets.	General equilibrium effects of LTVs/LTIs/LTDs are likely, i.e. a slowdown or contraction in asset prices affects balance sheets.
Risk-taking	●	Capital surcharge on systemically important institutions	
Expectations	●		

Source: ECB.

To organise the discussion, the next sub-sections start from the stylised representation of monetary policy transmission in Chart 1 and assess the impact of specific types of prudential policies, without aiming to be exhaustive given the many ways the policies can interact. In particular, three types of micro- and macroprudential instruments (MPIs) are assessed: capital-based, liquidity-based and asset-based instruments. Table 3 shows the interactions of monetary, macroprudential and microprudential policies with the transmission channels. Table 4 summarises the objectives of micro- and macroprudential policies and discusses how they can interact with monetary policy.

**Table 4**  
Interactions

Objectives of micro- and macroprudential policy		Monetary policy
Mitigate and prevent excessive credit growth and leverage	Financial stability (safeguarding against systemic risk)	Risk-taking and bank capital channels of monetary policy can be affected e.g. lower funding costs increase profitability and potential for retaining earnings
Mitigate and prevent excessive maturity mismatch and market illiquidity		Potential interaction with the interest rate channel. In the case of market liquidity disruptions: ELA, MRO and allotment type, asset purchases by the central bank
Limit direct and indirect exposure concentration		Potential interaction with transmission of monetary policy if reduction of exposures impacts on market functioning
Limit the systemic impact of misaligned incentives with a view to reducing moral hazard		
Strengthen the resilience of financial infrastructures		
Solvency risk of individual credit institutions by requesting institutions to hold adequate amounts of capital ('capital buffers')	Safety and soundness of credit institutions	Risk-taking and bank capital channels of monetary policy can be affected e.g. lower funding costs increase profitability and potential for retaining earnings
Limiting the exposure of a single institution to a client or a group of clients		
Liquidity risks induced e.g. by maturity mismatch		

Source: ECB.

### 3.2.1 Impact of capital-based MPIs on monetary policy transmission

Do different levels of capitalisation among banks have a bearing on their responsiveness with respect to monetary policy actions? The effect of changes to capital requirements on the transmission of monetary policy has been extensively studied in the academic literature. Intuitively, the response of bank lending to adverse shocks should be more sensitive the more fragile the banking system: a bank operating under high leverage would be hit harder by a shift in the riskiness of its portfolio. Consequently, leverage should affect monetary policy transmission: the bank lending channel should become less important once capital ratios are high. However, this effect can be mitigated by the use of countercyclical capital buffers.

Aghion and Kharroubi (2013) investigate the interplay between cyclical monetary policy and financial regulations on industry growth. They develop a version of a model with informational asymmetries, which gives rise to a trade-off between macroprudential and monetary policies. In the model, tighter capital regulations for banks hamper the effectiveness of countercyclical monetary policy. Intuitively, stricter regulation constrains the financial sector in providing credit. Banks therefore demand higher collateral from their borrowers, which weakens the responsiveness of credit demand to policy rates. However, the authors also argue that a sufficient release of countercyclical capital buffers would restore the effectiveness of monetary policy. The paper then tests these predictions from a cross-country and cross-industry panel regression. They find industry growth to be positively affected by the interaction



between industry-level measures of financial constraints and both interest rate cyclicity and financial sector regulations.

These results are supported for the euro area by Budnik and Bochmann (2016). Using factor-augmented structural VARs to model the joint dynamics of key macro-economic variables, individual bank balance sheet and interest rate data, they first confirm that higher capital buffers result in greater resilience of the banking sector, thereby stabilising credit supply. Second, the response of individual banks' credit volumes to both conventional and non-conventional monetary policy measures is lower for those banks that are better capitalised. Definitions of what counts as stable funding may affect monetary policy operations as well as the money and repo markets, for example by increasing the demand for central bank funding backed by non-high-quality liquid assets.

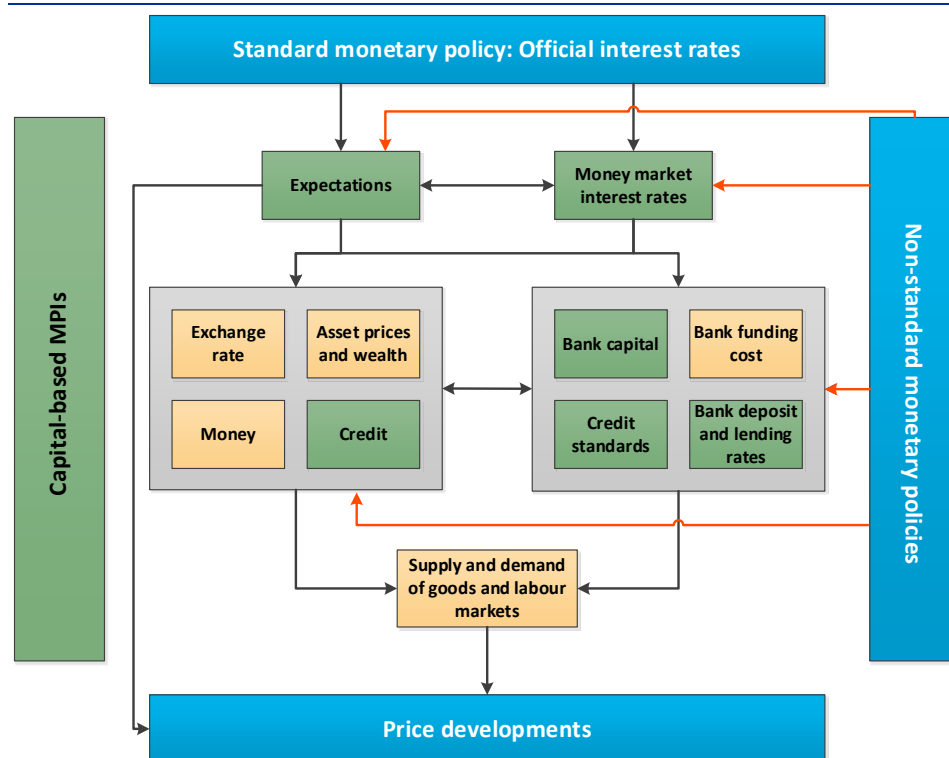
Evidence also suggests that the impact of capital-based MPIs on monetary policy is asymmetric, although the literature is not unanimous on this front. In general, the literature finds that banks' external finance premia depend on the extent to which they are funded by capital. Banks' ability to replenish capital would be greater at higher levels of capital, making them more robust to shocks. According to theoretical models, such as the one devised by Disyatat (2010), this implies that the external finance premium of highly capitalised banks – and thereby their lending – is also less sensitive to monetary policy shocks. Supporting this, empirical studies on Italian and US data find that the impact of policy rate changes on poorly-capitalised banks is larger; see Gambacorta and Mistrulli (2004), Kishan and Opiela (2006) and Van den Heuvel (2002, 2007).<sup>10</sup> Furthermore, Kishan and Opiela (2006) identified this effect before the crisis and the experience with troubled banks and low or negative credit growth in the euro area during the crisis appears consistent with this asymmetry. Consistent with this, Maddaloni and Peydro (2013) find that euro area banks with a better capital position could soften lending conditions more during the crisis than banks with higher capital constraints, suggesting better capitalised banks were more responsive to monetary policy actions. In the same vein, Dell'Ariccia et al. (2016) find that the risk-taking channel of monetary policy is stronger for better capitalised banks.

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<sup>10</sup> Borio and Zhu (2012) provide an overview of theoretical and empirical studies on the role of bank capital in monetary transmission.

**Chart 2**

Impact of capital-based MPIs on the transmission mechanism



Source: ECB.

Based on the above, the capital-based prudential instruments (MPIs) are indeed expected to affect the monetary policy transmission channels, as highlighted in green in Chart 2. In particular, this is going to materialise through:

1. the interest rate channel as, for example, requirements based on risk-weighted assets and the leverage ratio increase the cost of certain money market transactions, which will be reflected in market interest rates;
2. the balance sheet and profitability channel, since raising capital is costly and disincentivises balance sheet expansion through the provision of loans or asset purchases;
3. the bank capital channel, since the degree of capital constraints directly impacts on the supply of loans and costs associated with capital and provisioning to be passed on to credit standards and deposit rates;
4. the risk-taking channel, as capital-based MPIs encourage banks to invest in less risky assets and are therefore less supportive of banks' search for yield; and
5. an expectation-based effect, which is important to banks' capital planning, risk management and lending decisions. Capital-based MPIs tend to be credible as their activation is costly. Such a signal should thus have broader effects on lending standards and risk management practices, which will in turn impact on

the expectations of bank rates and the resilience of the system. These are very likely to be associated and/or interfere with the expectations of the future course of monetary policy.

One example of a potential conflict between monetary policy and prudential policy is the situation after the burst of an asset price bubble, where expansionary monetary policy could be somewhat hampered by restrictive macroprudential policies aiming at restoring financial stability (see also Beau et al. (2011)).

### 3.2.2 Impact of asset-based MPis on monetary policy transmission

The asset-based micro- and macroprudential instruments impose quantitative restrictions on the supply of credit and thus dampen potential credit growth directly, similar to a tightening of credit standards.

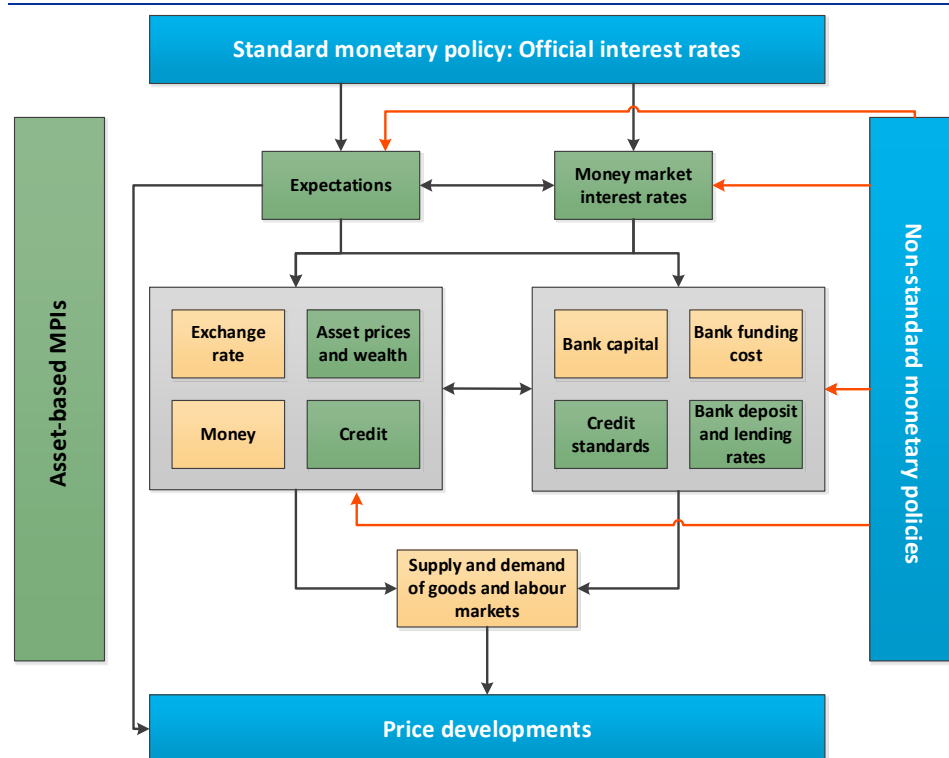
The channels of monetary policy (Chart 3) that are the most likely to be affected are:

1. the interest rate channel as e.g. exposure limits reduce the funding opportunities for banks, which is likely to be reflected in money market rates;
2. the wealth channel: rising asset prices do not automatically raise the available collateral necessary to take up additional credit, thereby inducing a dampening effect on the wealth channel (e.g. caps on loan-to-value ratios aim at addressing excessive demand for credit);
3. the risk-taking channel to the extent that the asset-based instruments will act to dampen the impact of the increased credit demand; and
4. the balance sheet and profitability channel through their impact on the net worth of borrowers and the collateral available to borrow against.

Based on the literature review in BIS (2012), there exists a large body of academic literature on the theory and evidence of LTV and LTI/DTI restrictions (see also Gelain et al, 2013). In comparison with other MPis, costs could be more limited as these tools only affect a specific proportion of borrowers.

**Chart 3**

Impact of asset-based MPIs on the transmission mechanism



Source: ECB.

### 3.2.3 Impact of liquidity-based MPIs on monetary policy transmission

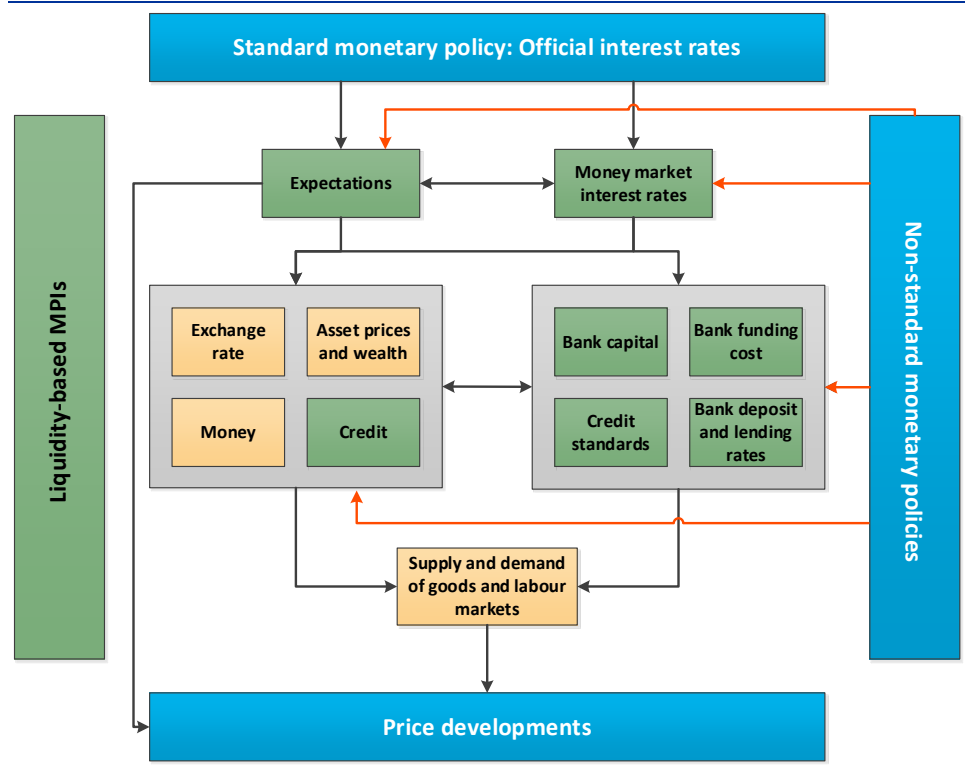
Liquidity-based micro- and macroprudential instruments alter banks' funding needs and may have direct repercussions for banks' deposit policies. In turn, increased funding costs are likely to be passed on to credit conditions. As a macroprudential measure, liquidity requirements – when applied to a large set of banks – are likely to determine the overall money market conditions and therefore further influence the transmission of monetary policy; see BIS (2015) for a related discussion. To the extent that these requirements aim at reducing the gap between the maturity of banks' assets and liabilities, they may reduce the interest rate risks of banks and may also have implications for capital requirements. Overall, as seen in Chart 4, liquidity-based MPIs are expected to impact on monetary policy transmission through the following channels:

1. the interest rate channel,
2. the balance sheet and profitability channel,
3. the bank funding and lending channel,
4. the bank capital channel and
5. the formation of expectations.

Empirical evidence suggests more liquid and longer-term funded banks may be less responsive to monetary policy actions (see, for example, Kashyap and Stein (2000) who report that monetary policy has a greater impact on banks with lower buffers of liquid assets).

**Chart 4**

Impact of liquidity-based MPIs on the transmission mechanism



Source: ECB.

### 3.3 Impact of monetary policy on the transmission of micro- and macroprudential policies

While prudential and monetary policies pursue different objectives, they do not act independently. Instead, monetary policy might potentially interact with the implementation of prudential policies through their impact on financial institutions and their choices in allocating savings to productive uses.

Like monetary policy, prudential policies are intended to modify banks' behaviour by constraining credit supply (e.g. capital buffers) and demand (e.g. LTV ratios) and therefore ultimately affect aggregate demand and inflation and work through similar transmission channels as monetary policy. In what follows, the interactions are conceptualised by identifying the channels through which monetary policy interplays with capital, asset and liquidity-based MPIs.

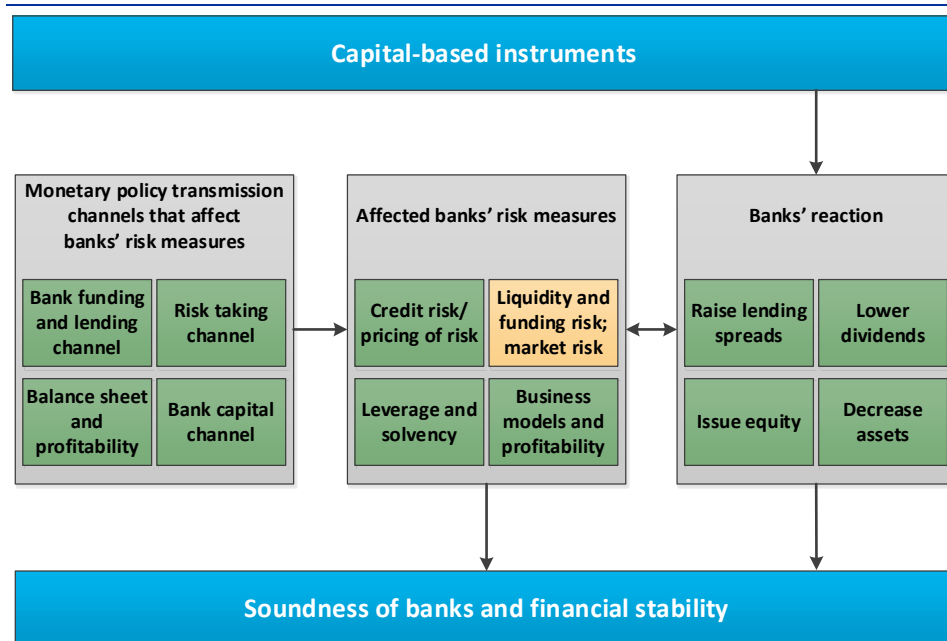
### 3.3.1 Impact of monetary policy on capital-based MPIs

The channels through which monetary policy could impact on the effects of capital-based MPIs are:

1. the bank funding and lending channel,
2. the balance sheet and profitability channel and
3. the risk-taking channel.

With respect to the first of these, monetary policy influences the costs of funding and the costs of supplying credit to the economy. Accommodative monetary policy therefore leads – ceteris paribus – to lower funding costs and a higher lending supply. Capital-based instruments also impact on the lending supply. In a situation where interest rates are low due to low inflation and low economic growth, microprudential supervisors have an incentive to tighten capital requirements to increase bank resilience to shocks. Banks may react to this by raising lending spreads or decreasing assets with adverse impact on loan supply thereby reducing the impact of the monetary policy measure (see Chart 5). Macroprudential supervisors may subsequently wish to release CCyBs and SRBs in a similar economic environment.

**Chart 5**  
Impact of monetary policy on the effects of capital-based MPIs



Source: ECB.

As concerns the balance sheet and profitability channel, on the one hand the net interest margin of banks tends to get squeezed when interest rates are low. This can have adverse implications for the profitability of banks, which could lead prudential supervisors to tighten capital-based requirements. On the other hand, lower interest

rates lead to higher asset price valuations, and to lower impairments and funding costs. Typically, one observes that the first effect of lower net interest margins dominates in the short term and profitability decreases with decreasing interest rates. However, over time the overall impact is ambiguous.

Within the risk-taking channel, subdued profitability encourages banks to take on more risk by extending the maturity transformation process, investing in riskier assets, extending credit to riskier counterparties, increasing leverage and expanding their balance sheet. This might stand in contrast to the aims of the prudential authorities, given that interest rates are typically low in economic downturns as this corresponds to times when the prudential authorities deem it undesirable for banks to increase their risk positions. Thus, prudential authorities may have an incentive to tighten capital-based requirements.

Lastly, within the bank capital channel, lower interest rates tend to increase the value of bank capital, thus making it less likely to hit capital constraints. This counters the effect of tighter capital requirements that might be applied if bank profitability decreases.

All in all, monetary policy actions may affect the set of risks to which banks are exposed. The impact of monetary policy measures on capital-based MPIs is ambiguous: the intended impact of capital-based MPIs that aim at decreasing those risks could be either reinforced or cancelled out by monetary policy actions, depending on which channel dominates.

### 3.3.2 Impact of monetary policy on asset-based MPIs

The channels through which monetary policy could impact on the effects of asset-based MPIs are:

1. the bank funding and lending channel,
2. the risk-taking channel,
3. the balance sheet and profitability channel, and
4. the bank capital channel.

One major aspect for the interplay of policies arises from balance sheet and risk-taking channels, which stem from informational asymmetries and collateral constraints. Banks face uncertainty about the repayment of loans. In the event of adverse shocks to aggregate demand or financial market uncertainty, banks therefore act to cut back leverage by restricting their (risky) lending. In addition, they require higher collateral. Such shocks therefore act to reduce credit supply. The initial effect is amplified by various market mechanisms, as the reduction in credit supply reduces aggregate demand and thereby also the market price of collateral. The feedback mechanism between credit supply and the price of collateral has been termed the 'leverage cycle' (e.g. Geanakoplos, 2009). Monetary policy can mitigate these effects by changing the policy rate. It does so in two ways, i.e. first, by

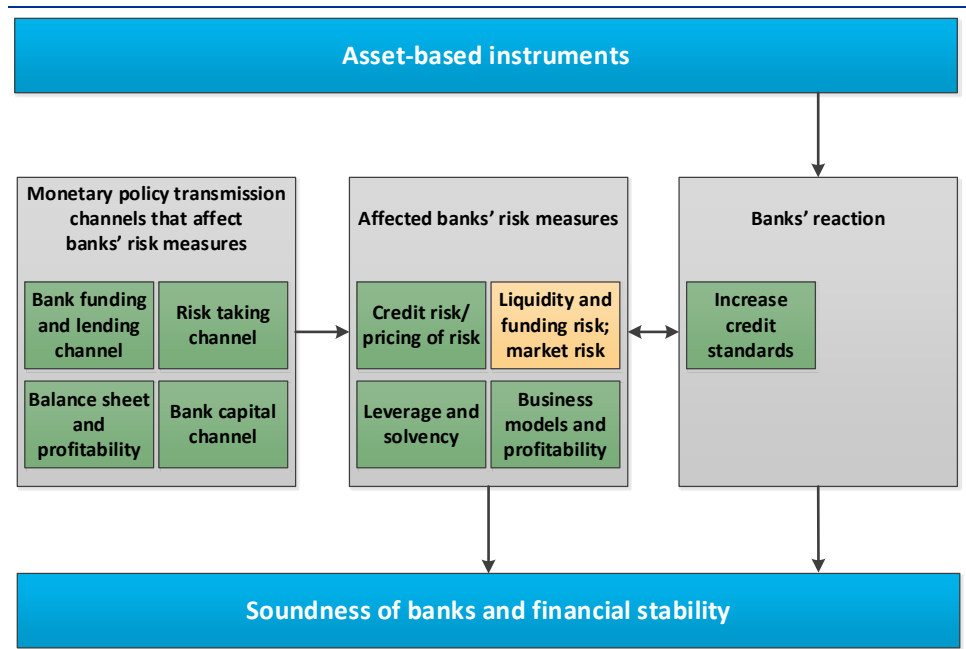
supporting aggregate demand, thus improving the liquidity conditions of financial intermediaries; and, second, by directly affecting the borrowing costs and risk-taking of financial intermediaries.

The use of real estate macroprudential instruments may generate some tensions between the two policies. When the economic and financial cycles are not aligned (e.g. when there is a risk of a real estate credit boom in an environment of low inflation and low economic activity), macroprudential authorities may wish to put limits on leverage by using instruments that target real estate exposures to prevent risks to financial stability. However, such measures could have a contractionary impact on the economy which could counteract the positive impact of the monetary policy measure and thus make it harder for monetary policy to offset risks to price stability. It should be noted nevertheless that macroprudential policies should be seen as playing an important role in complementing monetary policy given that they can address misalignments in specific segments and sectors that monetary policy cannot address given its broad impact on the economy, such as in the real estate market.

Finally, keeping interest rates low for extended periods (as a response to low inflation) may contribute to higher levels of risk-taking and excessive credit growth, leading to systemic risk.

**Chart 6**

Impact of monetary policy on the effects of asset-based MPis



Source: ECB.



### 3.3.3 Impact of monetary policy on liquidity-based MPIs

The channels through which monetary policy could interact with the effects of liquidity-based MPIs are:

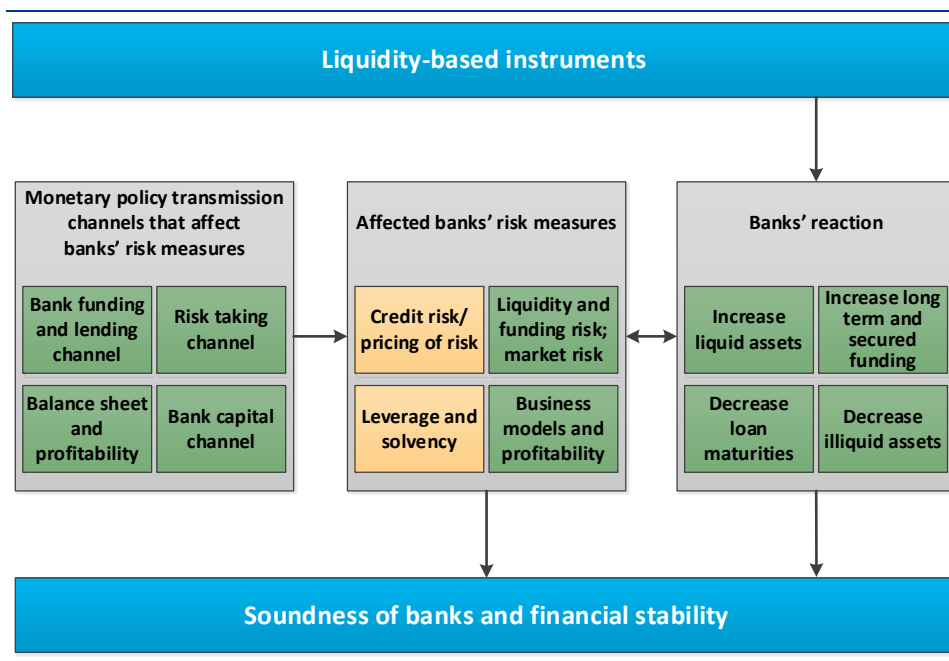
1. the bank funding and lending channel,
2. the risk-taking channel
3. the bank capital channel.

Concerning the first channel, the introduction of deposit facilities by the central bank interacts with the working of the LCR in so far as banks may want to lengthen the maturity of their funding to fulfil the LCR, which in turn could lead to a reduction in liquidity in short-term money markets, and maybe lead to a steeper yield curve, in so far as LCR induces banks to hold more long term government debt.

The LCR may also increase the demand for certain types of secured funding which could lead to a decoupling (wider spread) between secured and unsecured interest rates.<sup>11</sup>

#### Chart 7

Impact of monetary policy on the effects of liquidity-based MPIs



Source: ECB.

Furthermore, tensions could emerge through central bank lending. The introduction of the LCR (via the definitions of what counts as stable funding) may affect monetary policy operations as well as the money and repo markets, for example by increasing the demand for central bank funding backed by non-high-quality liquid assets.

<sup>11</sup> See ESRB (2014), Chapter 5, section 2.2. for references.

On the risk taking channel, the introduction of regulatory LCR generates a need for banks to hold highly liquid assets (i.e. typically government bonds) which might interact with the normal portfolio shifts induced by risk taking channel when monetary policy becomes more accommodative or contractionary. Over this dimension the LCR has some potential of dampening the risk taking channel and vice-versa, the presence of risk taking channel might change the appetite of banking institutions to hold government bonds (i.e. an highly liquid asset) thus interacting with the LCR regulation. Further research on the topic is however needed to draw firmer conclusions.

On the bank capital channel, an increase in interest rates may lead to a fall in the value of bank capital: as LCR induces the holding of a larger share of government bonds, which might have longer duration, this might also change the way monetary policy affects the bank capital channel.

## 4 Model-based quantitative illustrations of capital-based MPis

A large variety of theoretical and empirical models have recently been developed – both in academia and at central banks – that analyse more formally the various interactions between monetary and prudential policies that were described in the previous sections. Models in this field that have been or that are currently being developed at the ECB include those by Darracq Pariès, Jacquinet and Papadopoulou (2016), Darracq Pariès, Rancoita and Kok (2015) and Clerc et al. (2015), hereafter referred to as the DJP and DKR and 3D models respectively. These models can in particular shed light on the magnitude of the interactions between monetary, microprudential and macroprudential policies.

The DJP is a multi-country dynamic stochastic general equilibrium (DSGE) model for the euro area, introducing granular financial and banking frictions through which banks, firms and governments may default. More specifically, it features a reduced-form sovereign-bank nexus, risky banks facing capital constraints in a segmented banking specification, oligopolistic retail banking segments and financial frictions associated with corporate default and risky debt contracts. It is a six-region global model which is calibrated for Germany, France, Italy, Spain, the rest of the euro area and the rest of the world. Within its open economy multi-country dimension, the model also allows for cross-border lending. The structure of the model makes it an appropriate tool for analysing capital-based prudential policies in conjunction with monetary policy primarily through the bank funding and lending and the bank capital channels. Although the model is multi-country and can provide country-specific results, this section focuses on euro-area averages. A country-specific analysis of the interactions is beyond the scope of this paper and is left for future research.

The DKR model is a closed-economy DSGE model for the euro area with financially-constrained households and firms, including an oligopolistic banking sector facing capital constraints. The model is able to analyse both capital and asset-based macroprudential policies through the incorporation of housing loans and loan-to-value constraints. In Carboni et al (2013), the DKR model is used to provide an overview and some illustrative model simulations of the macroeconomic interdependence between macroprudential instruments and monetary policy. Darracq Pariès et al. (2015) extend the model into a two-country structural set-up in order to provide model-based illustrations of the strategic interactions between a single monetary policy and jurisdiction-specific macroprudential policies. As shown in the paper, countercyclical macroprudential interventions are found to support monetary policy conduct through the cycle.

The 3D model also analyses the impact of capital-based macroprudential policies on the real economy within a framework which allows for three layers of default (households, firms and banks). The model can also analyse the impact of capital regulation. Work in progress also aims at adding nominal frictions in order to also

make it a tool that can be used to analyse interactions between monetary policy and capital-based macroprudential policies.

In what follows, the impact of monetary and capital-based macroprudential policies on the economy and the banking sector is analysed through the lens of the DJP model. In some of the cases below, similar simulations through the lens of the 3D model are also discussed. First, this section analyses the transmissions of these policies, before going on to analyse the interaction between them. In addition to the short- and medium-term analysis, the long-term benefits of prudential policies are also discussed through the lens of the DJP model. As a final experiment, the impact of an external ad hoc decrease in bank capital is analysed and it is shown how that is influenced by the steady state level of capital buffers and the zero lower bound.

## 4.1 Transmission of monetary and capital-based macroprudential policies

This sub-section analyses the transmission of monetary policy and of capital-based macroprudential policies in the euro area through the lens of the DJP model, with the aim of understanding its impact on the banking and corporate sectors, output and inflation. It first discusses the transmission of a contractionary monetary policy shock before going on to focus on the transmission of an increase in regulatory bank capital requirements, while specifically exploring the role of banking sector characteristics, i.e. the importance of different phasing-in arrangements and different precautionary bank capital buffers. In the case of capital-based macroprudential policies, it is assumed that monetary policy has leeway to decrease interest rates and therefore boost the economy and alleviate some of the contractionary effects of higher capital requirements and disinflationary pressures.

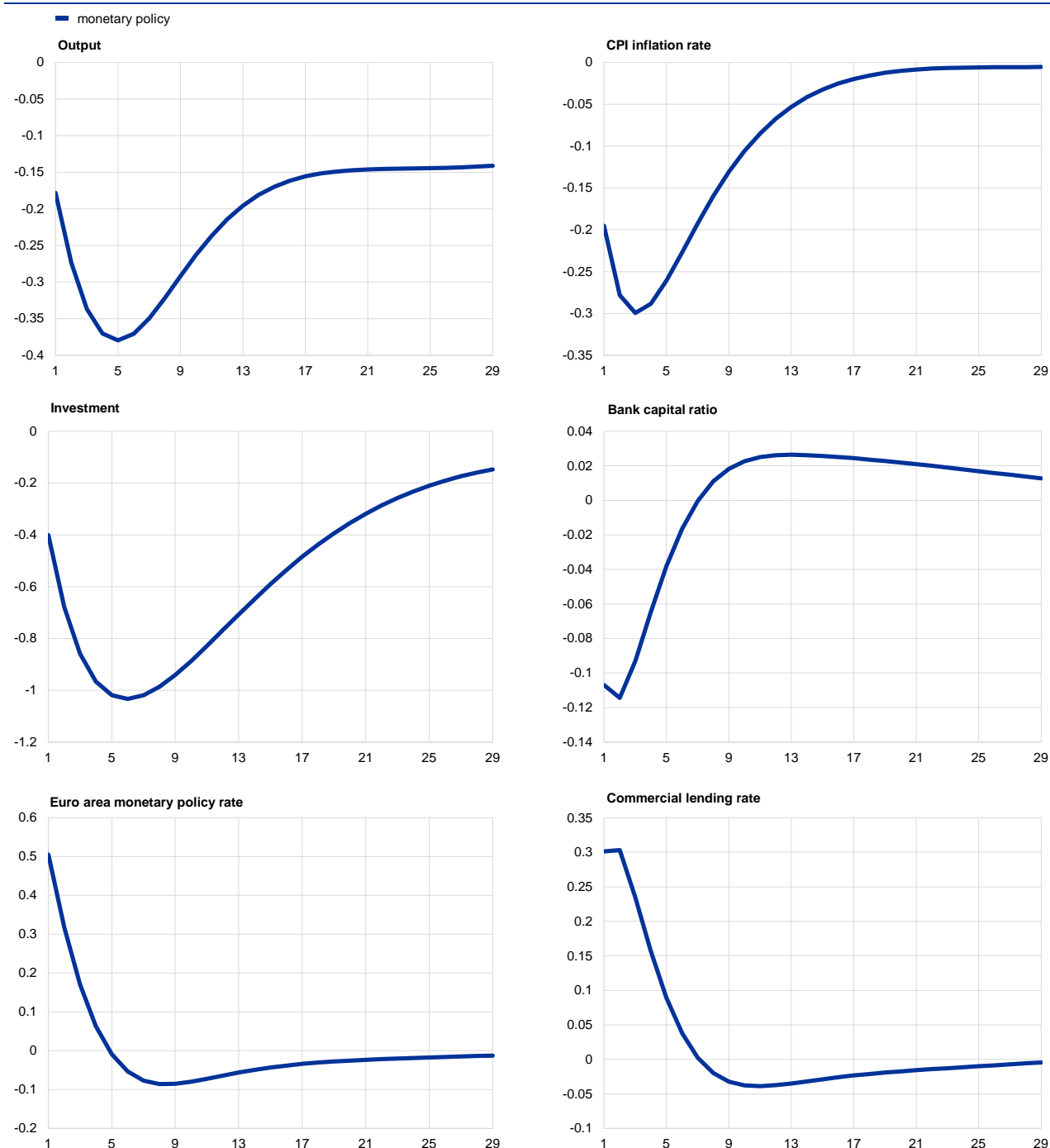
### 4.1.1 The transmission of a contractionary monetary policy shock

The transmission of contractionary monetary policy is simulated with a shock which initially increases the (annualised) short-term nominal interest rate by about 50 basis points. The corresponding impulse response functions (IRF) are plotted in Chart 8.

The unexpected increase in the monetary policy rate impacts on household deposit rates and transmits to sovereign bond yields, the latter being amplified due to sovereign risk since it leads to higher debt-to-GDP ratios and thereby to an increased probability of sovereign default. The increase of sovereign spreads also spills over to banks' funding costs which increase by more than the deposit rates. Everything else being equal, the bank funding cost increases, which in turn has a negative impact on the bank's profitability and its capital position. As a result, the regulatory capital constraint tightens, the bank default risk increases and banks' financing rates increase significantly more than the respective funding costs. The 50 bps increase in the short-term nominal interest rate results in a deterioration of the bank capital ratio (of assets) on impact by approximately 0.1 percentage points.

## Chart 8

### Impact of contractionary monetary policy



Source: ECB estimates based on Darracq Pariès, Jacquinot and Papadopoulou. (2016).

Notes: 50 bps increase in monetary policy rate in the euro area. Horizontal axis: quarters. Vertical axis: percentage deviations from baseline, except for inflation, interest rates and bank capital ratio which are expressed as annual percentage-point deviations. GDP and investments are reported in real terms.

The tightening of financing conditions ultimately transmits to commercial lending rates for entrepreneurs. Worsening economic conditions tighten financial constraints in the corporate sector, with higher corporate default rates and external financing premia. The financial accelerator mechanism in the model implies that commercial lending rates increase more than the ex-ante return on loans. The unexpected loan

losses also contribute to suppressing banks' capital positions: indeed, the ex-post return on loans deteriorates on impact before improving in line with the other financing costs. Overall, the pass-through to commercial lending rates of an unexpected and temporary increase in the monetary policy rate by 50 bps is around 30 bps. This feature is broadly in line with euro area wide evidence.

Aside from the interest rate channel, which predominantly acts on household consumption, the worsening credit conditions suppress investment and credit. Bank loans are demand driven and depend on the capacity of entrepreneurs to finance their investment projects from their net worth or debt. Labour demand and real wages decline and further reduce the consumption dynamics of households. Overall, inflation declines and is also reinforced by the initial nominal exchange rate appreciation, while real output decreases by approximately 0.4%.

#### 4.1.2 The transmission of capital-based macroprudential policies with different phasing-in arrangements

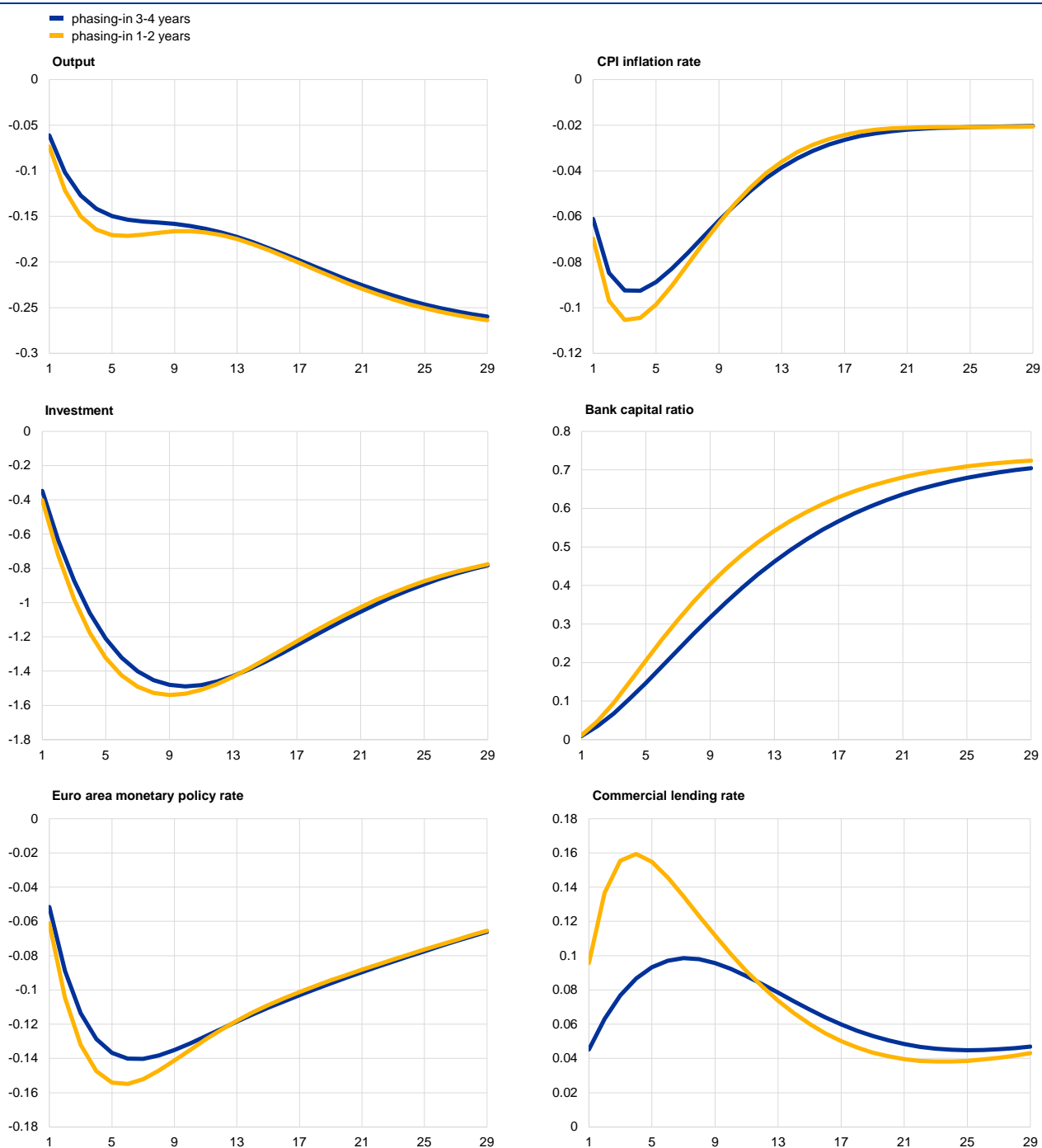
To illustrate prudential policy, this section presents the impact of an increase in bank capital requirements in the euro area. The shock is such that the capital ratio requirement is permanently raised by one percentage point, but is phased in within either a period of 3-4 years or 1-2 years, with the former being considered the benchmark case.

As shown by the impulse response functions (IRFs) in Chart 9, and assuming a 3-4 year phase-in period, at the announcement of the increase in capital requirements the one percentage point increase in the capital ratio requirement leads to transitory costs which have a bearing on GDP growth. More specifically, higher capital requirements imply that the risk that the banks' exhaust their capital buffer increases. As a result, bank funding costs go up which leads bankers to push up lending rates in order to boost net interest income and retained earnings. Subsequently, the higher capital requirements affect entrepreneurs as the impact on commercial lending rates peaks at about 10 bps before levelling off to a new higher equilibrium. The overall capital ratio of banks gradually increases, albeit resulting in smaller capital buffers in the new steady state (i.e. capital ratio increases by less than 1%). Turning to broader economic conditions, investment expenditures are significantly cut back, declining by 1.5% at the peak, resulting in a decrease in output in the first two years of approximately 0.15%. Furthermore, the ECB key rate can drop on impact by around 14 basis points and brings monetary easing.

The length of phase-in periods for the capital requirements matters. The longer the phasing-in period, the lower will be the impact on the macroeconomy as agents have a longer period for adjusting their capital shortfalls. In this respect, they are able to smooth out their actions resulting in less severe actions by the monetary authority to smooth out the business cycle. As shown in the same chart, in the case of a phasing-in period of 1-2 years the economy contracts further and monetary policy needs to be more accommodating in order to alleviate the negative impact.

## Chart 9

### Increase in regulatory bank capital requirements under different phasing-in arrangements



Source: ECB estimates based on Darracq Pariès, Jacquinot and Papadopoulou (2016).

Notes: 1% increase in regulatory requirements in the euro area. Horizontal axis: quarters. Vertical axis: percentage deviations from baseline, except for inflation, interest rates and bank capital ratio which are expressed as annual percentage-point deviations. GDP and investments are reported in real terms.

### 4.1.3 The transmission of capital-based macroprudential policies and the importance of precautionary bank capital buffers

The DJP model is also used to illustrate the importance of precautionary buffers. Banks prefer to operate with capital buffers above the regulatory requirements in order to avoid any penalty which regulators impose on them in the event of a breach of the regulatory requirements. This is an indication of the bank's initial financial strength. In this respect, the lower the capital buffers in the steady state, the higher will be the penalty and the higher the bank's financing rate.

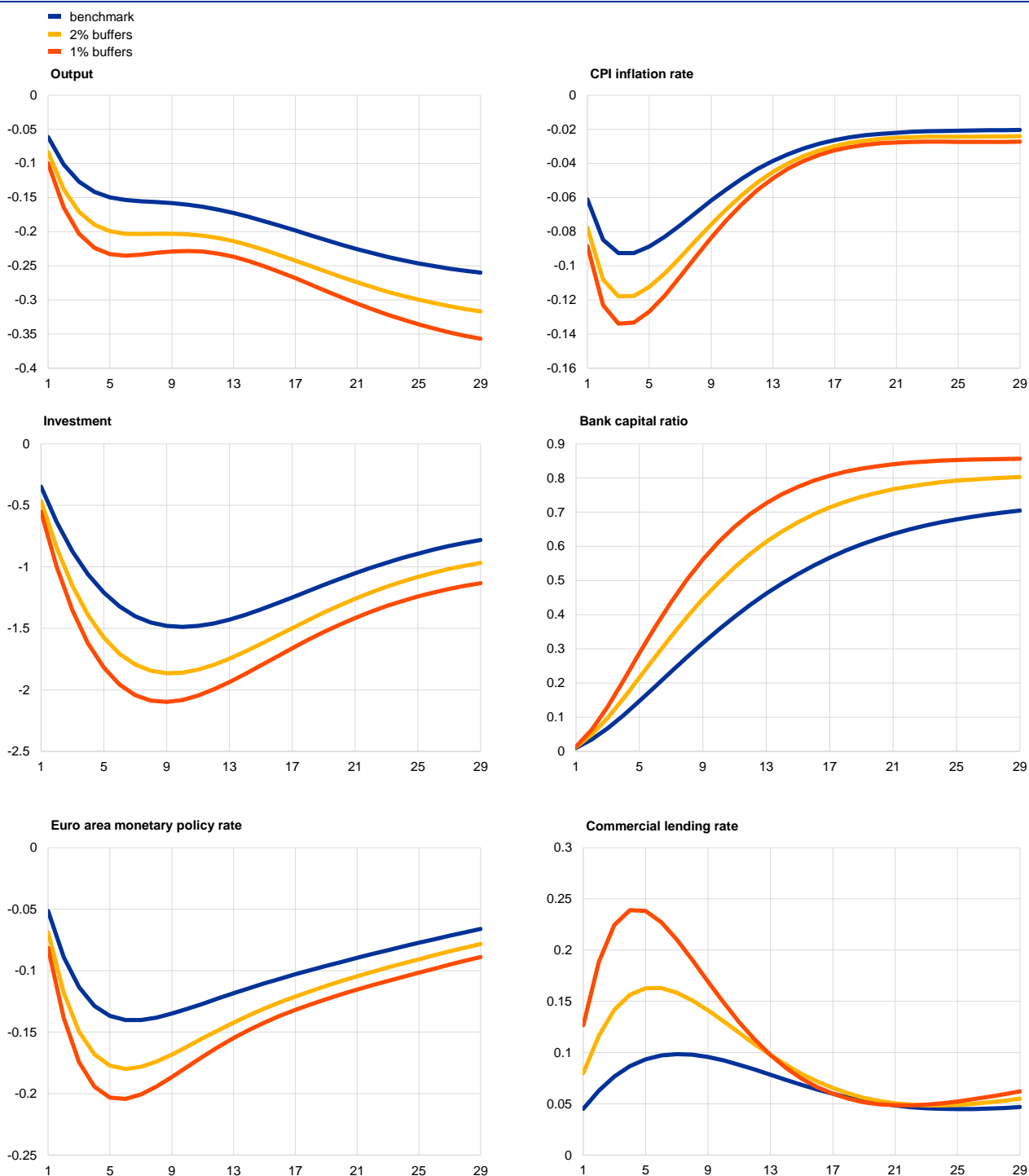
In what follows, the impact of banks' initial financial strength on the transmission of higher regulatory capital requirements is explored. Three cases are examined, the first being the same as the benchmark cases discussed above with phasing-in arrangements of 3-4 years. In the second, the initial financial strength is lower and translates into bank capital buffers half those in the benchmark case (from approximately 4% to 2%). In the third, the initial financial strength is even lower than in the second case and translates into bank capital buffers one quarter of those in the benchmark case (from approximately 4% to 1%).

As Chart 10 shows, the lower the bank capital buffer in the steady state, the higher the amplification of the negative impact on the macroeconomy resulting from the increase in bank capital requirements. This is due to the fact that bankers are pushed to recoup more forcefully any capital shortfall through higher loan-deposit margins in an attempt to avoid violating regulatory requirements.



**Chart 10**

The role of banks' initial financial strength



Source: ECB estimates based on Darracq Pariès, Jacquinot and Papadopoulou (2016).

Notes: 1% increase in regulatory requirements in the euro area. Horizontal axis: quarters. Vertical axis: percentage deviations from baseline, except for inflation, interest rates and bank capital ratio which are expressed as annual percentage-point deviations. GDP and investments are reported in real terms.

## 4.2 Interactions of monetary policy and capital-based macroprudential policies

This sub-section discusses the interactions of monetary and capital-based macroprudential policy. First, it analyses the implications of a standard expansionary monetary policy implemented together with an increase in regulatory bank capital requirements of the same size of the benchmark case described above. Subsequently, it analyses the implications on a capital-based policy of the zero lower bound which limits the central bank's ability to use standard interest rate policy.

### 4.2.1 Implications of capital-based macroprudential policies on the transmission of expansionary monetary policy

In order to gauge the degree of interaction between capital-based measures and monetary policy, an easing monetary policy shock in the euro area is added to the benchmark case where banks are initially in a strong financial position as measured by their capital buffers (approximately 4%), and the level of bank risk is very small. In a second step, a prudential capital-based policy is added.

The monetary policy shock to the model is the opposite of what has been discussed in Section 4.1.1, i.e. it is assumed that there is an initial decline in the short-term nominal interest rate of about 50 basis points. The corresponding IRFs are plotted in Chart 11.

In contrast to the contractionary monetary policy discussed above, expansionary monetary policy is able to lower bank funding costs thereby supporting bank profitability, loosening the regulatory capital constraint, reducing bank default risk and ultimately giving scope for increasing loan origination. The easing of financing conditions ultimately transmits to commercial lending rates for entrepreneurs.

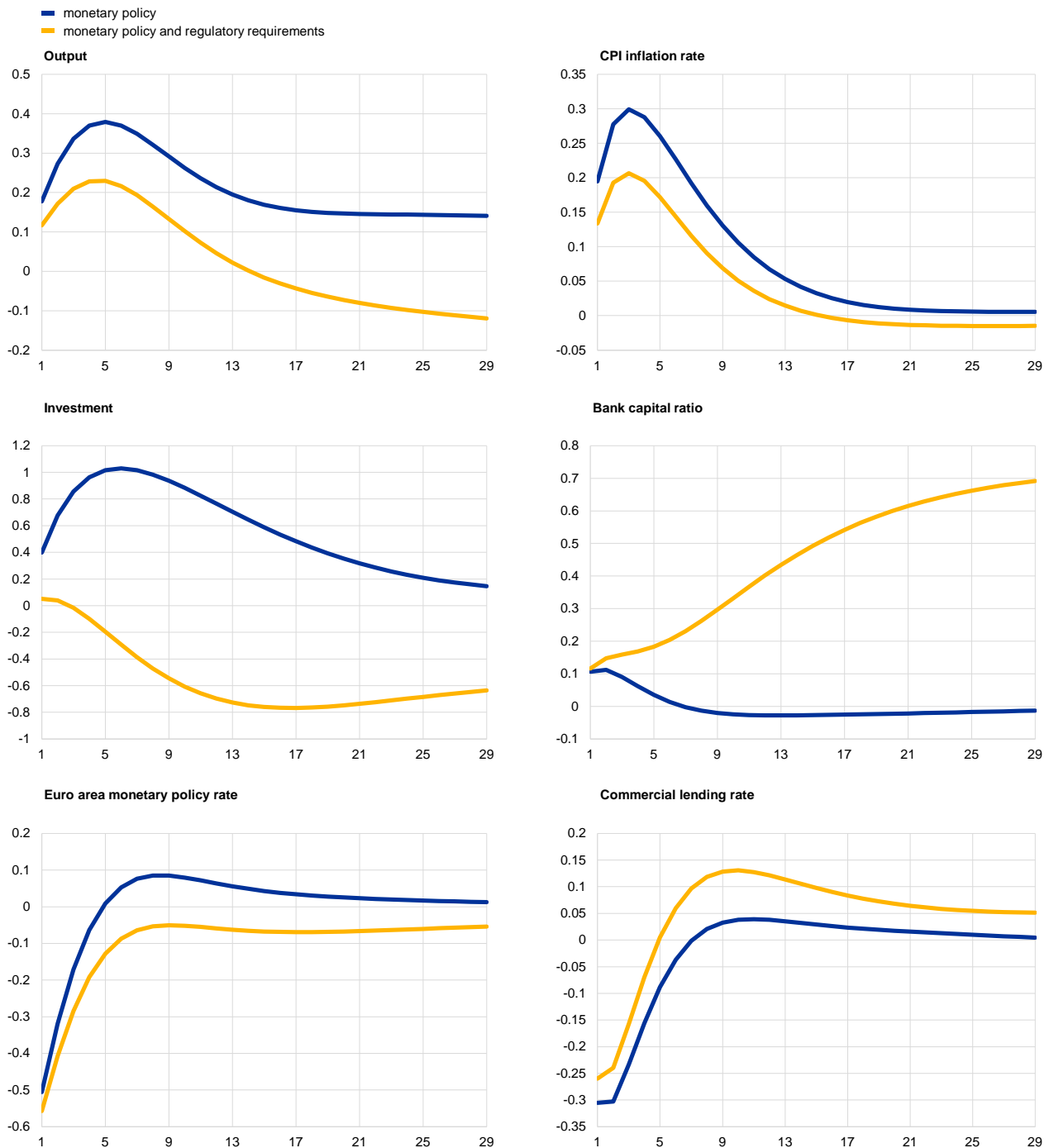
The unexpected drop in the monetary policy rate lowers household deposit rates and sovereign bond yields. Their impact is amplified due to the mitigation of sovereign risk as the expansionary monetary policy shock leads to lower debt-to-GDP ratios. The mild compression of sovereign spreads spills over to bank funding costs which decline by more than the deposit rates, supporting bank profitability, loosening the regulatory capital constraint, reducing bank default risk and ultimately giving scope for increasing loan origination. As commercial lending rates are pre-determined, the ex-ante return on loans and the unexpected improvements on loan losses also contribute to supporting banks' capital position. Overall, the pass-through to commercial lending rates of an unexpected and temporary decline in the monetary policy rate by 50 bps is around 30 bps. Favourable credit conditions stimulate investment and credit. Labour demand and real wages also pick up and further support the consumption dynamics of households. The macroeconomic impact is also reinforced by the initial nominal exchange rate depreciation. Overall, domestic inflationary pressures emerge and output growth improves with a peak effect of around 0.4% occurring approximately in six quarters' time.

Next, a 1% permanent increase in capital requirements with phasing-in arrangements of 3-4 years is added to illustrate the impact of capital-based MPIs on monetary policy transmission. As expected, the capital-based prudential instrument dampens the transmission of monetary policy, notably by offsetting part of its expansionary nature. More particularly, the pass-through to commercial lending rates is weaker at around 25 bps and the impact on GDP growth is also muted with the peak effect only reaching approximately 0.2%. The channels with the greatest interplay in the model following the above policies are the interest rate channel, the balance sheet and profitability channel, the bank capital channel, the risk-taking channel and the expectation-based effect.

Simulations undertaken with the 3D model for an increase in capital requirements provided qualitatively similar messages. However, the 3D model puts more emphasis on negative short-run effects of capital increases, while in the longer term the impact of capital increases can be rather muted or positive depending on the structural features of the economy. For example, if initial capitalisation of the banking system is particularly low and bailout costs to be borne by households are high, the benefits of higher capital will outweigh costs in the long run. Similar results can be also derived from the DKR model.

## Chart 11

### Monetary policy and regulatory bank capital requirements



Source: ECB estimates based on Darracq Pariès, Jacquinot and Papadopoulou (2016).

Notes: 50 bps decrease in monetary policy rate in the euro area and 1% increase in regulatory requirements in the euro area. Horizontal axis: quarters. Vertical axis: percentage deviations from baseline, except for inflation, interest rates and bank capital ratio which are expressed as annual percentage-point deviations. GDP and investments are reported in real terms.

## 4.2.2 Implications of the zero lower bound on capital-based macroprudential policies

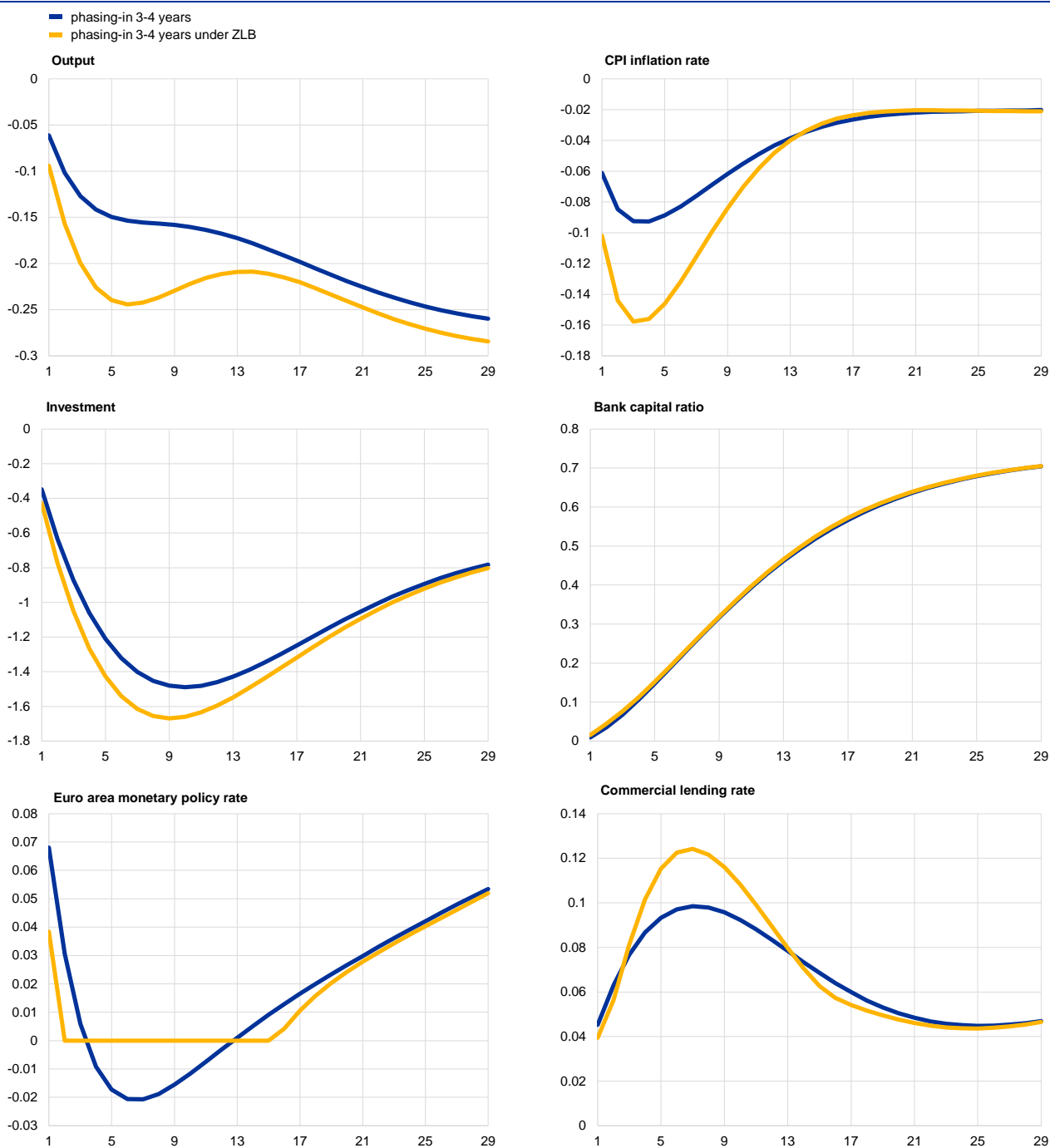
In the previous sections, the model allowed the monetary policy rate to react to the increase in capital requirements, which helped to smooth the MPI shock. In contrast, the following simulation assumes that soon after the implementation of higher capital requirements, the interest rates are at the zero lower bound and cannot be reduced further. The monetary policy rate is constrained at the lower bound two quarters following the implementation of the policy. As Chart 12 shows, based on the DJP model the effect of a one percentage point permanent increase in capital requirements with phasing-in arrangements of 3-4 years, as discussed in Chart 9, is now amplified further due to the fact that monetary policy rates are constrained by the zero lower bound. In this case, monetary policy is not as accommodative as before, resulting in higher transitory macroeconomic costs.

Simulations with the 3D model also point to a significant amplification of the impact of capital-based prudential policies when interest rates are at the zero lower bound: in this set-up, however, the presence of the zero lower bound can be moderated by a longer phase-in period for capital requirements.

Finally, the fact that certain central banks, including the ECB, have resorted to slightly negative policy rates only implies that the effective lower bound of the policy rate is below zero. The simulation results would also hold when that lower bound is reached. In reality, the central bank is likely to apply non-standard measures such as quantitative easing when it reaches the effective lower bound, and contractionary effects of MPIs may therefore raise the likelihood of non-standard monetary policy measures in a low interest rate environment.

**Chart 12**

Capital-based macroprudential policies with interest rates at the zero lower bound



Source: ECB estimates based on Darracq Pariès, Jacquinot and Papadopoulou (2016).

Notes: 1% increase in regulatory requirements subject to the zero lower bound, in the euro area. Horizontal axis: quarters. Vertical axis: percentage deviations from baseline, except for inflation, interest rates and bank capital ratio which are expressed as annual percentage-point deviations. GDP and investments are reported in real terms.

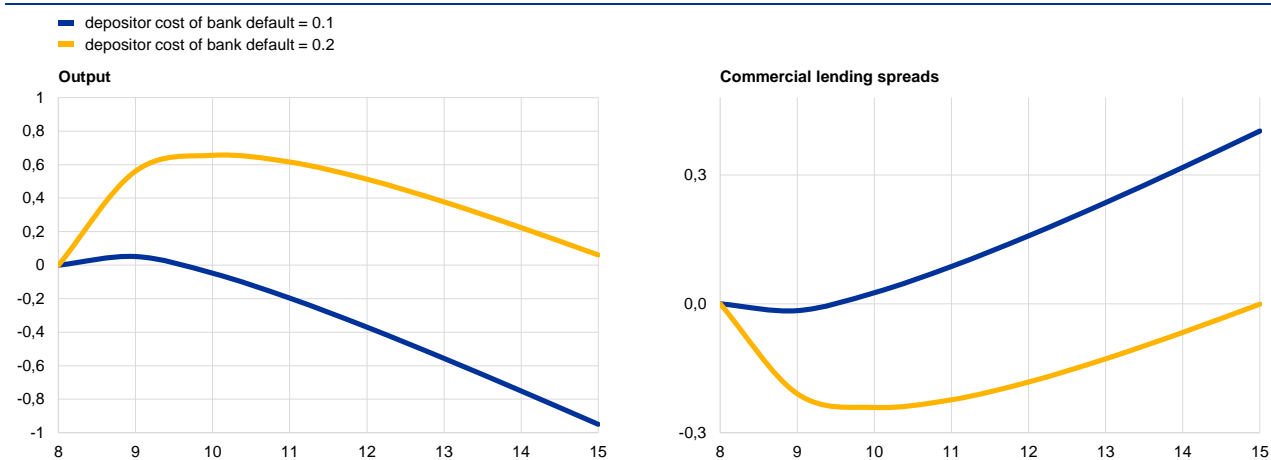
### 4.3 Long-term benefits of prudential policies

The DJP model can also expose the trade-offs between transitory costs versus potential long-term benefits of regulatory changes. On the one hand, higher capital requirements imply adjustment costs in the short term in order for banks to meet the larger equity requirements. On the other hand, there are longer-term macroeconomic benefits of tighter regulatory requirements as they make banks safer. In the model, they reduce the probability of banks defaulting and thereby the expected macroeconomic costs of bank failure over a given period of time, in turn weakening the sovereign-banking nexus. In view of these considerations, the benefits of raising capital would be stronger when banks are risky and weakly capitalised. This assumption provides a channel for higher capital requirements to ease the banks' financing conditions in the long-run due to the lower probability of bank default. Additional steady-state macroeconomic benefits also stem from the lower fiscal cost of deposit insurance which is assumed to be recouped out of public spending. The impact of deposit insurance is not analysed, however, since it is beyond the scope of this paper.

First, the model can illustrate the sensitivity of the steady-state allocation to higher capital requirements. Chart 13 shows the steady-state level of GDP and lending rate spreads for various levels of capital requirements starting from 8 to 15% and for different assumptions on the depositor cost of bank capital. The blue and yellow line correspond to simulations where the semi-elasticity to bank default probability in the model is calibrated either low (0.1) or high (0.2), respectively. As anticipated, the output and intermediation spreads tend to display hump-shaped patterns, which are more pronounced as the depositor costs channel of bank default is active. Capital requirements are costly for banks and this effect dominates as the increase in capital requirements becomes larger. For milder regulatory tightening however, the macroeconomic benefits of having safer banks outweigh the costs by deterring incentives for risk-shifting and lowering the costs for depositors. Quantitatively, with high depositor cost of bank default the steady-state output improves and lending rate spread compresses until capital requirements reach around 10-11% (see yellow line). Dampening the depositor cost channel dramatically mutes the scope for net benefits, with output declining below and spreads ending up above the initial steady state for capital requirements higher than 10% (see blue line).

### Chart 13

#### Steady state sensitivity to capital requirements



Source: ECB estimates based on Darracq Pariès, Jacquinot and Papadopoulou (2016).

Note: Incremental increase in capital requirements in the steady state, from 8 to 15%. Horizontal axes: capital requirements in per cent. Vertical access: output expressed as percentage deviation from initial steady state. Commercial lending rates expressed in annual percentage-point deviations from initial steady state. Initial steady state corresponds to capital requirements of 8%.

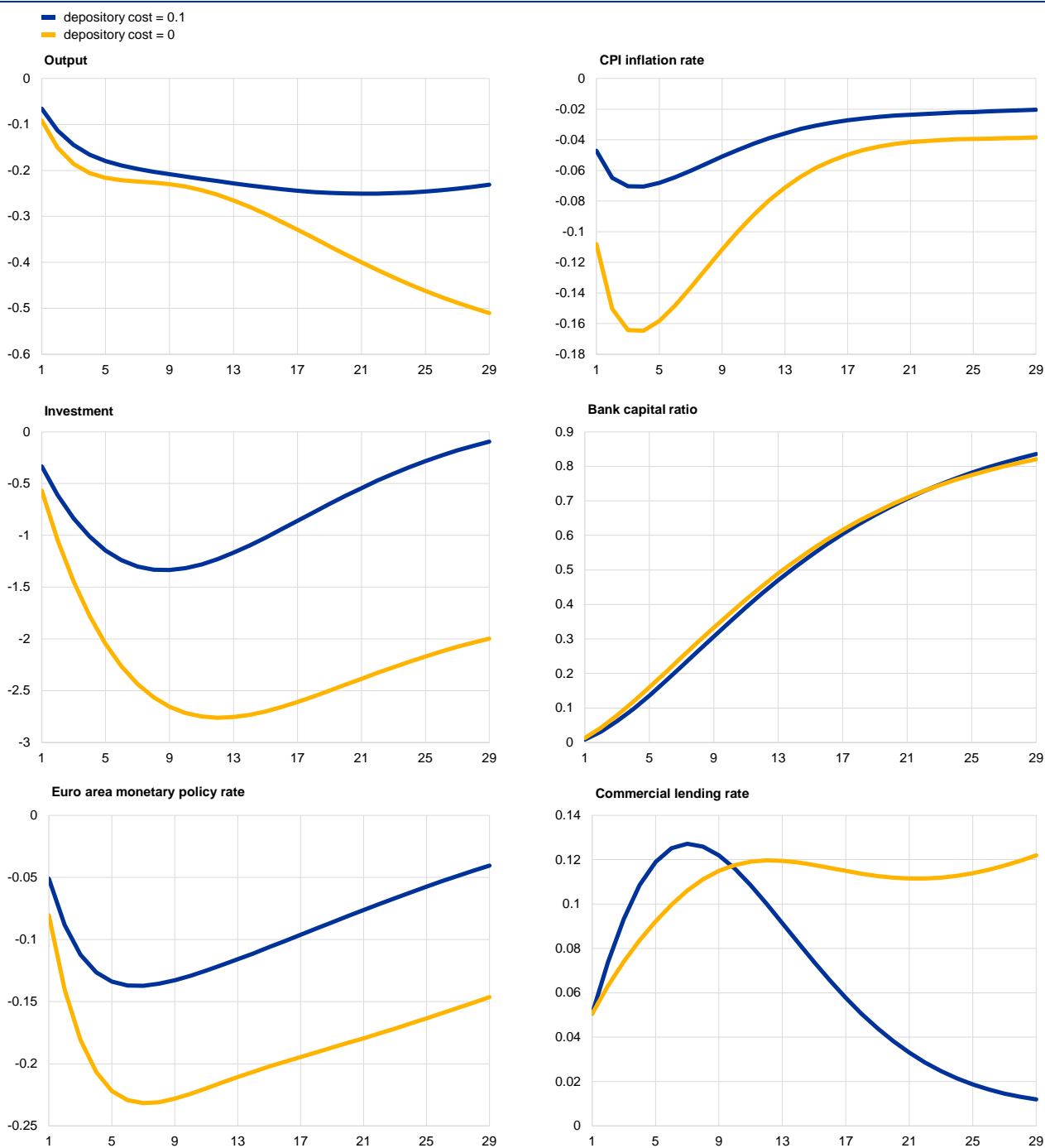
Second, the model can shed some light on the transitional dynamics. Chart 14 illustrates a scenario of a 1% increase in capital requirements (i.e. from 8 to 9%) phased in over 3-4 years, first in the case of no depositor cost of bank default and second in the case of mild benefits, as illustrated in Chart 13. In the case of high bank risk with low depositor cost of bank default, the 1% increase in capital requirements exhibits milder transitional dynamics. As shown in Chart 14, when ignoring the economic benefit channels given the very low probability of bank default in the steady state, output declines below and commercial lending rates end up above the initial steady state throughout the transition to the new steady state.

Overall, the simulations give polar illustrations for the transition to meaningful and sizeable long-term net benefits of higher regulatory requirements. Transitional costs are milder when banks engage in excessive risk-taking and are weakly capitalised and the new requirements are credibly announced and gradually phased in.



**Chart 14**

Role of depository cost of bank default on the dynamic adjustment from higher capital requirements



Source: ECB estimates based on Darracq Pariès, Jacquinot and Papadopoulou (2016).  
 Notes: 1% increase in regulatory requirements in the euro area. Horizontal axis: quarters. Vertical axis: percentage deviations from baseline, except for inflation, interest rates and bank capital ratio which are expressed as annual percentage-point deviations. GDP and investments are reported in real terms.

## 4.4 External bank capital shock

Beyond the analysis of monetary and capital-based macroprudential policies, this paper also explores the impact of a sudden loss of capital due to a specific and strong shock, for example substantial loss on banks' trading and loan books, which in turn puts severe pressure on their capital positions. In particular, the external shocks to bank capital are designed so that at the peak bank capital decreases by one percentage point and subsequently the shock follows a first order autoregressive process with autocorrelation being 0.9 to build expectations that capital might remain low for an extended period of time. In this case, banks are faced with a trade-off of either raising new capital or adjusting their asset side, or alternatively a combination of the two.

### 4.4.1 Importance of unconstrained monetary policy

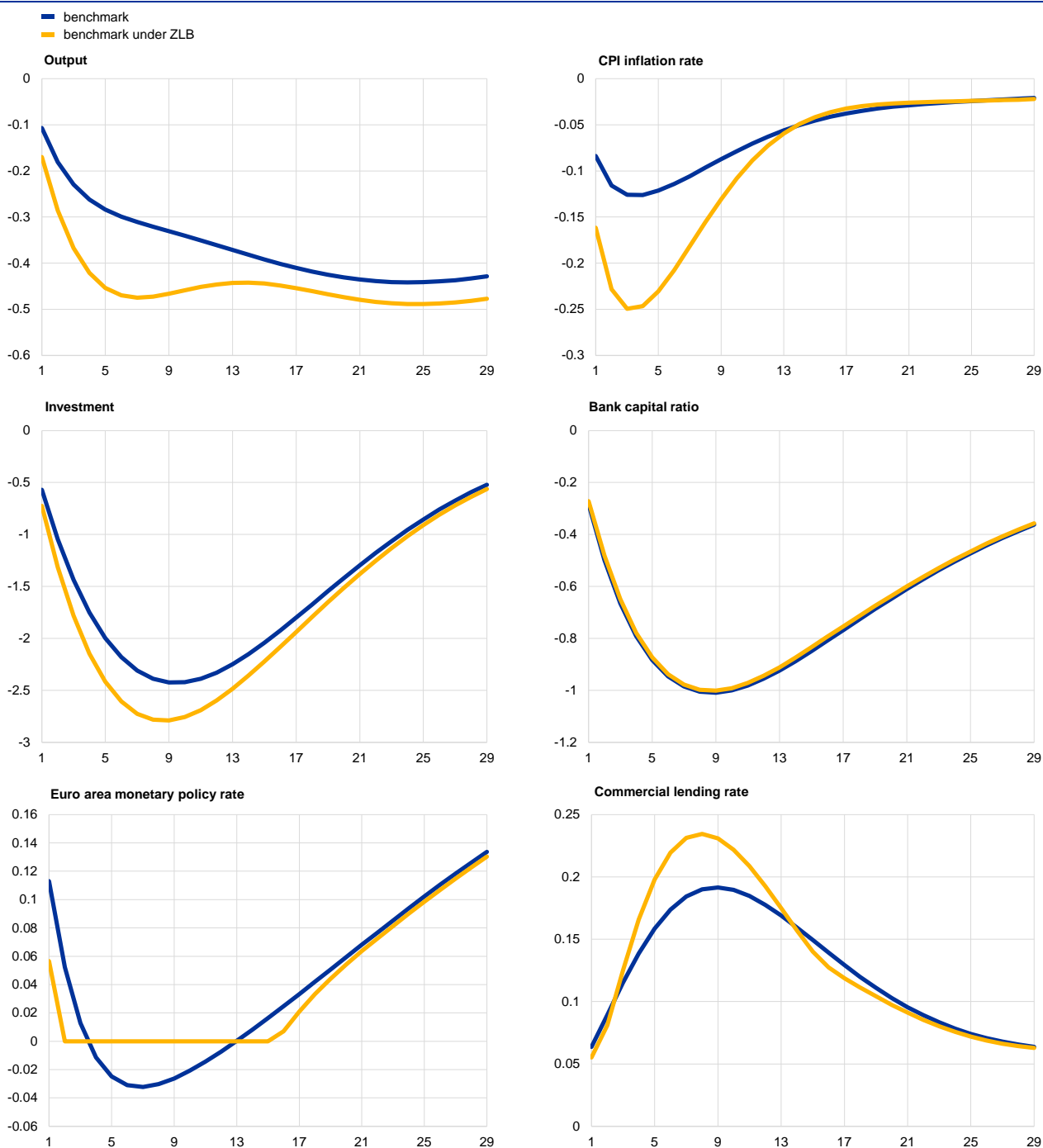
Chart 15 shows the impact of the shock in the benchmark case and when interest rates hit the zero lower bound soon after the shock, making the monetary authority unable to use the conventional monetary policy tool. The shortage of capital induced by the bank capital shock results in excessive bank leverage and higher risk of breaching the minimum capital requirements. In order for banks to replenish their capital buffer, bankers persistently increase their loan-deposit margins. The tightening of financing conditions ultimately extends to entrepreneurs through higher commercial lending rates.

In the very short term, commercial lending rates increase significantly more than the required return on loans received by banks, as contracting output and depreciating asset values imply higher credit risk compensation. This phenomenon reverses through the simulation horizon as corporate indebtedness and default rates recede, giving scope for the credit risk compensation to normalise. Monetary policy responds countercyclically, accommodating the banks' deleveraging process through substantial funding cost relief. It also stimulates consumption and investment.

In the event that the central bank cannot lower interest rates due to the zero lower bound, the macroeconomic multipliers are amplified and the impact on the economy is more severe.

**Chart 15**

External bank capital shock with interest rates at the zero lower bound



Source: ECB estimates based on Darracq Pariès, Jacquinot and Papadopoulou (2016).

Notes: decrease of euro area bank capital so that in the benchmark case bank capital ratio decrease by 1% approximately at the peak; shock is persistent i.e. follows an AR(1) process with autocorrelation being 0.9. Horizontal axis: quarters. Vertical axis: percentage deviations from baseline, except for inflation, interest rates and bank capital ratio which are expressed as annual percentage-point deviations. GDP and investments are reported in real terms.

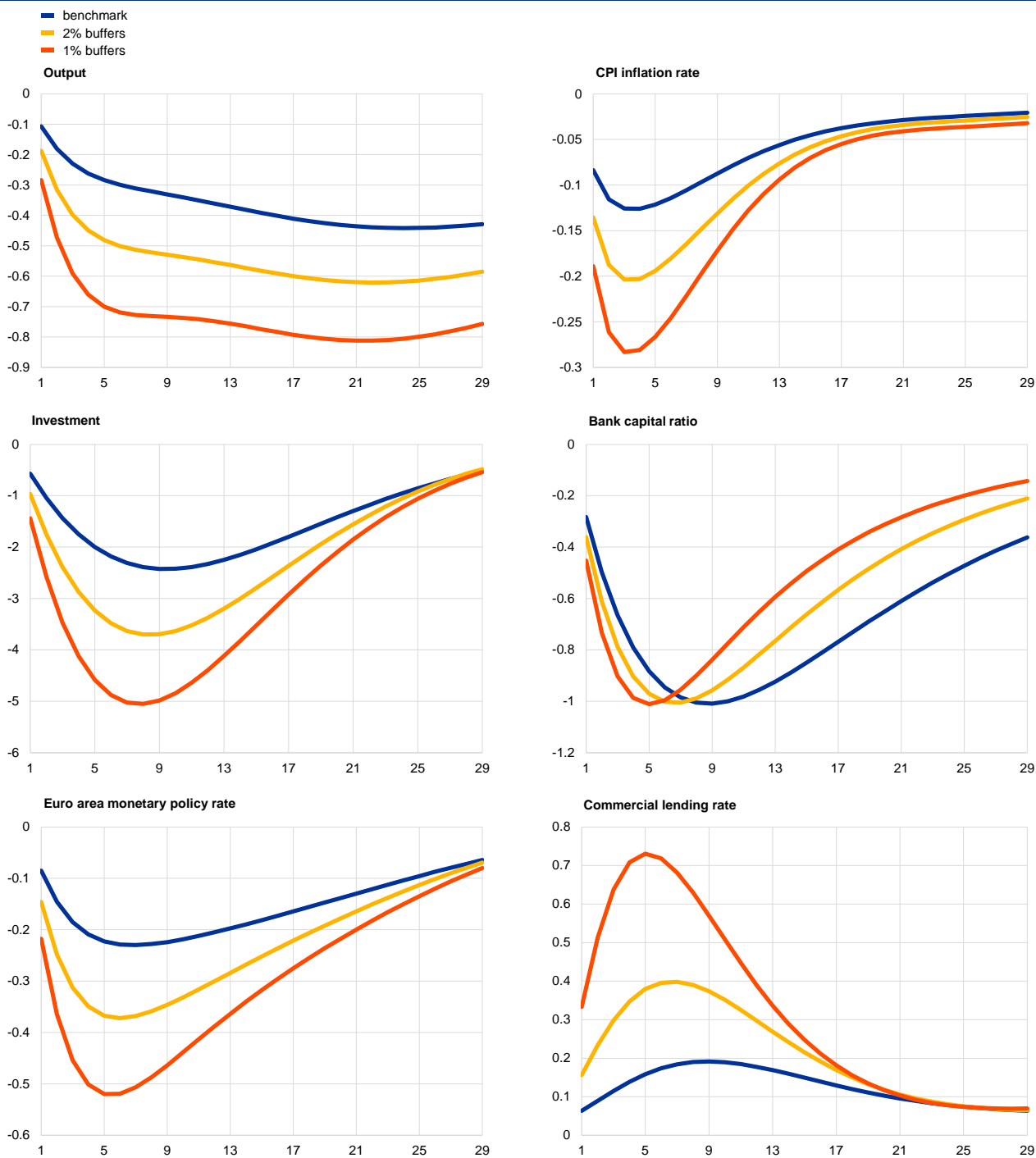
#### 4.4.2 Importance of precautionary bank capital buffers

In what follows, the impact of a disruption of banks' capital is explored when banks hold a different amount of precautionary buffers, which is taken to be an indication of their initial financial strength. It is customary for banks to hold some amount of capital in addition to the combined buffer requirements (which include both micro- and macroprudential requirements) as a precautionary voluntary measure. For the same amount of total capital, a large share held in the precautionary buffer implies that banks can withdraw capital in times of stress without being forced to deleverage in order to meet capital requirements.

Three cases are analysed: a benchmark case, in which precautionary capital buffers are set at approximately 4 percentage points, and two cases where precautionary buffers are 2 and 1 percentage points of risk-weighted assets. In all simulations, the shocks are designed so that at the peak there is a decrease in bank capital of 1%. Furthermore, the shocks are persistent and follow a first order autoregressive process with autocorrelation being 0.9. As observed in Chart 16, the lower the bank capital buffers, the stronger the impact on the banking sector and in the economy, since banks face a higher risk of breaching the minimum capital requirements. Therefore, in order to replenish their capital buffers, bankers will persistently increase their loan-deposit margins in a more forceful manner, resulting in a stronger tightening of financing conditions and higher commercial lending rates. The impact on the economy and real GDP is stronger, resulting in more accommodating responses of monetary policy.

**Chart 16**

**Bank capital shock and banks' initial financial strength**



Source: ECB estimates based on Darracq Parias, Jacquinot and Papadopoulou (2016).

Notes: decrease of euro area bank capital so that in the benchmark case bank capital ratio decrease by 1% approximately at the peak; shock is persistent i.e. follows an AR(1) process with autocorrelation being 0.9. Horizontal axis: quarters. Vertical axis: percentage deviations from baseline, except for inflation, interest rates and bank capital ratio which are expressed as annual percentage-point deviations. GDP and investments are reported in real terms.

## 5 Conclusions

This paper has highlighted several channels of interaction between monetary policy, micro- and macroprudential policies. The quantitative simulations show that there are important interactions between these different policies, but also complementarities. In particular, increases in capital requirements have transitional costs that may depress economic activity and inflation in the transition phase. These costs can be counteracted to some extent by looser monetary policy, but are considerably amplified when monetary policy does not react, as is the case when it faces the effective lower bound on its policy rate. Longer phasing-in periods for the introduction of capital requirements can help reduce the macroeconomic costs during the transition period. In any case, it is important to recognise that increases in capital requirements that lead to lower risk in the banking sector have substantial benefits for output in the longer term. In addition, the paper showed that the increased resilience brought about by higher capital buffers can significantly reduce the costs of negative bank capital shocks. While a deeper analysis of the interactions would have to consider a wide range of possible shocks hitting the economy, the illustrative simulations in this paper show that in order to assess the macroeconomic impact of each individual policy it is important to take into account the effects that changes in other policies may have on the respective transmission mechanism.

The results suggest that a constant sharing of information among the three policy areas is very beneficial in order to avoid conflicting effects and achieve better policy outcomes. Defining the institutional arrangements needed in order to coordinate these policies is beyond the scope of this paper.

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# Annex

## 1 Risks addressed by microprudential policies

Credit risk is the risk that a borrower will not be able to repay the loan granted to him/her by the bank. Such non-repayment causes a loss for the bank, i.e. a reduction in its assets that must be matched by a reduction in its capital. If too many loans are not repaid and there is not enough capital to bear the hit, the bank becomes balance-sheet insolvent. Calculations of credit risk typically involve calculating exposures at default (EAD) and estimating probabilities of default (PD) and loss given default (LGD, i.e. the fraction of the exposure that will be lost). These calculations are complex and since Basel II they can be done using either a standardised approach or an internal-ratings-based (IRB) approach (i.e. the banks use their own models for these calculations). Categories of credit risk considered include credit concentration risk, counterparty credit risk and settlement risk, country risk, credit risk from securitisations, foreign-exchange lending risk and specialised lending (EBA, 2014).

Market risk concerns potential losses arising from movements in market prices. Market risk exposures are largely but not exclusively due to trading activities, and drivers include exchange rates, interest rates or credit spreads. Categories considered include position risk (general and specific risk), foreign-exchange risk, commodities risk and Credit Valuation Adjustments (CVA) risk.

Operational risk is the risk of negative financial, business and/or reputational impacts resulting from inadequate or failed internal governance and business processes, people, systems or from external events (EU, 2013). According to the BCBS definition, it includes legal and compliance risks. It typically also includes information and communication technology (ICT) risks and can also include conduct risks and reputational risks, as is the case in the SSM framework. Typical operational risk events are caused by internal or external fraud, human error, business disruptions, system failures, breaches of contract and natural disasters.

Interest rate risk in the banking book (IRRBB) is the risk to a bank's capital and earnings arising from adverse movements in interest rates that affect the institution's banking book positions – broadly speaking, non-trading activities (BCBS, 2015). For example, changes in interest rates affect a bank's earnings through its net interest income (NII). Interest income lies at the heart of a bank's maturity-transformation role; it is the margin made from the slightly higher interest the bank receives from loans it has given out compared to the interest it pays out on deposits and other sources of funding.

Liquidity and funding risk concerns a potential situation whereby many depositors and investors withdraw funds they have provided to the bank, leaving the bank short of funds and forcing it to sell off assets quickly, often at a great cost. If the bank is unable to meet its repayment commitments to its creditors, e.g. because the assets it

holds are not liquid enough (cannot be sold quickly enough), it defaults and is described as being cash-flow insolvent.

## 2 Vulnerabilities addressed by macroprudential policies

Pricing of risk is a crucial element in the build-up of vulnerabilities. Under-pricing of risks can relate either to markets and/or banks. When it relates to financial assets, under-pricing of risk can be gauged by the price of assets being too high compared to what fundamental determinants of their fair value would indicate. When it relates to financial intermediaries, a more complex concept of risk-taking is involved.

When it comes to pricing of risk, its measurement changes according to the type of agents one looks at: financial markets, real assets or banks. Looking at corporate bond markets, investors demand premia according to their risk appetite in addition to the usual compensation for default risk of the borrower. Risk appetite or 'market sentiment' fluctuates over time as an expression of the financial cycle.

Looking at real assets, financial crises associated with the bust of housing price booms are typically harmful for the economy, hence the need for close monitoring of real estate prices, both in the residential and commercial sector. In particular, financial stability tries to benchmark such prices against a valuation of 'fundamental prices'.

Finally, looking at banks, risk-taking is mainly measured by a bank's funding structure, i.e. excessive exposure to wholesale funding, as well as the riskiness of its assets, i.e. a loosening of credit standards.

While this issue is also tackled by microprudential action, macroprudential policies look at how such behaviour can emerge when market failures are at play. Finally, some literature has shown that banks' internal models of valuation of risk can exacerbate this problem as internal banking models compute risk weights for loans.

1. **Leverage.** Once financial imbalances correct themselves, high leverage can multiply losses in the balance sheets of economic agents. Over-leverage relates in turn to potential over-borrowing by agents, also related to the under-pricing of risk explained in the previous paragraph.

The leverage of individual financial institutions falls under the remit of microprudential policy, but its fluctuations as a result of systemic phenomena are a matter for macroprudential policy. Leverage can concern financial institutions, which are subject to microprudential regulation, but also households and firms with excessive debt.

2. **Maturity and liquidity transformation.** This vulnerability refers to the main activities of financial intermediation, maturity transformation and liquidity creation. They are typically monitored by both micro and macroprudential functions, albeit from two different points of view, namely idiosyncratic and systemic.

Maturity transformation refers to the practice whereby financial intermediaries borrow short-term and lend longer term. Excessive maturity transformation can expose the banking system to bank runs, as creditors might refuse to roll-over short-term claims of some institutions, leading to a loss of confidence in the banking system.

The recent crisis has shown more complex types of runs based on more sophisticated financial instruments and market mechanisms which are subject to macroprudential analysis.

3. **Interconnectedness and complexity.** The systemic importance of a given entity will depend on its position and role in the network of interactions, including its size and connectedness in terms of number and strength of links to other entities. Interconnectedness means that the balance sheets of individual institutions are correlated and single actions will have consequences that can become disproportionately amplified, potentially having a negative impact on many other entities in the system.

Interconnection can be a result of direct cross-exposures of financial institutions through interbank markets or cross-holdings of securities or may be due to institutions having a common exposure to, inter alia, some specific security holdings, as was the case during the 2007 subprime crisis.

In the former case, the type of contagion effect is relatively direct – default of one institution jeopardises the financial system because of unpaid claims to other institutions. In the latter case, contagion can occur through a market mechanism whereby the prices of securities rapidly deteriorate with institutions selling off assets at fire-sale prices. This kind of spiral cannot be understood when considering the balance sheets of individual institutions in isolation, because, inter alia, they depend on how securities are concentrated in the balance sheets of the financial system. In both cases, the emerging behaviour of the financial system depends on the structure of network relationships between the banks; however, complexity arises when the banks themselves are uncertain about the whole financial network of their cross exposures.

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