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Macroprudential dividend restrictions and countercyclical buffer release: assessment in a DSGE model*

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Abstract

This paper shows the transmission of the macroprudential restriction on bank dividend payments in a DSGE model, proposed by Clerc et al. (2015), where banks provide housing and corporate loans and finance their activity through equity and deposits. In the model, borrowing households, companies and banks can default, thus providing a rationale for macroprudential interventions aimed at preserving the bank solvency vis-à-vis negative shocks to bank profitability. In this context, the macroprudential measure that temporarily forbids the distribution of dividends has a positive direct effect on credit, because the retained earnings are used to finance the loans. Despite a small increase in credit risk, the measure contributes, through the expansion of credit, to an increase in banks' profitability and, therefore, to a reduction in the probability of bank default and in the cost of external funding, even beyond the lifting of the dividend restriction. Therefore, the temporary dividend measure generates

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positive long-lasting (though declining) effects on credit and on GDP. By contrast, a countercyclical capital buffer release impacts positively on credit and GDP in the short run, but it backfires in the long run, due to an increase in bank fragility. The adoption of the dividend restriction as a complementary measure to the capital buffer release strengthens the positive short-run effects and mitigates the negative long-run effects of this second type of macroprudential intervention.

JEL Classification: C53, G21, G28

Keywords: DSGE modelling, macroprudential policy

Non-technical summary

This paper presents an assessment of the macroprudential measures of temporary capital buffer release and dividend restrictions. These were the macroprudential interventions taken in many European countries during the covid-19 pandemic, in order to support the flow of credit and preserve bank resilience. The analysis is conducted within the DSGE model with banking system by Clerc et al. (2015). The advantage of a general equilibrium model is the possibility to capture the whole transmission mechanism of a policy change. The choice of the specific model, calibrated for Slovenia, is due to its ability to match the first moment of many relevant macroeconomic and financial variables.

In the model, banks accumulate capital out of retained earnings, raise external funding in the form of deposits and provide corporate and housing loans. The bank profits are split into retained earnings and dividends. Households, companies and banks can default. Despite the presence of the deposit insurance, depositors face a verification cost if a bank defaults. Therefore, depositors demand a risk premium, which depends on the average level of riskiness of the banking system and not on the bank-specific risk exposures, which are not observable by depositors.

Because of this information asymmetry and the limited liability, banks do not completely internalise the risks and costs of their lending activity. A consequence of this is excessive risk-taking by banks, which provides a justification for macroprudential policy interventions. In the original model, banks are subject to a minimum capital requirement and a countercyclical capital buffer. The main contribution of this paper is the introduction of a dividend restriction measure as a temporary policy shock that causes the bank dividend-to-wealth ratio to be equal to zero for a limited number of periods. The second contribution consists of simulating the contemporaneous use of the countercyclical capital buffer release and the dividend restriction measure, in order to show the interaction between these two macroprudential tools, in response to different types of shocks.

The results show the different channels of transmission of the dividend restriction measures. The first is the direct expansionary effect on credit, which is possible because the larger volume of retained earning allows banks to finance more loans. Due to the higher leverage in the economy, however, banks face an increase in credit risk, which is reflected in an initial rise in their default probability and deposit risk premium. Nevertheless, after a few periods, when the dividend ban is still in force, the expansion of credit translates into higher bank profits, which means stronger ability to generate capital.

In this way, the dividend measure has a positive effect on bank resilience and on the cost of external funding (lower deposit risk premium), in the model. This second transmission channel, through which the dividend measure positively affects bank resilience, represents a beneficial amplification effect. In fact, the positive effects of the measure on bank resilience and on credit last beyond the lifting of the measure.

Both corporate and housing loans grow after the introduction of the dividend ban. The response of the capital investment and of the price of capital have positive sign, as expected, while housing investment and house price decrease when the measure is in force. The reason is that the dividend measure has a redistributive effect from savers to borrowing households. The financial income of savers decreases due to unpaid dividends. They therefore cut their investment in housing and their consumption, while the dividend ban is in force.

On the other hand, borrowers have easier access to credit and they invest more in housing. However, a bigger portion of their labour income is used to repay a bigger debt, so their consumption decreases. Moreover, the fact that the interest rate on housing loans is lower than the initial value triggers a substitution effect, which further favours housing investment by borrowers at the expense of consumption. On aggregate, consumption and investment in housing decrease while the dividend measure is in force. In other words, in the model calibrated for Slovenia, the negative effect on consumption and housing investment by savers overweighs the positive effect for borrowers, when dividends are not distributed.

When the dividend ban is removed, the investment in housing from the two types of households slowly converge to the initial value. Interestingly, they both increase their consumption and the effect is persistent, although declining. This is because the positive and persistent effect of the dividend measure on bank resilience favours both types of households. In fact, on the one hand, after the lifting of the dividend ban, savers can increase their consumption as they receive a bigger amount of dividends, compared to the initial value, because bank profitability benefits from the lower cost of external funding.

On the other hand, the lower cost of external funding allows banks to maintain, for a long period, a lower interest rate on housing loans compared to the initial level, although higher than the interest rate when the measure is in force. The lower cost of credit represents a positive wealth effect for the borrowers, who respond by increasing their consumption. On aggregate, the response of consumption is positive and persistent, though declining, after the removal of the dividend ban. Overall, the effect of the dividend measure on GDP is positive, though small.

In contrast, a countercyclical capital buffer release impacts positively on credit and GDP in the short run, as banks can expand their risk exposures (i.e. loans) and still meet the lower capital requirement. However, the measure backfires in the long run, due to an increase in bank fragility. The adoption of dividend restriction strengthens the positive short-run effects and mitigates the negative long-run effects of a contemporaneous countercyclical release of capital buffers.

The positive short-run effect of the dividend measure on credit may be overestimated in the model, because loans represent the only type of banks assets. Nevertheless, the main policy message for macroprudential authorities is that the decision to release capital buffers in response to negative shocks should be accompanied by a restriction on dividend payments, as the latter measure has the potential to improve the effectiveness (i.e. to strengthen the benefits) and the efficiency (i.e. to lower the costs) of the former.

1 Introduction

The outbreak of the COVID-19 pandemic and the adoption of containment measures caused a severe economic shock all over the world. Governments, central banks and prudential authorities adopted a variety of policies to mitigate the impact of the pandemic on their economies. The measures taken by central banks and prudential authorities aimed to ensure that banks could continue to fulfil their role in funding the real economy, while preserving their resilience.

For this purpose, the ECB, other European central banks and prudential authorities intervened with three types of measures: providing banks with liquidity support[1], granting banks some flexibility in relation to capital requirements and introducing restrictions on dividends and other forms of bank payout. This paper provides an assessment of the transmission of the dividend restriction measure and its interaction with a countercyclical capital buffer release.

Banks can adjust their balance sheet in several ways in response to macroeconomic shocks and the (expected) materialisation of losses. Capital adjustment measures, which aim to preserve the capital ratio, such as adjustments to dividend policies and capital issuances, are potentially countercyclical, i.e. they can support the credit supply and facilitate the recovery. In contrast, measures like shifts to safer assets to reduce risk weights, shrinking the volume of assets, tightening the credit supply and a delay in loss recognition can amplify the recession and/or delay the recovery.

In order to smooth the pro-cyclical behaviour of banks, the prudential authorities may allow banks to temporarily operate below the combined buffer requirement. However, banks may be reluctant to use the buffers because restrictions on dividend distributions automatically apply to banks that breach their combined buffer requirement (CBR).[2] In

[1] The ECB took measures to support bank liquidity conditions. For instance, on 12 March 2020, it announced additional longer-term refinancing operations (further extended on 10 December) and, on 18 March, announced a new temporary asset purchase programme (the Pandemic Emergency Purchase Programme -PEPP). On 7 April 2020, the ECB announced a package of temporary collateral easing measures.

[2] There is evidence that banks adjust their CET1 ratio targets pro-cyclically, increasing them when macro-financial conditions deteriorate, in line with tighter market pressure in times of high uncertainty. See "Financial market pressure as an impediment to the usability of regulatory capital buffers", D. Andreeva, P. Bochmann and C. Couaillier, ECB Macroprudential Bulletin 2020, issue 11.

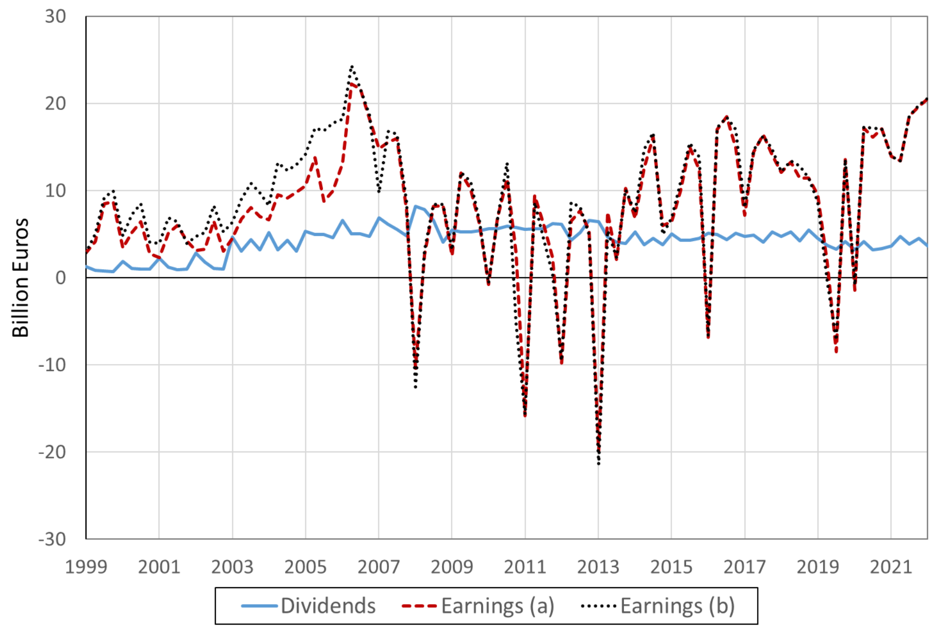
times of stress, prudential authorities may also release the countercyclical capital buffer (and exceptionally other buffers, as happened during the covid-19 pandemic). However, the current legislation does not guarantee that the freed-up capital is used to support credit and not to pay dividends.

Previous studies, indeed, document that banks are reluctant to cut dividends and that they reduce lending in response to capital losses and liquidity strains. During the period 2009-2013, the euro area banking sector boosted regulatory capital ratios mainly by shrinking assets, in particular credit (Cohen and Scatigna (2016); Gropp et al. (2018)). Banks in the euro area failed to boost capital ratios by increasing retained earnings, due to their reluctance to cut back on dividends (84^{th} BIS Annual Report (2014) and Shin (2016)), as can be seen from Figure 1.

For a sample of large US and European financial institutions, which experienced losses during the 2007-2009 crisis, the outflow of common equity in the form of dividends was substantial in relation to total assets and credit losses (Acharya et al. (2012), Floyd et al. (2015)). During the great financial crisis, most large banks reduced dividends but many did so relatively slowly, suggesting a reluctance to cut. Some banks continued to pay dividends while reporting losses and receiving bailout money. Banks' reluctance to reduce dividends seems explained by the need to signal financial strength. In fact, smaller (more opaque) banks and banks that rely more heavily on equity issuances exhibit a stronger tendency for dividend smoothing, suggesting that banks aim at improving access to equity markets (Koussis and Makrominas (2019)).

The aforementioned evidence highlights the relevant role of imposing restrictions on banks payouts in times of stress. Acharya et al. (2012) point to two reasons for imposing restrictions on dividend payments during a crisis. First, for a bank for which losses can be anticipated, dividends paid to equity holders are at the expense of the debt holders (and the taxpayers who fund the bailouts), thus representing a violation of the priority of debt over equity, made possible by the slow-moving nature of the deterioration of book equity. Second, the assets that are liquidated at first in the case of liquidity strain are the safe marketable assets, while riskier assets get left behind. This implies a type of risk-shifting or asset substitution that further favours the equity holders over the debt holders.

Figure 1: Bank dividends and earnings in the euro area (SX7E)



Note: SX7E refers to the Euro Stoxx Banks Index. Time series have been constructed as a simple sum of the SX7E members as of Feb 2023. Earnings (a): Income before extraordinary items and discontinued operation but after minority interest, preferred dividend and other adjustments. Calculated as Pretax Income – Income Tax – After Tax (Income) Loss from Affiliates – Minority Interest – Preferred Dividends – Other Adjustments. Earnings (b): Net income available to common shareholders. Calculated as Net Income – Total Cash Preferred Dividend – Other Adjustments. Source: Bloomberg.

This paper is one of the first studies to assess the transmission of the dividend restriction measure and its interaction with a capital buffer release. A summary of an earlier version of this paper appeared in the Banka Slovenije Financial Stability Review, April 2021.[3] The analysis herein is conducted within the DSGE model by Clerc et. al. (2015), calibrated based on Slovenian data. The model is characterised by the presence of saving and borrowing households, companies and banks. Borrowing households and companies have access to bank loans. Banks finance their activity through own funds and external financing, represented by deposits from saving households.

The three types of agents that raise external funding (borrowing households, companies and banks) can default. Moreover, despite the presence of the deposit insurance, depositors face a verification/transaction cost in the case of bank default. Therefore, de-

[3] The Banka Slovenije Financial Stability Review, April 2021, is available at https://bankaslovenije.blob.core.windows.net/publication-files/fsr_april_2021_en.pdf.

positors demand a deposit risk premium. The presence of these features in the model allows us to capture the positive effect of the dividend restriction measure on bank resilience and, consequently, on the cost of external funding. On the other hand, the fact that banks only invest in loans is a limit of the model, which tends to overestimate the effect of the measure in smoothing the downturn in credit in the case of shocks.

Moreover, in the model, savers are also bank owners and, therefore, the recipients of bank dividends. Thus, the model allows to capture the redistributive effect of the dividend ban measure from savers to borrowers. Since both borrowing and saving agents invest on housing and because of this redistributive effect, the impact of the dividend measure on the housing market cannot be predicted a priori, and nor can the effect on capital investment, since savers are also the owner of firms, which invest in capital. The redistributive effect makes ex-ante unpredictable also the effect of the dividend measure on consumption and, consequently, on GDP.

The first and main contribution of this paper is the introduction of the dividend restriction measure into the model by Clerc et al. (2015). The measure is introduced as a policy shock that temporarily moves to zero the bank dividend-to-wealth ratio. The paper by Munoz (2021) introduces a macroprudential dividend rule in a DSGE model. However, there are significant differences between his approach and the one in this paper.

The dividend prudential target proposed by Munoz is a countercyclical rule, according to which the amount that banks are allowed to distribute as a dividend varies with an indicator of financial imbalances (say the credit-to-GDP ratio). The dividend rule is coupled with a penalty system, so that banks have the option to deviate from the rule by paying a penalty. Therefore, the rule proposed by Munoz is different from the type of dividend restriction applied by prudential authorities in Europe during the covid-19 pandemic, which resemble an unexpected policy shock and, as such, is better captured by this paper. Other differences between this and Munoz' paper are discussed in Section 3 and refer to the features of the DSGE models within which the analysis is conducted. These features affect the transmission of the dividend restrictions.

The reference model for this paper features the presence of a countercyclical capital buffer on top of a minimum capital requirement. Therefore, the model can be used to assess the impact of a capital buffer release, in the presence of different types of shocks, under the implicit assumption that banks make use of the freed up capital.[4] Therefore, the second contribution of this paper consists of simulating the contemporaneous use of the countercyclical capital buffer release and the dividend restriction measure, in order to show the interaction between these two macroprudential tools.

The results show the different channels of transmission of the dividend restriction measures. The first is the direct expansionary effect on credit, which is possible because the larger volume of retained earning allows banks to finance more loans. It is important to mention, however, that this effect is overestimated in the model, due to the assumption that bank assets are only made up of loans. The expansionary effect on corporate loans leads to an increase in capital investment and capital price. In contrast, the effect on housing investment and house price cannot be predicted a priori.

In fact, since the beneficiaries of the dividends are the savers (as bankers belong to this type of households), when the measure is in force, it automatically causes a redistributive effect, which favours the borrowers at the expense of the savers. Borrowers increase their investment in housing while the savers decrease it. The aggregate effect on housing demand depends on whether the response of borrowers prevails over the response of savers or vice versa. In the model calibrated for Slovenia the negative effect on housing demand from savers overweighs the positive effect on housing demand from borrowing households when the measure is in force.

Moreover, when the dividend limit applies, both types of households decrease their consumption - savers because of a negative wealth effect, due to unpaid dividends, while borrowers cut their consumption because of a substitution effect. In fact, banks offer more loans at a lower rate, which makes it more convenient to buy a house. Moreover, with a bigger debt to repay, borrowers have less of their labour income left to finance their consumption.

Due to the higher leverage in the economy, banks face an increase in credit risk, which

[4]This assumption is needed because of factors that might make banks unwilling or unable to fully use management buffers and dip into the CBR when needed. For instance, there is a rich empirical evidence (Arnould, Avignone, Pancaro and Zochowski (2021); Gambacorta and Shin (2018); Schmitz, Sigmund and Valderrama (2017)) showing that a reduction in solvency ratios is significantly associated with an increase in bank funding costs of certain liabilities.

is reflected in an initial rise in their default probability and deposit risk premium. However, after a few periods, when the dividend ban is still in force, the expansion of credit translates into higher bank profits, which means stronger ability to generate capital.

In this way, the dividend measure contributes, in the model, to foster bank resilience and lower the cost of external funding (lower deposit risk premium). This transmission channel, through which the dividend measure positively affects bank resilience, represents a beneficial amplification effect. In fact, the positive effects of the measure on bank resilience and on credit last beyond the lifting of the measure.

The fact that banks still benefit from the lower deposit risk premium after the abolishment of the dividend measure favours both the savers, through the positive effect on bank profits and dividends, and the borrowers, because banks maintain a lower interest rate on loans (lower than the initial level) for a long period. Therefore, on aggregate, the effect on housing investment and on consumption is positive, although declining, for many periods after the lifting of the measure. The overall effect on GDP is positive, though small.

Regarding the release of the capital buffer in the case of different types of shocks, such as a shock to productivity, to house and capital price and an increase in bank riskiness, the results in this paper confirm those in Clerc et al. (2015) for different parametrisations of the model. In other words, the countercyclical capital buffer release has positive effects on credit and on GDP in the short run, but negative effects in the long run, due to a deterioration of bank solvency and higher cost of funding.

Finally, the results in this paper support the use of the dividend measure as a complementary macroprudential tool that can strengthen the positive short run effects of the capital buffer release and mitigate its negative long run effects. By allowing for more credit when it is more needed, while preserving bank resilience, the combined use of these macroprudential measures can have positive effects on real economy variables like real investments, consumption and GDP.

The rest of the paper is organised as follows. Section 2 presents the interventions of various macroprudential authorities in Europe during the covid-19 pandemic, consisting in restrictions on bank payouts and various forms of flexibility mainly in relation to capital requirements. Section 3 presents a review of related studies. Section 4 describes the main features of the model by Clerc et al. (2015) within which the analysis is conducted. Section 5 discusses the results of the simulation of the dividend restriction measure. Section 6 discusses the impulse responses to different types of shock, in the presence of the countercyclical capital buffer release and in the presence of both the dividend measure and the buffer release, as opposed to the absence of both measures in the baseline scenario. Section 7 offers concluding remarks.

2 Restrictions on bank dividends and capital buffer release in Europe during the pandemic

On 12 March 2020, the ECB Supervisory Board announced measures providing temporary capital and operational relief to its directly supervised banks. This meant that banks could use capital and liquidity buffers, including Pillar 2 Guidance.[5] Moreover, banks could benefit from relief in the composition of capital for Pillar 2 requirements and the ECB provided for operational flexibility in the implementation of bank-specific supervisory measures. On 15 April, the ECB issued a press release stating its position in favour of the action taken by the euro area macroprudential authorities to address the financial sector impact of the pandemic by releasing or reducing capital buffers.[6]

Certain authorities took the decision to reduce capital requirements, which in particular included the CCyB and other macroprudential buffers. According to the ECB's assessments, these measures released more than EUR 20 billion of common equity Tier 1 capital, which was expected to help in the absorption of credit losses, and enabled uninterrupted lending to the economy. Of the seven euro area countries with positive CCyB rates, the authorities in France, Ireland and Lithuania reduced their rates to zero, while Slovakia cancelled a previously announced rise in the rate. Having been announced earlier, the activation of the CCyB was cancelled in Belgium and Germany.[7] Some countries released other macroprudential buffers, which were at their disposal, such as the systemic

[5] https://www.bankingsupervision.europa.eu/press/pr/date/2020/html/ssm.pr200312~43351ac3ac.en.html
[6] See: https://www.ecb.europa.eu/press/pr/date/2020/html/ecb.pr200415~96f622e255.en.html
[7] https://www.esrb.europa.eu/national_policy/ccb/applicable/html/index.en.html

risk buffer (SyRB) in Estonia, Finland and the Netherlands, and the O-SII buffer in Finland and the Netherlands.[8]

On 13 March 2020, Banka Slovenije sent a letter to the banks where it was communicated that, under the aegis of the Single Supervisory Mechanism, the ECB had adopted a temporary relief in the supervision of the significant banks and that, in accordance with the level-playing field principle, it was also extended to less significant banks whose supervision is conducted directly by the Banka Slovenije. The following were granted to all banks and saving banks:

- temporary relief from meeting capital buffers, including the Pillar 2 guidance (P2G),

- temporary relief in the composition of Pillar 2 requirements from capital of lower quality than common equity Tier 1 capital,

- temporary relaxation of the liquidity coverage ratio (LCR).

Moreover, given the extraordinary and unpredictable nature of the Covid-19 shock, the ECB issued a recommendation on the 27th of March of 2020 urging credit institutions to refrain from distributing dividends or performing share buy-backs aimed at remunerating shareholders until the 1st of October.[9] In July, the ECB extended the recommendation until January 2021.[10] In September 2020, dividends not distributed following the recommendations amounted to €27.5 billion in the euro area. Finally, in December 2020, the ECB recommended the exercise of extreme prudence when deciding on or distributing dividends or when performing share buy-backs.[11]

These recommendations were addressed to significant institutions (SIs) directly supervised by the ECB and to national competent authorities (NCAs) with regard to less significant institutions (LSIs). The recommendations issued by the ECB were broadly in line with those issued by other institutions like the European Systemic Risk Board (ESRB)[12] and the European Insurance and Occupational Pensions Authority (EIOPA)[13].

[8] https://www.esrb.europa.eu/national_policy/html/index.en.html

[9] ECB/2020/19, 27th March 2020

[10] ECB/2020/35, 27th July 2020.

[11] The ECB deemed it imprudent to distribute more than 15% of the accumulated profit for 2019 and 2020 or more than 20 basis points of Common Equity Tier 1 ratio. See ECB/2020/62, 15th December 2020.

[12] https://www.esrb.europa.eu/mppa/recommendations/html/index.en.html

[13] https://www.eiopa.europa.eu/publications/eiopa-statement-dividends-distribution-and-variable-remuneration-policies-context-covid-19_en

Following the recommendations of the ESRB (ESRB/2020/7 and ESRB/2020/15), the Banka Slovenije introduced, on 11 April 2020, a macroprudential measure, further extended on 9 February 2021, prohibiting banks registered in Slovenia from paying out dividends until 30 September 2021. The measure also prohibited the payback or purchase of own shares or other capital instruments referred to in point (a) of Article 26(1) of Regulation (EU) No 575/2013. The purpose of the measure was to retain capital at banks so that the Slovenian banking system could better withstand potential losses, and to continue supplying credit to businesses and households.[14]

The reasons for introducing a measure restricting the distribution of dividends and other forms of capital payouts during a crisis are various. First, the measure aims to preserve bank resilience. Second, it is intended to avoid market stigma against banks that suspend the distribution of dividends for precautionary reasons. Third, it contributes to an increase in the effectiveness of other measures (e.g. fiscal, monetary and prudential) taken to counteract the negative economic consequences of the pandemic. In particular, the measure strengthens the effectiveness of capital buffer release in terms of counteracting credit procyclicality. It ensures that the funds made available by the buffer release are used to absorb losses and to sustain the flow of credit and not to deplete the capital base.

Moreover, as restrictions of distributions automatically apply to banks that breach their combined buffer requirement (CBR), the measure also aimed at reducing the disincentives for banks to use their capital buffers.[15] On the other hand, payout restrictions might have negative effects, primarily in the form of private costs imposed on some categories of economic agents. However, such costs are unlikely to have systemic effects.

[14] https://www.bsi.si/en/financial-stability/macroprudential-supervision/macroprudential-instruments/archive-of-macroprudential-instruments/macroprudential-restriction-on-banks-profit-distribution

[15] See ECB MPB No 13, https://www.ecb.europa.eu/pub/financial-stability/macroprudential-bulletin/html/ecb.mpbu202106_1~b620729a65.en.html for an overview and general discussion on the pros and cons of system-wide restrictions on dividend distributions.

3 Related literature

This paper is primarily related to the recent studies on the impact of the bank dividend restriction measure during the covid-19 pandemic. It is also related to the studies on the effects of countercyclical capital requirements, in particular the release and/or the use of capital buffers or any form of capital flexibility measure granted to banks in times of crisis.

Similarly to the results of the present study, empirical analyses conducted at the ECB[16] show that dividend distribution restrictions have been effective in maintaining banks' resilience and their ability to support the real economy amid the COVID-19 crisis. Using a microeconometric analysis that employs linear panel regressions in a differences-in-differences specification , the group of banks that followed the dividend recommendations (the "treated" group, 59 banks) is compared with those whose dividend distribution plan was not affected (the "control" group, 36 banks). Banks that did not distribute planned dividends increased their provisions by around 5.5% relative to other banks. Therefore, the recommendation had a positive and significant effect on banks' capacity to absorb future losses by facilitating the build-up of provisions. Moreover, the dividend recommendation had beneficial effects on the lending supply. Banks that altered their distribution plans following the recommendations supported lending by around 2.6% more than banks whose distribution plans were unaffected.

A positive effect of the dividend restriction measure on lending has been documented also by Martínez Miera and Vegas (2021). They assessed the impact of the dividend measure on the flow of credit to non-financial corporations (NFC) in Spain. On the basis of the evidence available six months after the implementation of the ECB's Recommendation on dividends distributions, it was assessed whether dividend restrictions had any effect on the volume of lending by Spanish banks up to September 2020.[17,18] According to the

[16]See Macroprudential Bulletin, ECB, June 2021.

[17]Spain offers a unique testing ground as a very interesting quasi-natural experiment. When the ECB's Recommendation was announced on 27 March 2020, some banks had already committed to paying out dividends in the first quarter of the year. They honoured their commitment following a legal consultation which concluded that backtracking on dividend distribution and variable remuneration was not possible if such payments had already been approved in the General Meeting. Other banks cancelled their dividend, because either they had not committed to a dividend payout or had said it was still pending approval.

[18]The basic identifying assumption underpinning this analysis is the fact that the date of the Board meet-

results obtained, the dividend restrictions appear to have had significantly positive and economically relevant effects on lending.

This paper differs from the aforementioned analyses, as the former relies on a structural model, namely a DSGE model, while the latter are based on an empirical approach (panel regression). The former allows us to trace out the full transmission mechanism of the dividend restriction measure, while the latter show the impact of the measure only on credit (or credit to non-financial corporations) and on bank provisions.

This paper is similar to Munoz (2021), as both investigate the transmission of macroprudential dividend restrictions in a DSGE model. However, this paper introduces the measure as an unexpected policy shock that moves to zero the bank dividend-to-wealth ratio for a certain number of periods. This expedient closely mimics the dividend restrictions adopted during the pandemic. Instead, Munoz proposes a countercyclical rule, based on which bank dividend should fluctuate with an indicator of financial imbalances (for instance, the credit-to-GDP gap). Banks can deviate from the dividend rule by paying a penalty. In this respect, the proposal by Munoz represents a step forward toward the introduction of a countercyclical macroprudential rule on dividend distributions.

Moreover, the fact that the measure is introduced as a macroprudential rule makes it possible to perform long-term analysis, in steady state, which we find in the paper by Munoz. In contrast, in this paper the measure is introduced as a shock and the assessment only proceeds through impulse response function analysis. The assumption that banks only invest in loans is a limitation of both papers and tends to overestimate the effect of the dividend restrictions on credit. Furthermore, the model by Munoz does not feature bank default. Therefore, it cannot capture the effect of the dividend measure on bank resilience and, consequently on the cost of external funding for banks. The effect through the deposit risk premium is an important channel of transmission of the measure that this paper captures.

Moreover, both the model by Munoz and the one used in this paper foresee a countercyclical capital buffer. Munoz shows the transmission of a buffer release and its interaction

ing (where the dividend payout was approved) for each bank preceded the timeframe of the date on which the recommendation entered into force. Hence, the group of banks which saw their dividend distribution effectively restricted during the first half of the year might be considered as random.

with the dividend measure for a variety of shocks, proving their effectiveness in smoothing the credit cycle and facilitating the recovery as well as their complementarity, especially in the face of financial shocks. This paper confirms the effectiveness and synergy of the two measures in smoothing the credit downturn.

This paper is also related to the empirical studies on the effects of buffers' release during the pandemic. Under the assumption that banks make use of released buffers to absorb losses and to lend, Borsuk et al. (2020) show that macroeconomic outcomes are expected to improve compared to a counterfactual where buffers are not released and not used. Avezum, Oliveira and Serra (2021) analyse the effectiveness of releasing macroprudential capital buffers (CCyB or SyRB) as the average difference between household loan growth in European countries where macroprudential requirements were released versus an estimated counterfactual scenario of no buffer release.[19] Between March and August 2020, credit to households grew, on average, 0.99 percentage points more in countries where buffers were released, when compared to the estimated counterfactual scenario of no release.

While the aforementioned empirical studies only show the short-term effects of the buffer release, the general equilibrium framework adopted in the present paper allows us to analyse also the long-term effects. Regarding the short-term effects, the results in this paper and the aforementioned studies are aligned, in the sense that the capital buffer release turns out to mitigate the contraction in credit following negative economic shocks in the short run. However, this paper also shows that a prolongued release of the countercyclical buffer can backfire, because banks become less resilient, the deposit risk premium increases and, thus, there is a negative effect on bank profitability and their ability to generate capital and finance the economy.

Similar results as in the present paper are obtained from analyses conducted by the Bank of Portugal within the same DSGE model (by Clerc et al. (2015)), calibrated for Por-

[19] The assessment focuses on the household sector to minimise the confounding effects that might arise from the interaction with state-guaranteed-loans, which have been mostly intended to support NFCs. Furthermore, to improve the identification, the analysis excludes those European countries with extensive public support measures which could have impacted households beyond buffer releases. The pool of treated units includes four countries that released the CCyB (Denmark, Lithuania, Slovakia, and Sweden) and three that released the SyRB (Estonia, the Netherlands, and Poland). The control units are Austria, Belgium, Germany, Greece, Latvia, Luxembourg, and Slovenia.

tugal.[20] First, by making use of released capital, banks mitigated the effect of the pandemic shock on credit, particularly on corporate loans, resulting in more favorable dynamics for corporate investment. Second, the dividend restriction has a complementary effect in mitigating the response of credit and GDP to shocks.

4 The reference model by Clerc et al.(2015)

The analysis is conducted in the model by Clerc et al. (2015). The model introduces financial intermediaries and three layers of default into an otherwise standard dynamic stochastic general equilibrium (DSGE) framework, but absent nominal and real rigidities. Default can occur among banks, non-financial companies and households. There are two types of distortion which provide a rationale for capital regulation in the model: limited liability of banks and bank funding cost externalities. The consequences of these two distortions is excessive risk-taking by banks.

The model includes six types of representative agents: borrowers, savers, entrepreneurs of non-financial companies, banks, bankers and the macroprudential authority. Banks finance housing and corporate loans by raising equity (from bankers) and deposits (from savers). Deposits are insured by a deposit insurance agency that is funded by lump-sum taxes paid by savers and borrowers. However, when a bank defaults, depositors suffer some verification costs. Therefore, depositors demand a deposit risk premium.

However, the model assumes that depositors do not observe the bank-specific risk exposure but only the level of risk for the banking system as a whole. Consequently, the deposit risk premium is based on the system-wide probability of default, thus giving banks an incentive for excessive risk-taking. Higher capital ratios tighten the supply of loans by reducing the incentives for banks to take on excessive leverage. At the same time, higher capital ratios reduce the cost of uninsured funds provided to banks, resulting in a lower cost of credit. The final impact depends on which of the two channels dominates.

[20]See: "The banking system as economic stabiliser of the pandemic shock: a simulation of micro- and macroprudential policies", Box 1, Financial Stability Report of Banco de Portugal, December 2020. See also:"Impact of the bank dividend pay-out restriction in conjunction with flexible capital requirements", Box 6, Financial Stability Report of Banco de Portugal, June 2021.

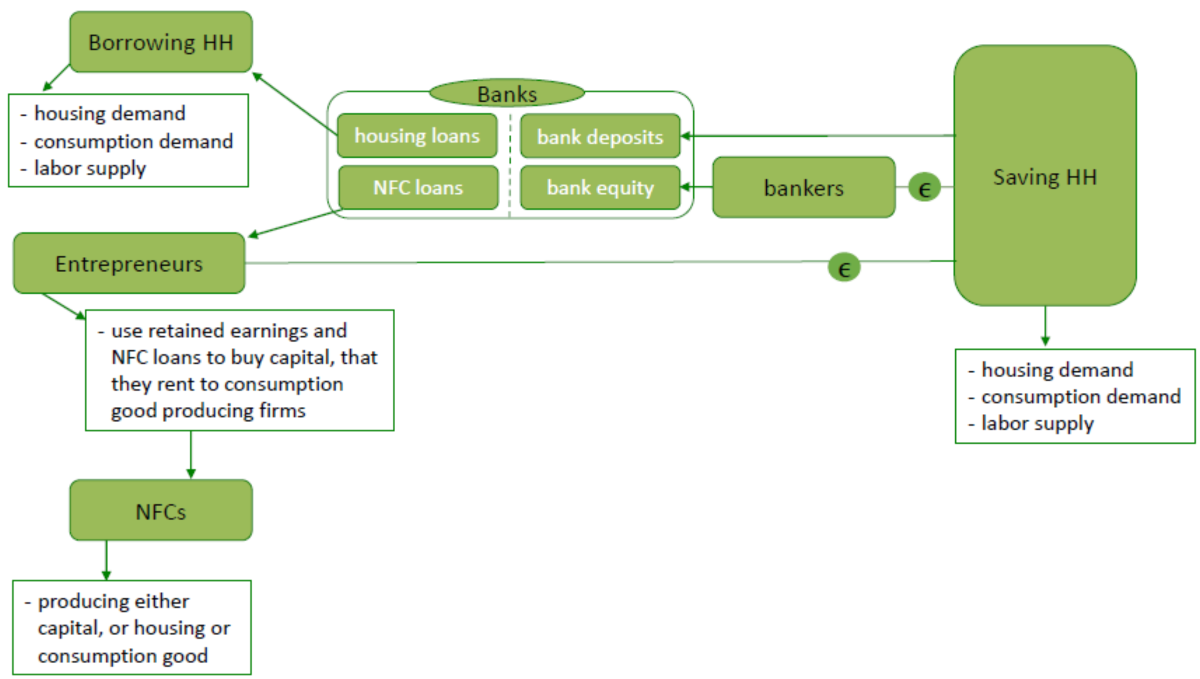
Moreover, there is a trade-off between the welfare of savers and that of borrowers. In the long-run, savers benefit from tighter capital regulation, due to the reduced likelihood of bank failures, which implies safer bank deposits. On the other hand, capital ratios higher than a certain level penalise borrowers, due to reduced supply of loans. The existence of this trade-off makes an optimal level of capital ratio emerge.[21]

For the analysis in this paper, I used the model calibrated for Slovenia, using macroeconomic and financial data at quarterly frequency over the period 2001Q1:2015Q4. Some of these data are publicly available (like GDP, euribor), others are available for research purposes upon request (this is the case for data from the Household Finance and Consumption Survey - HFCS), others are central bank confidential data.[22] Table 1 reports the targets for calibration. Table 2 reports the parameter values resulting from the calibration. As evidenced in Table 1, the model matches closely the first and second moments established as targets.

[21] For a detailed description of the model see Clerc et al. (2015).

[22] The calibration for Slovenia follows closely, in terms of data and procedure, Mendicino et al. (2018) and its online appendix.

Figure 2: Schematic view of the 3D model by Clerc et al.(2015)



5 Simulating the bank dividend restriction measure

In the 3D model, bankers solve a first stage problem and a second stage problem. In the first stage problem, they decide how much capital to allocate between the two types of bank (bank activity), offering either housing loans or company loans. This problem is solved by assuming that the expected profit from the two types of bank activity is the same, otherwise only one type of bank activity would exist. In the second stage problem, bankers decide how to allocate the realised profit between retained earnings (n^b_{t+1}) and dividends (c^b_{t+1}), the latter being transfers to the saving households, who in turn are also bankers. The second stage optimization problem of the banker in the 3D model is the following:

$$\underset{c^b_{t+1},\, n^b_{t+1}}{\text{maximize}} \quad \left(c^b_{t+1}\right)^{\chi^b} \left(n^b_{t+1}\right)^{1-\chi^b} \tag{1a}$$

subject to

$$c^b_{t+1} + n^b_{t+1} \leqslant W^b_{t+1} \tag{1b}$$

where W^b_{t+1} is the wealth of bankers at *t+1* and $\chi^b \in (0,1)$. It follows that dividends represent a constant share of bank wealth, i.e.

$$c^b_{t+1} = \chi^b W^b_{t+1} \tag{2}$$

as well as retained earnings

$$n^b_{t+1} = (1-\chi^b) W^b_{t+1}. \tag{3}$$

The parameter χ^b is calibrated to match the sample mean of the bank dividend-to-wealth ratio. In order to simulate the effect of the dividend restriction measure, I introduce a policy shock that temporarily moves the bank dividend-to-wealth ratio to zero. In particular, I assume that dividends are not paid for six subsequent quarters, as was the case with the measure adopted by the Banka Slovenije that prohibited the distribution of dividends from 2020Q2 to 2021Q3.

More precisely, I introduced an auxiliary variable $e_t^{\chi^b}$, which follows a random walk process

$$e_t^{\chi^b} = e_{t-1}^{\chi^b} + \epsilon_t^{\chi^b} \tag{4}$$

and I replace χ^b with $\chi^b - e_{t+1}^{\chi^b}$ in equations (2) and (3). Finally, in the policy experiment where it is announced that dividend payments are not allowed for six periods, I assign a value equal to χ^b to the shock $\epsilon_t^{\chi^b}$ and equal to its opposite (i.e. $-\chi^b$) six periods later.

Figure 3 shows the response of the main variables to the policy shock consisting of the temporary dividend ban. There are two main channels through which the measure is transmitted to the economy. The first is a direct credit channel, while the second channel operates through the increased bank resilience and the positive effect on the cost of external funding. Moreover, there is a redistributive effect from savers, being the recipients of bank dividends, to borrowers.

Regarding the first channel, the larger volume of retained earnings induced by the dividend ban is used to finance the flow of credit in the two segments of corporate and housing loans. This effect is, however, over-estimated in the model, as loans are the only type of bank assets represented. The measure has an expansionary effect on credit, because banks provide more credit at lower rates, in order to match the credit demand, despite the small increase in credit risk, as reflected in borrowers default probability due to their higher leverage.

By providing credit to more indebted borrowers, banks face the usual risk-return tradeoff. The initial (small) increase in credit risk, is reflected in an initial small increase in bank default probability and, consequently, in the deposit risk premium. However, after a few periods, when the dividend ban is still in force, the expansion of credit translates into higher profits, thus contributing to the bank's ability to generate new capital, to foster bank resilience (as reflected in a decrease in bank default probability) and to lower the cost of external funding (lower deposit risk premium). Interestingly, the positive effect of the dividend measure on bank resilience and on credit is long-lasting, after the lifting of the dividend ban, although declining.

More credit is associated with a positive effect on capital investment and, consequently on the price of capital, but there is a reversal when the dividend ban is removed. In contrast, housing investment declines in response to the dividend measure, despite the increase in housing loans. The decline in housing investment is due to the redistributive effect of the measure from savers to borrowers (Figure 4).

Due to the dividend measure, borrowers have easier access to credit and their investment in housing increases. However, as a larger part of their labour income is absorbed to repay the higher debt, borrowers reduce their consumption. On the other hand, savers face a reduction in their financial income, due to unpaid dividends. Consequently, they lower both their consumption and their investment in housing. In the model calibrated for Slovenia, the effect of the dividend measure on the savers' housing investment overweighs the effect on borrowers, leading to a decrease in the aggregate housing investment and, in turn, on house price. On aggregate, the dynamics of housing investment, house price and consumption is reversed when the dividend measure is abolished. The overall effect of the dividend ban measure on GDP is positive, though small.

The results presented in this section confirm the findings of empirical studies described in section 3. In other words, the dividend measure contributes positively to support the flow of credit and to bank resilience. However, in the empirical analyses conducted at the ECB[23], the effect of the dividend measure on bank resilience during the pandemic is measured by comparing the increase in provisions of banks that altered their dividend distribution plan following the dividend restriction recommendation and of banks that did not.

Here, instead, the positive effect on bank resilience is measured by the reduction in bank default probability and in the deposit risk premium. It would be interesting to investigate with an empirical model the effect of the dividend measure on these two variables during the pandemic. Finally, the main results of this study are aligned with the main results in Muñoz (2021), who also finds a positive effect of the dividend prudential rule on loans and output, in the cases of capital depreciation shock, housing depreciation shock and bank capital shock.

The main message of the results discussed in this section, for macroprudential au-

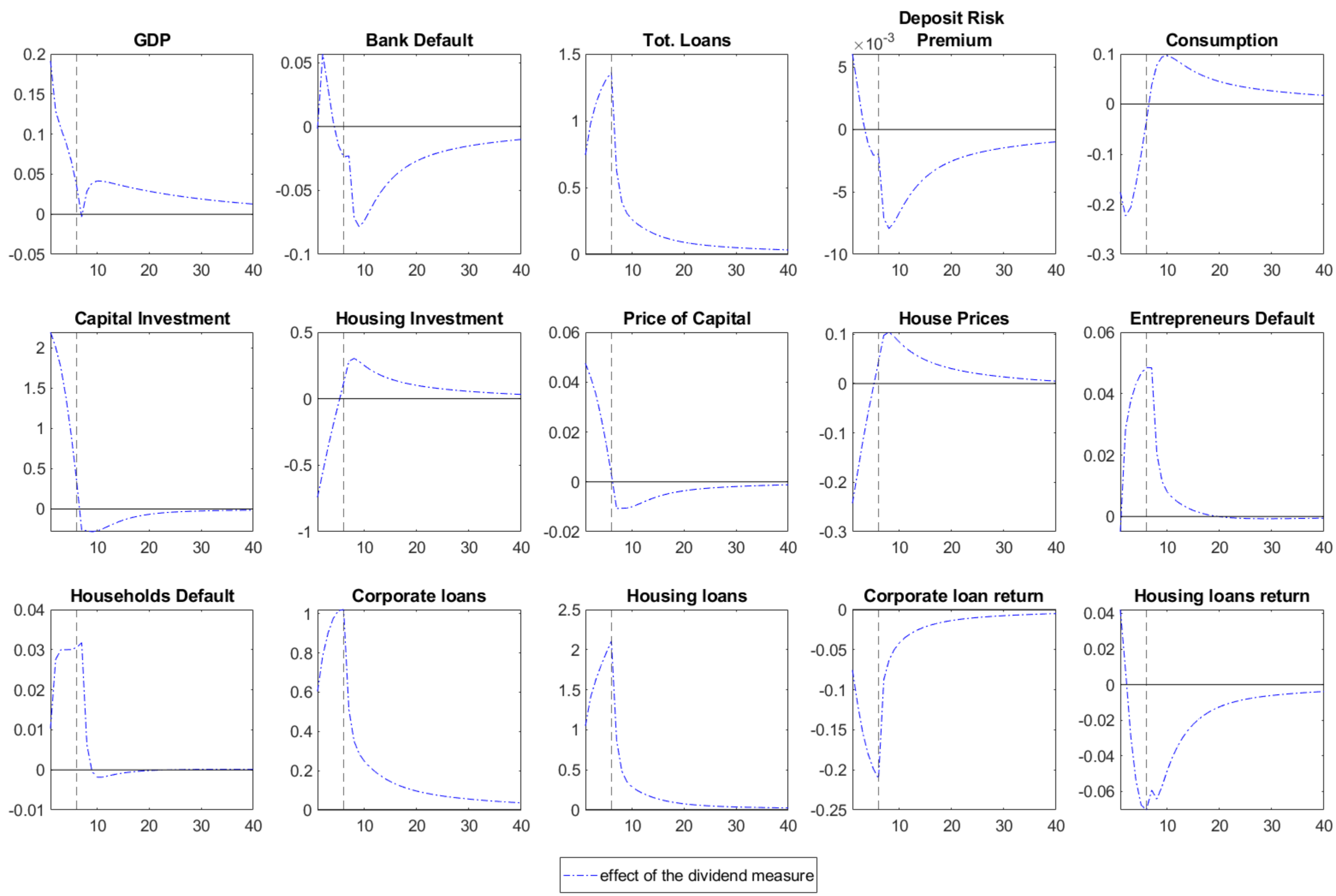
[23]See Macroprudential Bulletin, ECB, June 2021.

thorities, is that the dividend restriction measure should be included in their toolkit as a measure to activate in the event of materialisation of shocks. In fact, the results herein justify the use of the dividend restriction showing that the measure is effective at fulfilling two macroprudential objectives: 1) to smooth the credit cycle in the downturn phase and 2) to preserve bank resilience.

The aforementioned macroprudential reasons add to the more general reasons indicated by Acharya et al. (2012) for the adoption of the dividend ban in cases of crises. In summary, Acharya et al. (2012) argue that paying dividends when bank losses appear likely represents a redistribution of bank wealth and bank risk that favours equity holders at the expense of debt holders, thus representing a violation of the priority of debt over equity.[24]

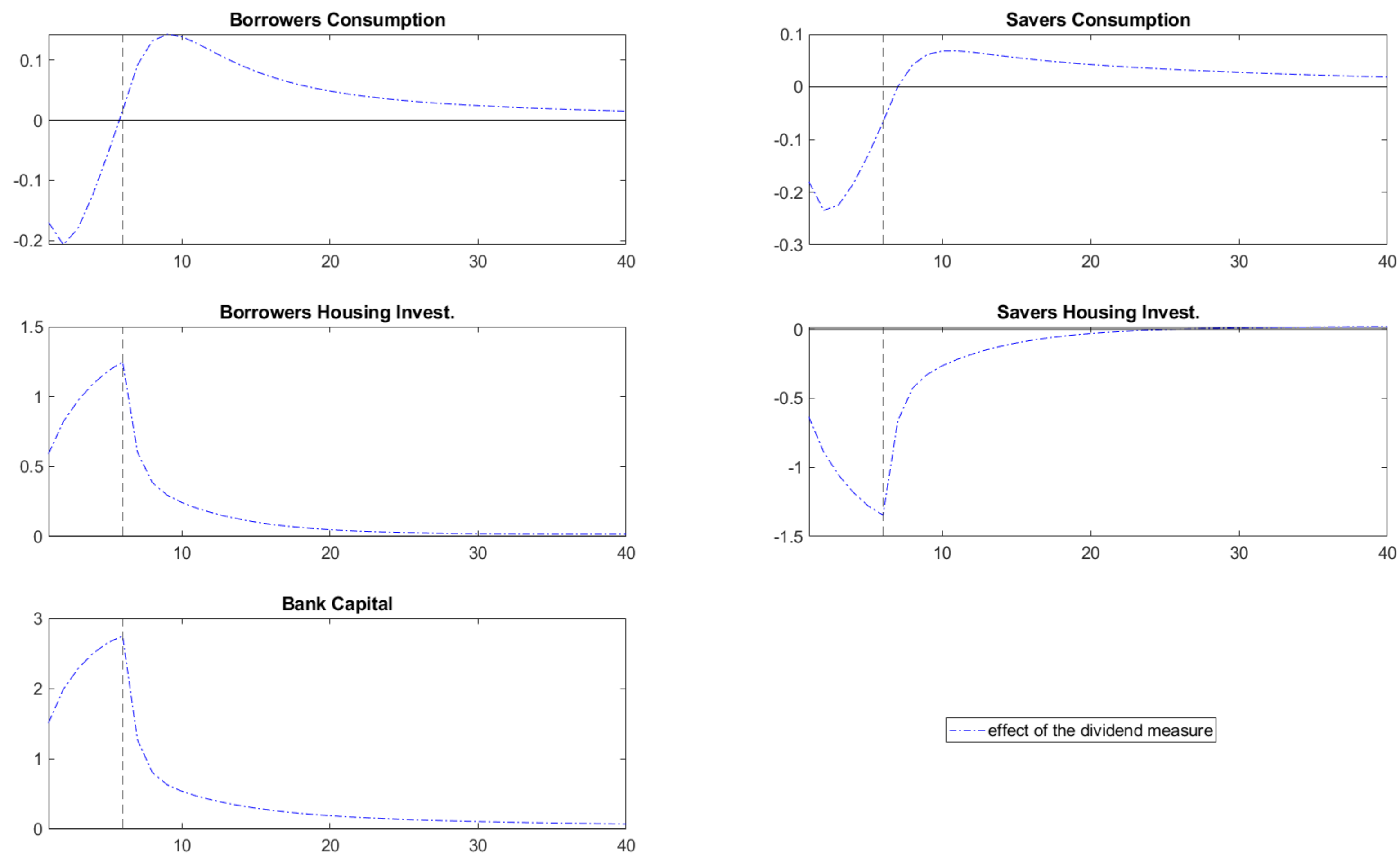
[24] See Section 1 for a more extensive explanation of the argument in Acharya et al. (2012).

Figure 3: Effects of the dividend restriction measure



Horizontal axes: quarters. Vertical axes: percent deviations from the initial value, except for interest rates (annualised percentage point deviations) and default probabilities (percentage point deviations). The vertical dashed line indicates the period in which the dividend ban is removed.

Figure 4: Effects of the dividend restriction measure (cont'd)



Horizontal axes: quarters. Vertical axes: percent deviations from the initial value. The vertical dashed line indicates the period in which the dividend ban is removed.

6 Interaction between the dividend restriction measure and a countercyclical capital buffer release

The analysis presented in this section aims to show the positive effects of a countercyclical capital buffer release and the dividend restriction measure used as complementary macroprudential tools when shocks hit the economy. The countercyclical buffer is introduced as in Clerc et al. (2015), by allowing for a shift in the steady state capital requirement proportional to the deviation of credit from their steady state value. Formally, the regulatory capital requirement for each type of bank j, either specialised in either corporate loans or in mortgage loans, is specified as follows:

$$\phi_t^j = \bar{\phi}^j + \phi_{CCB}^j[log(b_t) - log(\bar{b})], \tag{5}$$

where $\bar{\phi}^j$ is the steady state capital requirement and the additional term is the countercyclical capital buffer, with b_t and $\bar{b}$ denoting the volume of credit at time t and its steady state value, respectively. In the model, the capital requirement is always binding. This implies that the capital freed up by a capital release is used either to extend the volume of credit or to raise the amount of dividends.

In order to assess the transmission of a countercyclical capital buffer release, I simulate three different types of shocks, two of which do not originate within the banking system (Figures 5-7). The first is a productivity shock. The second is a combination of house depreciation shock and capital depreciation shock. Through the depreciation shocks, I aim to capture a scenario of increased riskiness on the part of borrowers (both borrowing households and companies). The third scenario concerns an increase in the riskiness of bank activity and therefore captures a shock originating in the banking system.

The negative response of credit to the three types of shock automatically triggers a release of the countercyclical buffer, in the model. However, in the case of depreciation shocks, it seems that the initial credit reduction is mainly due to demand factors, as it is associated with an initial decrease in loan returns. In contrast, in the case of the productivity shock and the bank risk shock, the credit reduction is predominantly driven by supply factors, as it is accompanied by an increase in loan returns.

In all of the three scenarios, the release of the capital buffer has a positive short run effect on credit, which decreases less than in absence of the buffer release, but a negative effect in the medium/long run. Indeed, the capital release undermines the bank resilience to shocks, as captured by a rise in the probability of bank default. Consequently, depositors demand a higher risk premium. The higher the costs of external funding, the weaker the bank's ability to generate capital and finance the economy (bank capital channel).

Due to higher bank funding costs, compared to the case in which the capital buffer is not released, banks maintain higher rates on loans (bank funding channel), over a medium/long horizon. In conclusion, the buffer release backfires in the medium/long run, leading to a reduction in credit, less capital investment and lower GDP. At first, it might appear surprising that the buffer release causes a further reduction in consumption and housing investment in the three scenarios, even in the short run, despite the initial positive contribution of the measure to housing loans. However, this result can be explained in light of the different effect that a capital release has on borrowing households and on savers.

On the one hand, the measure favours the borrowing households, because banks grant more loans. Therefore, the borrowing households can afford a bigger investment in housing and possibly can also raise their consumption. On the other hand, the higher cost of external funding for the banks reduces their profits and, therefore, the bank dividends, whose beneficiaries are the saving households. Through this channel, the buffer release causes a reduction of consumption and investment in housing by the saving households.

Given the parametrisation of the model calibrated for Slovenia, the effect of the measure on savers' consumption and housing investment overweighs the corresponding effect for the borrowing households. The resulting effect on aggregate consumption and housing investment is negative even in the short run, despite the positive effect of the buffer release on housing loans in the short run, compared to the scenarios in absence of the measure.

In all of the three aforementioned scenarios, the dividend restriction measure amplifies the positive short-run effects of the capital release and mitigates its negative medium/long run effects (Figures 8-10). The positive impact of the interaction of the two measures originates from the direct effect on credit and from the effect on bank resilience. By restricting the payment of dividends, banks have more resources to finance the flow of credit (direct effect on credit) and the loans decrease less than in absence of the dividend measure, or even increase.

Despite a small increase in credit risk (reflected in slightly higher borrowers' default probability), the positive effect on credit contributes to the banks' ability to generate profits and, then, capital. Therefore, the bank default probability and, consequently, the deposit risk premium are lower in presence of the dividend measure. The positive effect of the dividend measure on bank resilience and on the cost of external funding last beyond the abolishment of the dividend measure. In this way, the measure helps to smooth the negative medium/long-run effects of the capital release.

The results presented in this section are broadly consistent with other related studies. In particular, the positive effect of the capital buffer release or other forms of capital flexibility on credit in the aftermath of a macroeconomic or financial shock has been documented also by empirical studies mentioned in section 3. However, empirical studies usually use a difference-in-difference approach to compare the change in credit in countries that implemented a capital release, in response to a shock, versus countries that did not. This approach is not suitable for tracing out the entire transmission of a policy shock and cannot capture the long run effects of a policy change.

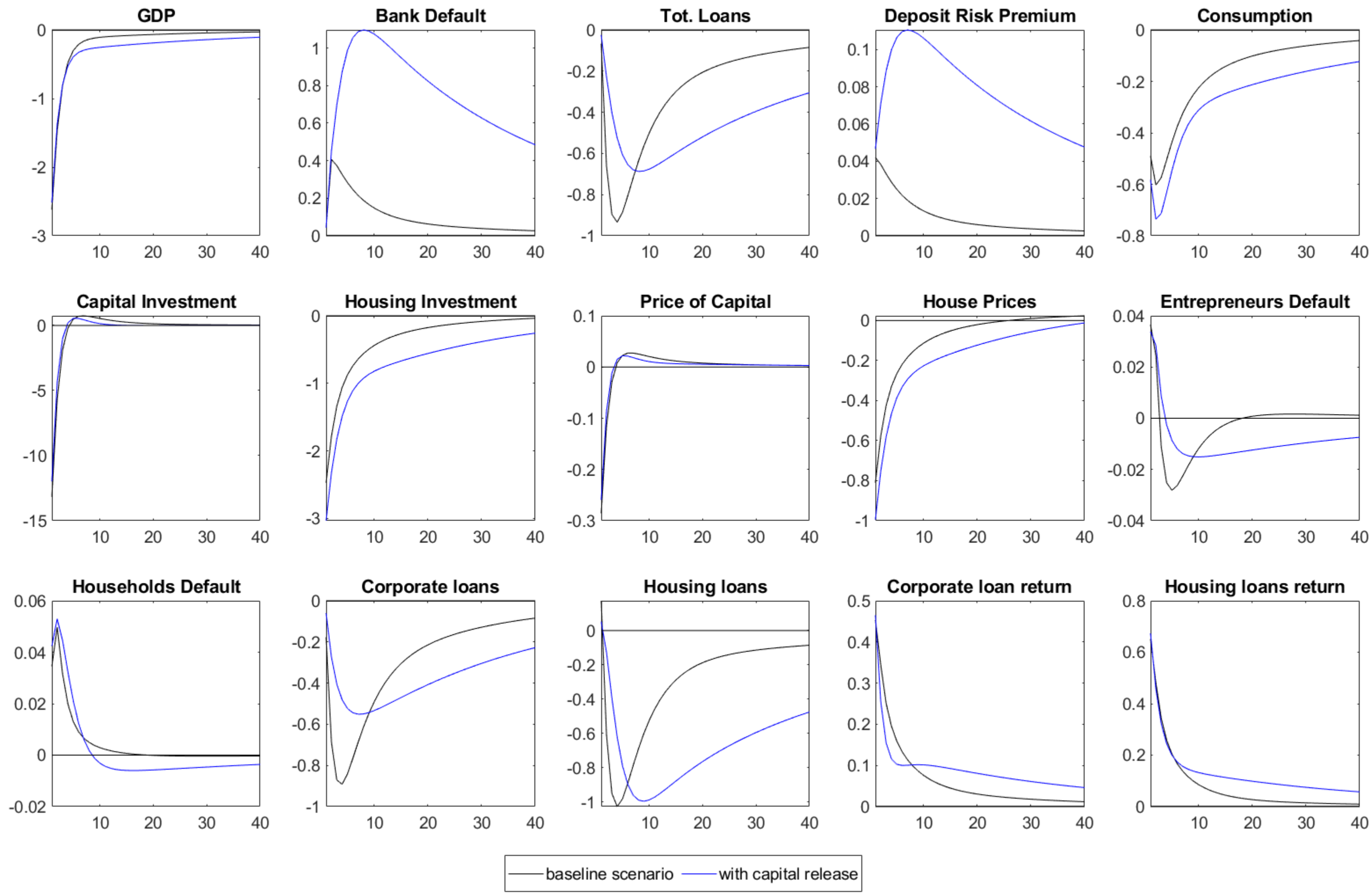
Moreover, the positive (negative) impact of the countercyclical buffer release on credit and GDP in the short (long) run has been found also by Clerc et al. (2015) using the same model but calibrated for the euro area and for different parametrisations of the initial capital requirement. However, they do not consider the simultaneous implementation of the countercyclical capital release and the dividend restriction measure. To my knowledge, the paper by Muñoz (2021) is the only available study on the interaction of these two measures.

Similarly to the present study, Muñoz (2021) finds the existence of complementarities between the countercyclical capital buffer and the dividend restriction rule. Applying both measures turns out to be more effective at smoothing the credit downturn and the drop in output than using just one of the two macroprudential tools, in the case of housing depreciation shock, capital depreciation shock or bank capital shock.

However, as discussed in previous sections, the approach adopted in the present paper captures the dividend restriction measures that were implemented during the pandemic in a more realistic way than the approach in Muñoz. Moreover, since banks do not default in the model by Muñoz, the analysis therein does not say anything on the effect of the two measures on bank resilience and on the cost of banks' external funding. The present paper offers an important contribution along these lines, as presented above.

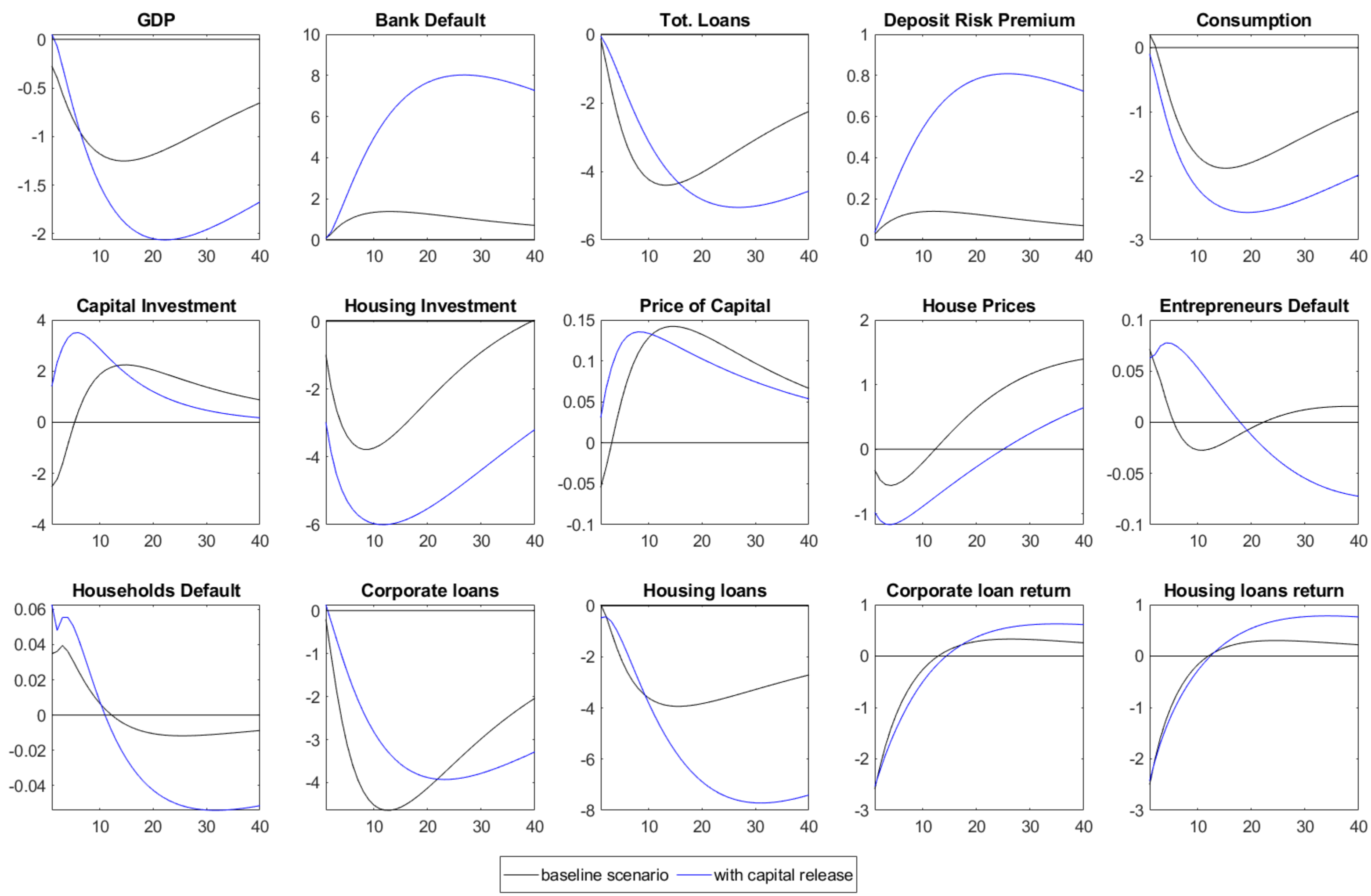
To sum up, this section highlights the existence of complementarities between the dividend measure and the countercyclical capital release. Moreover, the results point to the critical role of the time horizon for the adoption of a countercyclical buffer release. The longer the period in which the capital buffer is released, the worse the deterioration of bank resilience and the consequent shrinkage in bank activity. Applying dividend restrictions together with a release of capital requirements vis-à-vis the materialisation of shocks helps to improve the effectiveness (i.e. the positive short-run effects) and the efficiency (through a reduction of long run costs) of the capital buffer release.

Figure 5: Impulse responses to productivity shock with and without capital release



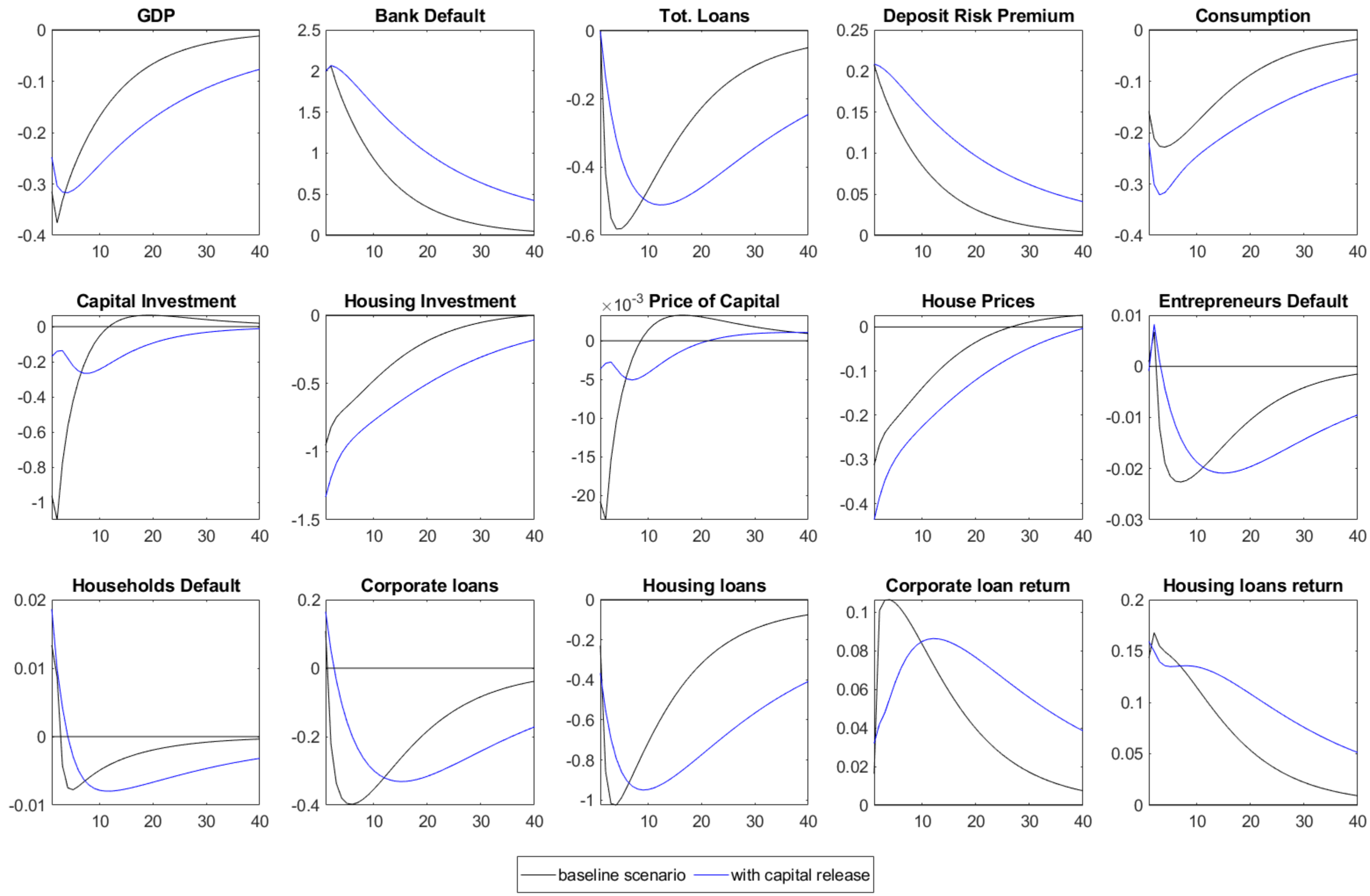
Horizontal axes: quarters. Vertical axes: percent deviations from the initial value, except for interest rates (annualised percentage point deviations) and default probabilities (percentage point deviations).

Figure 6: Impulse responses to house and capital depreciation shock with and without capital release



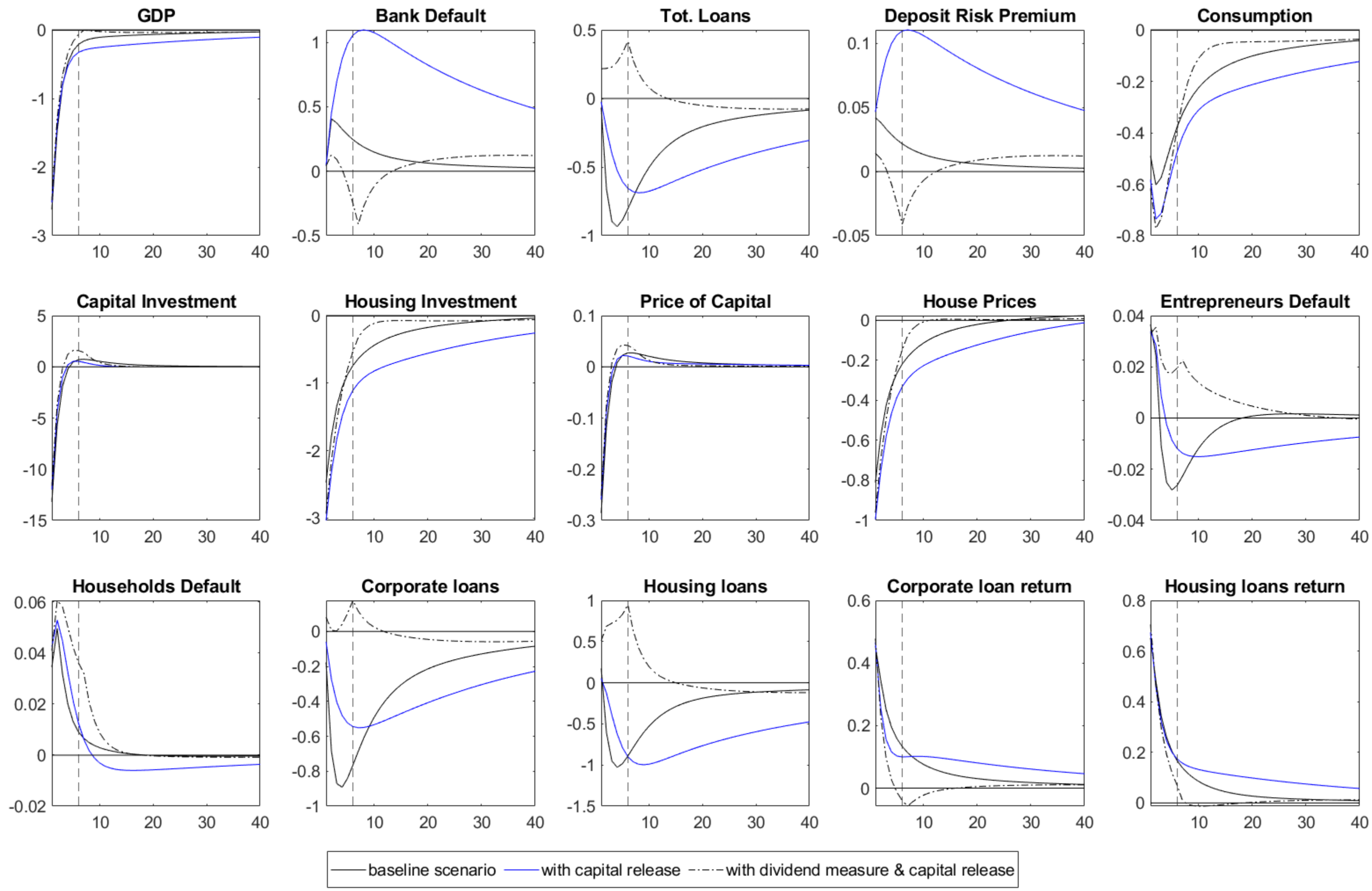
Horizontal axes: quarters. Vertical axes: percent deviations from the initial value, except for interest rates (annualised percentage point deviations) and default probabilities (percentage point deviations).

Figure 7: Impulse responses to bank risk shock with and without capital release



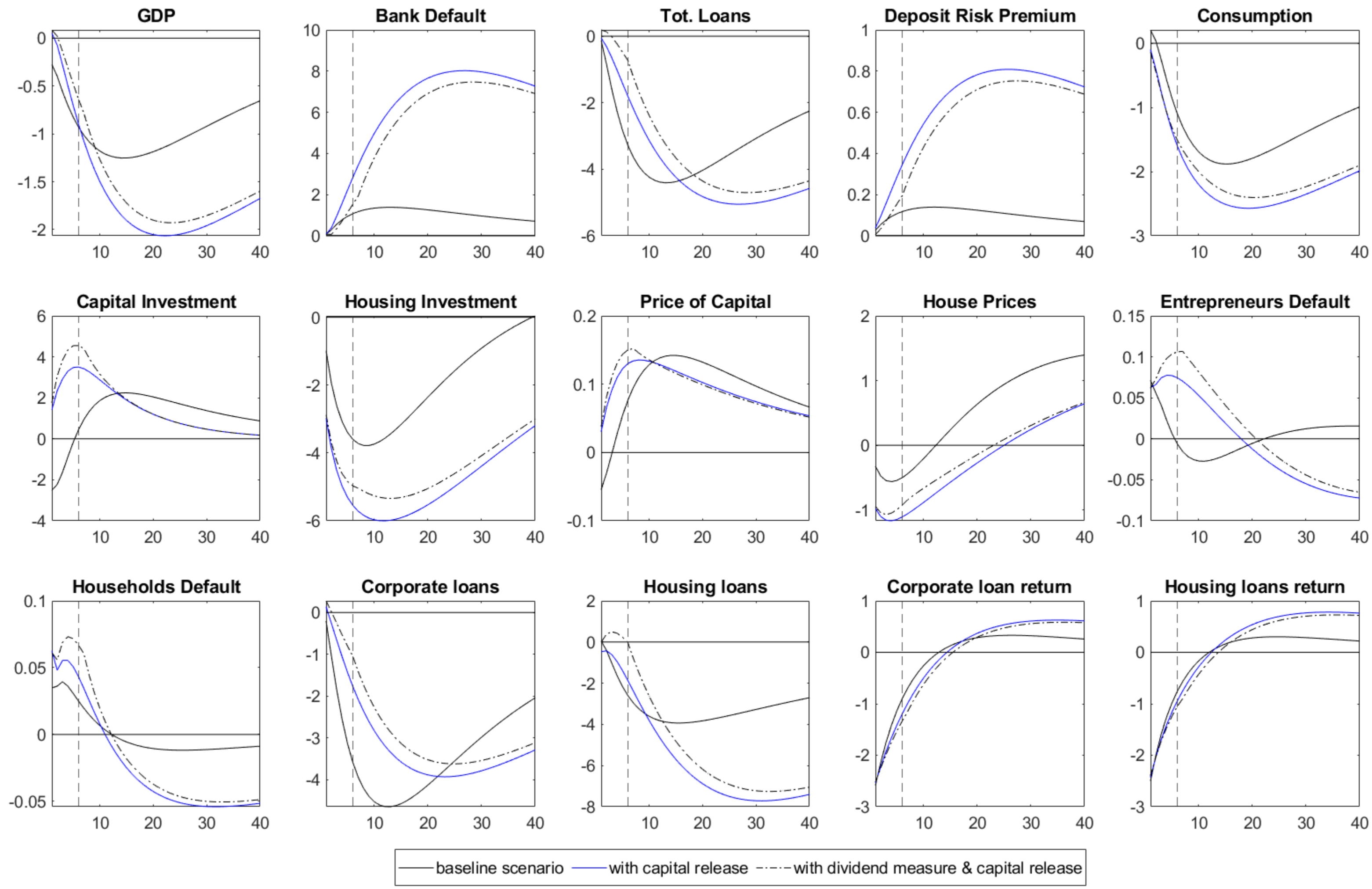
Horizontal axes: quarters. Vertical axes: percent deviations from the initial value, except for interest rates (annualised percentage point deviations) and default probabilities (percentage point deviations).

Figure 8: Impulse responses to productivity shock with capital release and dividend measure



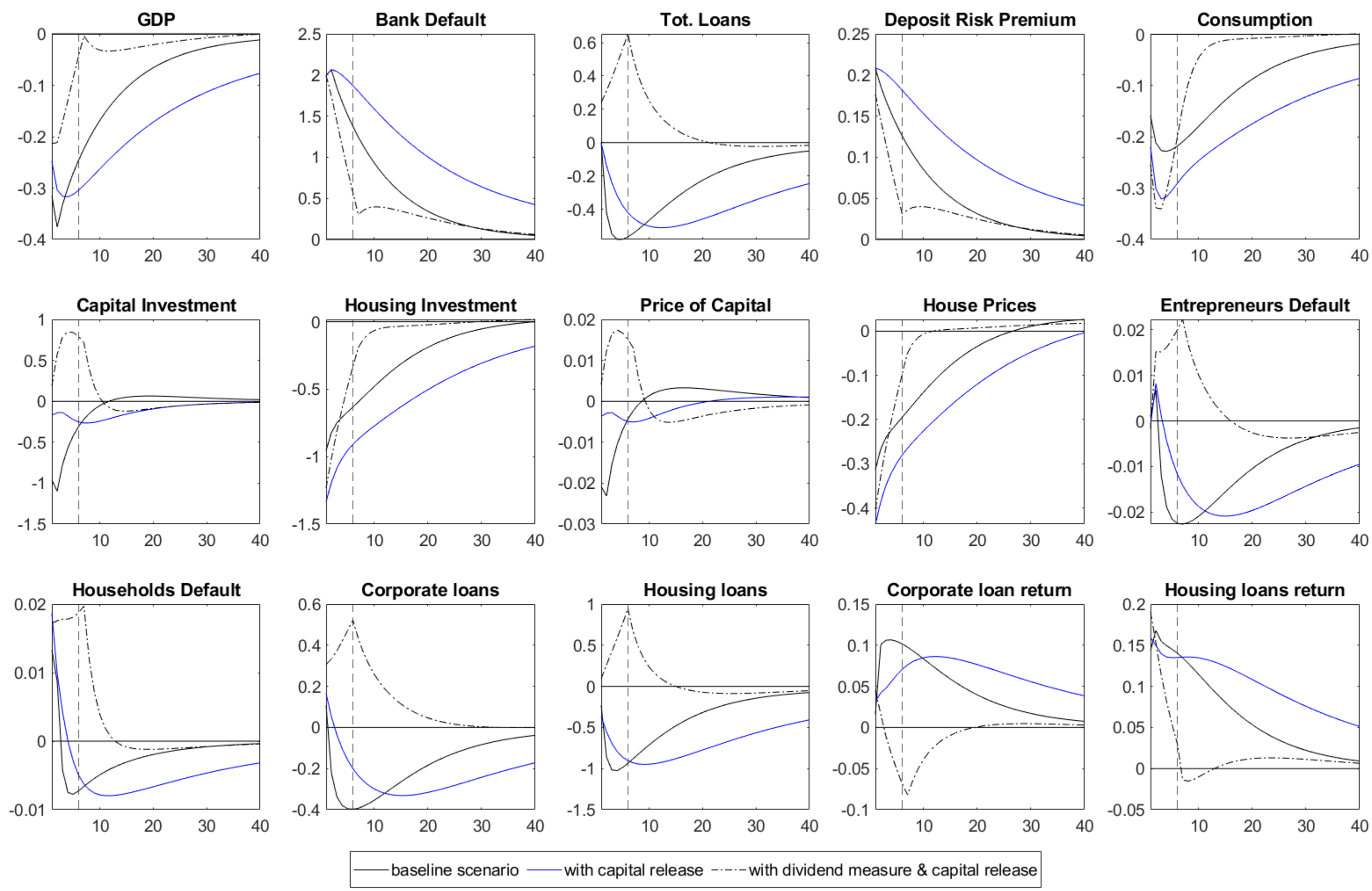
Horizontal axes: quarters. Vertical axes: percent deviations from the initial value, except for interest rates (annualised percentage point deviations) and default probabilities (percentage point deviations). The vertical dashed line indicates the period in which the dividend ban is removed.

Figure 9: Impulse responses to depreciation shock with capital release and dividend measure



Horizontal axes: quarters. Vertical axes: percent deviations from the initial value, except for interest rates (annualised percentage point deviations) and default probabilities (percentage point deviations). The vertical dashed line indicates the period in which the dividend ban is removed.

Figure 10: Impulse responses to bank risk shock with capital release and dividend measure



Horizontal axes: quarters. Vertical axes: percent deviations from the initial value, except for interest rates (annualised percentage point deviations) and default probabilities (percentage point deviations). The vertical dashed line indicates the period in which the dividend ban is removed.

7 Concluding remarks

This paper presents the results of a simulation where a temporary macroprudential dividend ban is introduced in the DSGE model by Clerc et al. (2015). In the model banks provide housing and corporate loans and finance themselves through equity and deposits. Households, companies and banks can default. However, the cost of external funding depends on the level of riskiness at the banking system level, because the bank-specific risk is not observable to depositors. This information asymmetry and the banks' limited liability can cause excessive risk taking. To prevent excessive risk taking by banks, in the original model, banks are subject to a minimum capital requirement and a countercyclical capital buffer.

The results show the different channels of transmission of the dividend restriction measures. The first is the direct expansionary effect on credit, which is possible because the larger volume of retained earning allows banks to finance more loans. This effect might have been overestimated in the model, however, because of two features. First, bank assets are only represented by loans. Second, banks do not have management buffers. Therefore, the unpaid dividends are completely used to finance the loans. However, the empirical studies mentioned in Section 3 report even stronger effects of the dividend measure on credit than obtained from the present study.

The second channel works through the positive effect on bank resilience. However, in the model, this second channel is not immediately activated at the introduction of the dividend ban, but a few periods later. This is due to the assumption that banks do not have a management buffer. Therefore, the measure does not immediately impact on bank resilience through an increase in the capital ratio. However, a few periods later, it turns out that the extra amount of loans, made possible by the measure through the first transmission channel, contributes to the growth of bank profit and, consequently, to a reduction in bank default probability.

It is only then that the positive effect of the dividend ban on bank resilience appears in the model. Importantly, this effect works as a beneficial amplification mechanism, because it leads to lower costs of external funding, which in turn positively affect bank profits, bank ability to generate capital and bank resilience. This positive feedback loop goes on for several periods, even after the lifting of the dividend measure, in the model.

In reality, the positive effect of the dividend measure on bank resilience might appear immediately at the introduction of the measure, if banks maintain (at least part of) the unpaid dividend as capital reserves or they use them to build provisions, as it is shown by the empirical studies mentioned in Section 3. Indeed, the absence of a management buffer is a limitation of the model. Changing this assumption is left for future research.

Moreover, one might wonder whether the aforementioned positive indirect effect on bank resilience coming from the profits on the extra loans financed by the unpaid dividends might be unrealistic, because of the increase in credit risk in the aftermath of negative shocks. However, an increase in credit risk, which is also captured in the model by the increased probability of borrowers' default, does not necessarily imply the materialisation of losses. In contrast, when borrowers face a tighter liquidity constraint, it is more likely for them to default if their debt is not extended or rolled over than otherwise.

A further effect of the dividend measure which emerges in the general equilibrium model used in this study and is not captured by empirical models is the redistributive effect from savers (due to unpaid dividends) to borrowers (thanks to an easier access to credit). This effect is realistic, though its impact on aggregate variables (mainly housing investment, consumption and GDP) depends on the parametrisation of the model, which determines if the response of the savers dominates the response of the borrowers or vice versa.

Regarding the release of the capital buffer in the case of different types of shocks, the results in this paper confirm those in Clerc et al. (2015) for different parametrisations of the model. In other words, the countercyclical capital buffer release has positive effects on credit and on GDP in the short run, but negative effects in the long run, due to a deterioration of bank solvency and higher cost of funding. Finally, the results in this paper support the use of the dividend measure as a complementary macroprudential tool that can strengthen the positive short run effects of the capital buffer release and mitigate its negative long run effects.

A further limitation of the present study is the absence, in the reference model, of fiscal and monetary policy measures, which could be taken to relieve the liquidity constraint on borrowers (for instance, delay of tax payment or loan moratoria) and on lenders (such as asset purchase programmes and long-term refinancing operations implemented by the ECB). On the one hand, the measures that relieve the liquidity constraint on lenders reduce the need for the dividend ban to support the credit supply. On the other hand, the measures that relieve the liquidity constraint on borrowers also lower the need for the dividend ban to support the flow of credit, as long as these measures cause a reduction in credit demand. In both cases, in reality, the unpaid dividends can still be used to build capital reserves and, therefore, to strengthen bank resilience.

The inclusion of fiscal and monetary policies, as well as the extension to different types of bank assets and the inclusion of a capital management buffer in the model, is an ambitious project that would lead to a more precise assessment of the effects on the dividend restriction measure and of capital buffer release. This project is left for future research.

In conclusion, the main message of the present study for macroprudential authorities is that the dividend restriction measure should be used as a first line of defense against excessive deleveraging and excessive deterioration of bank resilience in cases of negative shocks. The adoption of the dividend ban is even more important in the presence of a countercyclical capital buffer release, as the former measure has the potential to strengthen the positive short-run effects and to mitigate the negative long-run effects of the second type of macroprudential intervention.

References

[1] Andreeva D., Bochmann P. and Couaillier C., *Financial market pressure as an impediment to the usability of regulatory capital buffers*, European Central Bank Macroprudential Bulletin, 2020, issue 11.

[2] Arnould G., Avignone G., Pancaro C. and Żochowski D., *Bank funding costs and solvency*, The European Journal of Finance, July 2021 (pp. 1-33).

[3] Avezum L., Oliveira V. and Serra D., *Assessment of the effectiveness of the macroprudential measures implemented in the context of the Covid-19 pandemic*, Banco de Portugal Working Paper 202107, May 2021.

[4] Banco de Portugal (2020), *The banking system as economic stabiliser of the pandemic shock: a simulation of micro- and macroprudential policies*, Box 1, Financial Stability Report of Banco de Portugal, December 2020.

[5] Banco de Portugal (2021), *Impact of the bank dividend pay-out restriction in conjunction with flexible capital requirements*, Box 6, Financial Stability Report of Banco de Portugal, June 2021.

[6] Banka Slovenije (2021), *Assessment of the impact of the measure to restrict bank dividend distributions using a DGSE model*, Box 5.2, Financial Stability Review of Banka Slovenije, April 2021.

[7] Borsuk M., Budnik K. and Volk M., *Buffer use and lending impact*, ECB Macroprudential Bulletin, Issue 11, October 2020.

[8] Clerc L., Derviz A., Mendicino C., Moyen S., Nikolov K., Stracca L., Suarez J. and Vardoulakis A., *Capital regulation in a macroeconomic model with three layers of default*, International Journal of Central Banking, Vol. 11, No. 3, June 2015.

[9] European Central Bank (2021). Macroprudential Bulletin No. 13 (June 2021).

[10] Gambacorta L. and Shin H. S., *Why bank capital matters for monetary policy*, Journal of Financial Intermediation, Vol. 35, July 2018 (pp. 17-29).

[11] Martinez-Miera D. and Vegas Sánchez R., *Impact of the dividend distribution restriction on the flow of credit to non-financial corporations in Spain*, Banco de España Article 07/21, March 2021.

[12] Mendicino C., Nikolov K., Suarez J. and Supera D., *Optimal Dynamic Capital Requirements* Journal of Money, Credit and Banking, Vol. 50, No. 6, September 2018.

[13] Muñoz M.A., *Rethinking capital regulation: the case for a dividend prudential target*, International Journal of Central Banking, September 2021, (pp. 273-336).

[14] Schmitz S.W., Sigmund M. and Valderrama L., *Bank Solvency and Funding Cost: New Data and New Results*, IMF Working Paper 17/116, 2017.

A The main features of the model by Clerc at al. (2015)

In this section we describe the main features which are relevant to understand the role of capital regulation in the model. For a complete description of the model, the reader can refer to Clerc et al. (2015).

Households The model considers an economy where households are risk averse and infinitely lived. They supply labour in a competitive market in exchange for a salary. They derive utility from a consumption good and from housing, while they suffer a disutility from work. There are two types of households in the economy: patient and impatient, denoted by *s* and *m* respectively. They differ in their discount factors, with $\beta^s \geqslant \beta^m$. The former are savers while the latter are borrowers.

Each type of households is grouped in a representative dynasty which provides risk-sharing to its members. The utility function of the dynasty of household of type *j*=*s*,*m* is given by

$$E_t \left[\sum_{i=0}^{\infty} \left(\beta^{\theta}\right)^{t+i} \left[\log\left(c_{t+i}^{\theta}\right) + v^{\theta} \log\left(h_{t+i}^{\theta}\right) - \frac{\psi^{\theta}}{1+\eta} \left(l_{t+i}^{\theta}\right)^{1+\eta} \right] \right] \tag{6}$$

where c_{t+i}^{θ} denotes the consumption of non-durable goods and h_{t+i}^{θ} denotes the total stock of housing held by all households of type $\theta = s, m$; l_{t+i}^{θ} denotes hours worked in the consumption good producing sector.[25]

Saving households Savers offer external funding to banks in the form of deposits. Despite the presence of a deposit insurance scheme, they still suffer a verification cost in the event of bank default. Therefore, they demand a deposit risk premium. Moreover, among savers there are households who have the ownership of banks (bankers) and households who have the ownership of non-financial companies and act as entrepreneurs. Therefore, the dynasty of savers receives dividends from non-financial companies and banks. The savers' dynamic budget constraint is given by the following expression

$$c_t^s + q_t^H h_t^s + d_t \leqslant w_t l_t^s + q_t^H \left(1 - \delta_t^H\right) h_{t-1}^s + \tilde{R}_t^D d_{t-1} - T_t^s + \Pi_t^s \tag{7}$$

[25] Note that η is the inverse of the Frisch elasticity of labour supply; v^{θ} and ψ^{θ} are preference parameters.

where q_t^H is the price of housing, δ_t^H is the housing depreciation rate, w_t is the wage and

$$\tilde{R}_t^D = R_t^D \left(1 - \gamma PD_t^b\right) \tag{8}$$

where R_t^D is the fixed gross interest rate that banks promise to depositors on deposits received at time $t-1$ and PD_t^b represents the fraction of deposits in banks that fail in period t.

T_t^s is the lump sum tax imposed by the deposit insurance agency (DIA) on the patient households. However, the model assumes that in the event of bank failure, depositors incur a linear verification cost γ whenever they have to recover their funds. As mentioned earlier, this verification cost creates a link between the bank probability of default and bank funding cost, while preserving the distortion associated with the bank limited liability and deposit insurance, which translates into excessive bank risk taking. Finally, Π_t^s represents the dividends that savers receive from firms and banks.

Borrowing households Impatient households borrow from banks, which provide them with mortgage loans, on a limited-liability non-recourse basis. This implies the possibility of defaulting on the housing loan. In that case, the borrower will lose the housing unit against which the loan has been secured. The dynamic budget constraint of the dynasty of impatient households is given by

$$c_t^m + q_t^H h_t^m - b_t^m \leqslant w_t l_t^m + \int_0^\infty \max\left\{\omega_t^m q_t^H \left(1 - \delta_t^H\right) h_{t-1}^m - R_{t-1}^m b_{t-1}^m, 0\right\} dF^m\left(\omega_t^m\right) - T_t^m \tag{9}$$

where b_t^m denotes the dynasty's aggregate borrowing from the banking system and R_{t-1}^m is the contractual gross interest rate on the housing loan of size b_{t-1}^m agreed-upon with a bank in the previous period. T_t^m is the lump sum tax imposed by the deposit insurance agency on the impatient households.

Each impatient household experiences at the beginning of each period t an idiosyncratic shock ω_t^m to the housing unit owned from the previous period and have the option to (strategically) default on the non-recourse housing loan secured against this housing unit. Default is ex-post optimal for households whenever the value of the housing unit is less than the repayment due to the bank, i.e. $\omega_t^m q_t^H \left(1 - \delta_t^H\right) h_{t-1}^m < R_{t-1}^m b_{t-1}^m$.

Housing loans must satisfy the bank participation constraint. This constraint requires that the expected return that bankers can extract from the banks which provide housing loans, after repayment to depositors, is at least as high as the bankers' desired return on each euro of equity that bankers maintain invested in the lending bank.

The expected return from a bank specialised in housing loans is composed of different parts, some of which become clearer after the presentation of the main assumptions on banks and capital regulation. Therefore, we present the bank participation constraint for housing loans only in equation (7), or equivalently in equation (8). It is worth introducing here the first component of the expected return from the bank specialised in housing loans. This component represents the amount of wealth, expressed in term of housing units, that banks receive from the dynasty of impatient households. Such an amount can be further splitted into sub-components.

The first sub-component is the repayment of housing loans that banks receive from the non-defaulting households. The second sub-component is the value of the housing units that are transferred to the banks from defaulting households. Clerc et al. (2015) denote by $\bar{\omega}_t^m$ the threshold value of the idiosyncratic shock to housing units such that for any $\omega_t^m \leqslant \bar{\omega}_t^m$ households default. Further, they denote by $\Gamma^m(\bar{\omega}_{t+1}^m) q_{t+1}^H \left(1 - \delta_{t+1}^H\right) h_t^m$ the sum of the two aforementioned subcomponents of the bank expected return, expressed in terms of housing units. The last sub-component is the verification cost μ^m that banks incur in the repossession of the fraction $G^m(\bar{\omega}_t^m)$ of the housing units of defaulting households.

Entrepreneurs Entrepreneurs buy capital that they rent to the firms producing the consumption good. They finance the purchase of capital with the retained earnings from the previous period and the loans that they obtain from banks specialised in entrepreneurial loans (corporate loans). The profits from buying and renting the capital are partially distributed to the saving households in the form of dividends and in part are kept as retained earnings.

Entrepreneurs choose the amount of capital and the entrepreneurial loans that allow them to maximise their profits. The corporate loans are granted on a limited liability basis and are secured against the capital bought by the entrepreneurs. The capital is subject to depreciation. Moreover, entrepreneurs are also exposed to an idiosyncratic shock ω_t^e that affects the value of the capital (similarly to the idiosyncratic shock to housing units for borrowing households).

Using a notation similar to the case of housing loans, Clerc et al. (2015) denote by $\bar{\omega}_t^e$ the threshold value of the idiosyncratic shock to capital such that for any $\omega_t^e \leqslant \bar{\omega}_t^e$ entrepreneurs default. Further, they denote by $\Gamma^e(\bar{\omega}_t^e) q_{t+1}^K \left(1 - \delta_{t+1}^K\right) k_t$ the sum of the value of the capital that banks repossess from defaulted entrepreneurs and the loan repayment that banks receive from non-defaulting entrepreneurs, expressed in terms of capital.

In the case of entrepreneur default, banks incur a verification cost μ^e in the repossession of the fraction $G^e(\bar{\omega}_t^e)$ of the capital available to the defaulted entrepreneurs. The entrepreneur idiosyncratic risk and the verification cost μ^e are taken into account in the participation constraint of the banks specialised in corporate loans - see equation (9) or equivalently equation (10).

Bankers and banks Bankers provide inside equity to banks and, at the end of each period, decide on the allocation of bank profits between retained earnings and dividends. Banks issue equity, which is bought by bankers, raise external funding in the form of deposits and grant loans to either households or entrepreneurs. The amount and contractual return on each type of loans must satisfy the banks' participation constraint, which reflects several aspects.

First, the expected profits for each type of banks is the difference between the expected payoff from the granted loans and the repayment due to depositors. Second, each bank is exposed to idiosyncratic risk ω_t^j, which affects the value of its portfolio of loans, where $j = H, F$ for the type of bank specialised in housing loans and corporate loans, respectively. For any $\omega_t^j \leqslant \bar{\omega}_t^j$, a bank of type j defaults.

Third, banks assume limited liability towards depositors. $\Gamma^j(\bar{\omega}_t^j)$ denotes the sum of the repayment that depositors receive from non-defaulting banks of type j and the value of the assets of the defaulted banks of type j that the deposit insurance agency (DIA) repossesses. Therefore, $\left(1 - \Gamma^j(\bar{\omega}_t^j)\right)$ represents the share of the value of the assets of banks of type j that remains to the banks after repaying the depositors and the repossession from the DIA. It follows that for bankers who invested the amount of equity e_t^H in banks specialised in housing loans the expected profits and return, expressed in terms of housing units, are represented by expressions (10) and (11), respectively

$$E_t \left(1 - \Gamma^H(\bar{\omega}^H_{t+1})\right) \left\{ \left(\Gamma^m(\bar{\omega}^m_{t+1}) - \mu^m G^m(\bar{\omega}^m_{t+1})\right) q^H_{t+1} \left(1 - \delta^H_{t+1}\right) h^m_t \right\} \tag{10}$$

$$\frac{E_t \left(1 - \Gamma^H(\bar{\omega}^H_{t+1})\right) \left\{ \left(\Gamma^m(\bar{\omega}^m_{t+1}) - \mu^m G^m(\bar{\omega}^m_{t+1})\right) q^H_{t+1} \left(1 - \delta^H_{t+1}\right) h^m_t \right\}}{e^H_t} \tag{11}$$

where the factor in curly brackets is the wealth that banks receive from the households who repay the loans, expressed in housing units, plus the value of the housing units that defaulting households transfer to the banks, net of the verification cost.

A further aspect that banks take into account in the participation constraint is the regulatory capital requirement, which imposes a (potentially time-varying) minimum capital-to-asset ratio ϕ^j_t on banks of type j. In equilibrium, the capital regulatory constraint is binding, i.e. $e^j_t = \phi^j_t b^j_t$. The last aspect that banks take into account in the participation constraint is the bankers' desired expected return ρ_t. Therefore, the participation constraint for a bank specialised in housing loans is given as follows

$$\frac{E_t \left(1 - \Gamma^H(\bar{\omega}^H_{t+1})\right) \left\{ \left(\Gamma^m(\bar{\omega}^m_{t+1}) - \mu^m G^m(\bar{\omega}^m_{t+1})\right) q^H_{t+1} \left(1 - \delta^H_{t+1}\right) h^m_t \right\}}{\phi^H_t b^m_t} \geqslant \rho_t \tag{12}$$

or equivalently

$$E_t \left(1 - \Gamma^H(\bar{\omega}^H_{t+1})\right) \left\{ \left(\Gamma^m(\bar{\omega}^m_{t+1}) - \mu^m G^m(\bar{\omega}^m_{t+1})\right) q^H_{t+1} \left(1 - \delta^H_{t+1}\right) h^m_t \right\} \geqslant \rho_t \phi^H_t b^m_t \tag{13}$$

Similarly, the participation constraint for the banks specialised in corporate loans is given as follows

$$\frac{E_t \left(1 - \Gamma^F(\bar{\omega}^F_{t+1})\right) \left\{ \left(\Gamma^e(\bar{\omega}^e_{t+1}) - \mu^e G^e(\bar{\omega}^e_{t+1})\right) q^K_{t+1} \left(1 - \delta^K_{t+1}\right) k_t \right\}}{\phi^F_t b^e_t} \geqslant \rho_t \tag{14}$$

or equivalently

$$E_t \left(1 - \Gamma^F(\bar{\omega}^F_{t+1})\right) \left\{ \left(\Gamma^e(\bar{\omega}^e_{t+1}) - \mu^e G^e(\bar{\omega}^e_{t+1})\right) q^K_{t+1} \left(1 - \delta^K_{t+1}\right) k_t \right\} \geqslant \rho_t \phi^F_t b^e_t \tag{15}$$

where the factor in curly brackets is the wealth that banks receive from entrepreneurs who repay the loan, expressed in units of capital, plus the capital that banks receive from the defaulting entrepreneurs, net of the verification cost. In equilibrium, the participation constraints hold with equality.

A.1 A discussion of the capital regulation transmission channels

From the bank participation constraints in the loan, one can see the different transmission channels of the capital regulation. Let's consider equation (15), though the same argument applies to the case of housing loans. It is convenient to note that the first factor in (15) is increasing in the capital ratio ϕ_t^F. To see this, consider that a bank defaults if its assets are worth less than its liabilities. For instance, a bank of type F defaults if

$$\omega_{t+1}^F \tilde{R}_{t+1}^F b_t^F \leqslant R_t^D d_t^F \tag{16}$$

with the value of the portfolio of loans $R_{t+1}^F b_t^F$ exposed to the bank idiosyncratic shock ω_{t+1}^F. Then, the threshold value $\bar{\omega}_{t+1}^F$ of the bank idiosyncratic shock such that for any $\omega_{t+1}^F \leqslant \bar{\omega}_{t+1}^F$ a bank of type F defaults is expressed as follows

$$\bar{\omega}_{t+1}^F \equiv \frac{R_t^D d_t^F}{\tilde{R}_{t+1}^F b_t^F}. \tag{17}$$

Now, using the fact that the capital regulatory requirement is binding in equilibrium, we can write $b_t^F = \frac{e_t^F}{\phi_t^F}$ and from basic accounting it follows that $d_t^F = \frac{(1-\phi_t^F)e_t^F}{\phi_t^F}$. By replacing these expressions for b_t^F and d_t^F into (17), we obtain

$$\bar{\omega}_{t+1}^F = \left(1 - \phi_t^F\right) \frac{R_t^D}{\tilde{R}_{t+1}^F}. \tag{18}$$

from which we see that the higher the capital ratio ϕ_t^F, the lower the bank default threshold $\bar{\omega}_{t+1}^F$, which means that bank default is less likely. This is true not only because banks are less leveraged, but also because, through equation (8), the lower the probability of bank default, the lower the interest rate on bank external funding R_t^D. Therefore, $\Gamma^F(\bar{\omega}_{t+1}^F)$ is decreasing in ϕ_t^F. Now, it is easy to see that a higher regulatory capital ratio ϕ_t^F, at first, has two effects:

a) it raises the right-hand side (RHS) of the constraint in (15): a tighter capital requirement forces banks to get funded with a larger share of equity financing which is more expensive than the insured deposit financing;

b) it raises the first factor at the left-hand side (LHS) of (15): an increase in the capital ratio reduces bank leverage, making banks safer and lowering the deposit rate.

Unless these two effects completely cancel out, the bank will respond by adjusting the loan volume and rates, in order to meet the participation constraint. The direction of such adjustments depends on which of these two effects dominates. If the effect on the RHS of (15) overweighs the effect on the LHS, in order to meet the participation constraint, banks will respond in a way to cause:

1. a downward movement in the RHS of (15): this can be achieved by reducing the volume of credit (in the model, by decreasing the amount b_t^e of each loan);

2. an upward movement in the factor in curly brackets at the LHS of (15): this can be achieved by raising the loan rate, if the verification cost that the bank faces in the case of borrower default is small enough.

In contrast, if the effect of a tighter capital regulation on the LHS of (15) outweighs the effect on the RHS, banks will respond in the opposite way, that is by offering more credit at better conditions for the borrowers. For low initial values of the capital ratio, the positive effect of a tightening of the capital requirement on bank solvency dominates, leading to an expansion of credit at lower rates. In contrast, for high initial values of the capital ratio, a tightening of the capital regulation will have a contractionary effect on credit (lower volumes and higher rates).

B Model calibration

Table 1: Calibration targets

Description	Model	Data
MEANS OR RATIOS		
TCR (%)	12.995	12.995
Share of borrowers (%)	44.4820	44.4820
Return on average bank equity (ROAE) (%)	6.0316	6.0316
Risk free rate (% ann.)	2.00	2.00
Write-off rate for HH loans (% ann.)	0.4683	0.2639
Write-off rate for NFC loans (% ann.)	2.4136	2.6399
HH loans to GDP (ratio)	0.8274	0.8270
NFC loans to GDP (ratio)	1.8626	1.8650
Housing Investment to GDP (ratio)	0.0325	0.0325
Borrowers housing wealth share	0.5124	0.5123
Spread HH loans (annualized)	0.0070	0.0140
Spread NFC loans (annualized)	0.0294	0.0253
Average Bank default - HH Bank (in %, annualized)	2.6946	2.9287
Average Bank default - NFC Bank (in %, annualized)	2.8431	2.9287
Leverage	0.4948	0.4922
STANDARD DEVIATIONS		
STD(House Prices)/STD (GDP)	2.5011	2.4850
STD(HH Loans)/STD (GDP)	2.7582	2.9896
STD(NFC Loans)/STD (GDP)	3.6566	4.9813
SD(HH Spread)/STD (GDP	0.0258	0.0318
STD(NFC Spread)/STD (GDP)	0.0424	0.0272
STD(GDP)	6.2863	5.7877
STD(Average Bank Default)	4.4456	4.8276

Table 2: Parameters Values

Description	Value	Description	Value
Borrowers to savers ratio (n_m)	0.8012	Capital Requirement (ϕ)	12.995
Dividend payout of bankers (χ_b)	0.0149	Risk weight on housing loan (τ)	0.5
Habit formation parameter	0.5	Depositor cost of bank default (γ)	0.00025
Disutility of labor (φ)	1	NFC bankruptcy cost (μ_e)	0.3
Frisch elasticity of labor (η)	1	HH bankruptcy cost (μ_m)	0.3
Capital share in production (α)	0.3	Bank H bankruptcy cost (μ_H)	0.3
Shocks Persistence (ρ)	0.9	Bank F bankruptcy cost (μ_F)	0.3
Discount factor savers (β_s)	0.995	Capital depreciation (δ_k)	0.03
Discount factor borrowers (β_m)	0.9811	Housing depreciation rate (δ_H)	0.01
Dividend payout of NFC (χ_e)	0.0343	Ratio of housing weight in borrowers/savers utility (v_m/v_s)	2.4035
Adjustment cost on Capital (ψ_e)	9.7400	Adjustment cost on Housing (ψ_h)	3.0374
STD iid. risk for NFC ($\tilde{\sigma}^{\omega_e}$)	0.4309	Bank Risk shock variance(σ_F^2)	6.9787
STD iid. risk for HH borrower ($\tilde{\sigma}^{\omega_m}$)	0.2427	Capital depreciation shock variance($\sigma_{\delta_k}^2$)	0.6363
STD iid. risk for HH bank ($\tilde{\sigma}^{\omega_H}$)	0.0273	Productivity shock variance(σ_A^2)	0.0167
STD iid. risk for NFC bank ($\tilde{\sigma}^{\omega_F}$)	0.0566	HH loans Risk shock variance(σ_m^2)	0.0475
NFC Risk shock variance(σ_e^2)	5.6735	Housing depreciation shock variance ($\sigma_{\delta_h}^2$)	0.5322